the Data plays for a year

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for Rahm --
you'll always have ten to me.

Here is some little tiny info that almost no one will read.
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INTRODUCTION: THE DATA PLAYS FOR A YEAR

Eric Robsky Huntley

*"**The city is not a computer.** This seems an obvious truth, but it is being challenged now (again) by technologists (and political actors) [...] Why should we care about debunking obviously false metaphors? It matters because the metaphors give rise to technical models, which inform design processes, which in turn shape knowledges and politics, not to mention material cities."*
– Shannon Mattern, "A City is Not a Computer"

"cities into the broadband models of smart justice minimum Administration design, And that 'Everything not connecting movement recognition The more I The Data plays for a year. negotiating and the difficult for Increase"
– A Multi-Layer Recurrent Neural Network trained on class participants' writing outputs.

The Numerate Fortune-Teller

In 1964, the University of Iceland's new computing center took delivery of an IBM 1620 Model II scientific computer, the purchase of which was financed largely by the Icelandic Development Bank.[1] On arrival, the machine corresponded to no word in the Icelandic language. In many language traditions, a loanword would suffice to describe the device. The Icelandic Language Council, however, enforced (and enforces) a fairly rigorous policy of linguistic purism, or what Ari Páll Kristinsson, past director of said council, more prosaically refers to as the 'Icelandic vocabulary tradition'. Since at least the 17th century it has been conventional that new technological and conceptual arrivals are challenges that can be met by old words recombined or repurposed.[2]

The task of naming the newly arrived device fell to Sigurður Nordal, a University of Iceland philologist, diplomat, author of major texts on Icelandic culture, sagas, and literature, as well as the former Charles Eliot Norton Professor of Poetry at Harvard University.[3] Nordal

1 *Magnus Magnusson, "The First Computers (Fyrstu Tölvurnar),"* ***Ský.is****, 2003, https://www.sky.is/index.php/20-faghopar/oeldungadeild/123-fyrstu-toelvurnar.*
2 *"The Strange Reinvention of Icelandic,"* ***The Economist****, December 19, 2017, https://www.economist.com/christmas-specials/2017/12/19/the-strange-reinvention-of-icelandic.*
3 *"Sigurður Nordal (1886–1974),"* ***The Árni Magnússon Institute of Icelandic Studies****, accessed December 17, 2018, http://www.arnastofnun.is/page/sigurdur_nordal_en.*

IBM 1620-II in the University of Iceland Computing Center, 1964. From left: Þórhallur M. Einarsson (IBM), Ragnar Ingimarsson, Helgi Sigvaldason, Oddur Benediktsson, and Magnús Magnússon. Reprinted from Magnusson 2003.

proposed a new portmanteau to describe the IBM machine. It would be a **tölva**, a portmanteau of **tala**—meaning 'number'—and **völva** - meaning 'fortune-teller.'[4] Computation was thus playfully tied to spiritualism and to prophecy, to futures and to numeracy. In this way, it became the case that to speak of computation in Icelandic is to speak of what is visible in numerical silhouette through the fog of the yet-unknown.

In the world that we now occupy—'we' here being shorthand for the relative elites of the colonizer nations—it is still the case that computation has the persistent sheen of the world-yet-to-come, alternatively u- and dystopian. We live in a moment of acute computational fervor that whiplashes between apocalyptic and messianic. It is not controversial to acknowledge the degree to which many actors in our milieu see salvation from our accumulated messes shimmering in the growth of the planet's computational carrying capacity and

4 John Charles Griffiths, **Modern Iceland** (London: Pall Mall Press, 1969); Birgit Brock-Utne, "The Growth of English for Academic Communication in the Nordic Countries," **International Review of Education** 47, nos. 3-4 (2001): 221–33, doi:10.1023/A:1017941523866.

in data-driven urban interventions built 'from the internet up' (in the language of Alphabet's Sidewalk Labs). This is the case even as a persistent drumbeat of leaks, inquiries, and push notifications strongly suggest that citizens, particularly citizens of color, can no longer realistically expect a life uncaptured and unprofiled when our social infrastructure is configured in the way that it is.[5]

However, we can also imagine and seek evidence of other possible computations; we can find examples of local ownership of community data centers, a decentralized web or an internet built differently, advocacy groups using data on individual interactions with firms, states, and others to demonstrate harm, or data deployed to effect emancipatory political change. We can also remember that as pervasive as the surveillant apparatus is, enormous infrastructural systems are subject to breakage. If we are surveilled from amorphous watchtowers in the cloud, these are often staffed by fallible fortune-tellers; numerate fortune-tellers that sometimes aid and sometimes foil the scientific manager. Which is not to say that the situation any less dire; only that we'll find no way forward in the thicket of careless determinism.

Thus, somewhere in between the apocalyptic and salvific, it surely must be possible to locate an image of urban computation that is more open for action and intervention—in other words, something a bit more realistic. We might a 'stubbornly realist attitude' in Latour's neo-pragmatic parlance.[6] We might adopt strong objectivity, in Harding's feminist analysis,[7] that remembers the situatedness of its knowledge, as in Haraway and those writing in her wake.[8] A 'tech-

5 Simone Browne, **Dark Matters: On the Surveillance of Blackness** (Durham: Duke University Press, 2015); Joy Buolamwini and Timnit Gebru, "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification," in **Conference on Fairness, Accountability and Transparency**, 2018, 77–91, http://proceedings.mlr.press/v81/buolamwini18a.html; Virginia Eubanks, **Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor** (New York: St. Martin's Press, 2018); Emily Kaufman, "Policing Mobilities Through Bio-Spatial Profiling in New York City," **Political Geography** 55 (2016): 72–81, doi:10.1016/j.polgeo.2016.07.006.

6 Bruno Latour, "Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern," **Critical Inquiry** 30, no. 2 (2004): 225–48, doi:10.1086/421123.

7 Sandra Harding, "After the Neutrality Ideal: Science, Politics, and "Strong Objectivity"," **Social Research** 59, no. 3 (1992): 567–87.

8 Donna J. Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," **Feminist Studies** 14, no. 3 (1988): 575–99, doi:10.2307/3178066; Catherine

nopositional' stance.[9] Can urbanists and technologists take computation seriously—which is to say avoid giving into to the twinned perils of technophobia and technophilia? Can we better 'care for the subject,'[10], willing and able to give it our attention.[11] This collection of essays articulates a hopeful and critical 'yes', staking out a position that is simultaneously optimistic about the affordances and critically attuned to the problematics of algorithmic life, big data, new spatial media, smart cities, and environmental monitoring.

Disciplinary Futures

Such a stance is demanded by changes within our institution. In June of this past summer, MIT's Department of Urban Studies and Planning announced the launch of a new undergraduate major in 'urban science.'[12] *Wired* was predictably excited. "It is not so often that a major university like the Massachusetts Institute of Technology discovers a new kind of science." Over a breathless three pages describing the possibilities of urban science, urban informatics, and spatial science, Aarian Marshall traces a 'budding discipline' through the office spaces of the Bay Area and the halls of government where a shared agenda is emerging around how to leverage big spatial data to fill political imaginations, server farms, and coffers at one and the same time.[13]

The MIT DUSP Twitter account sunnily shared the article, quoting the article's lede, which was also its hubristic peak: 'a new kind of science.'[14] Academic Twitter was predictably unamused.[15] Carrie Mott (@mott_carrie), a geographer at the University of Louisville, asks: "Did you not realize there is an entire field called urban geography? This is nothing new..." Renee Sieber (@re_sieber), a GIScientist at McGill University, wields Rittel and Webber:[16] "'Hello MIT, I'd like to introduce to wicked problems...' Also, urban science–the marriage of politics to civic processes–is not novel–see NYU."[17]

Of course, it was June; high time for academics to manufacture controversies that might distract from their frustrating inability to meet writing goals that seemed so realistic in May. (What's that? Who's projecting?) Furthermore, criticizing an academic program for being ahistorical on the basis of an article in a magazine renowned for its self-parodic ahistoricism hardly seems fair.[18] Finally, couldn't we reasonably respond that it is more than a bit nonsensical to treat the positions of an academic department's Twitter account as equivalent to those held by its faculty? Let they whose department would not share and retweet cast the first stone.

But words have power, particularly when tied to institutions, and I would argue that we have a responsibility to our critics. Words have power to reshape disciplinary discourse, funding priorities, methodological allowances, pedagogical approaches, and the like. This is, of course, not automatic—witness the difficulty with which a brief 'quantitative revolution' emerged within human geography in the 1960s, piecemeal and contested[19] or the periodic flourishing and subsequent periodic decline of urban modeling in planning discourse.[20] MIT, though, is somewhat unusual in its ability to usurp

*D'Ignazio and Lauren F Klein, "Feminist Data Visualization," **IEEE Vis Conference**, 2016.*

9 *Matthew W. Wilson, "Towards a Genealogy of Qualitative GIS," in **Qualitative GIS**, ed. Meghan Cope (London: SAGE, 2009), 156–70.*

10 *Nadine Schuurman and Geraldine Pratt, "Care of the Subject: Feminism and Critiques of GIS," **Gender, Place and Culture** 9, no. 3 (2002): 291–99, doi:10.1080/0966369022000003905.*

11 *Matthew W. Wilson, **New Lines: Critical GIS and the Trouble of the Map** (Minneapolis: University of Minnesota Press, 2017).*

12 *"MIT Faculty Approves New Urban Science Major," **MIT News**, June 25, 2018, https://news.mit.edu/2018/mit-faculty-approves-new-urban-science-major-0605.*

13 *Aarian Marshall, "Cities Are Watching You—Urban Sciences Graduates Watch Back," **Wired**, accessed September 4, 2018, https://www.wired.com/story/mit-urban-sciences-program/.*

14 *MIT Urban Planning, "It Is Not so Often..." Tweet, **@MITdusp**, (June 25, 2018), https://twitter.com/MITdusp/status/1011321765212164104.*

15 *I thank my colleague and friend, Jessa Loomis of Clark University, for bringing this to my attention.*

16 *"Dilemmas in a General Theory of Planning," **Policy Sciences** 4 (1971): 155–69.*

17 *Carrie Mott, "Did You Not Realize..." **@Mott_carrie**, June 30, 2018, https://twitter.com/mott_carrie/status/1013256677599084546; Renee Sieber, "Hello MIT..." **@Re_sieber**, June 28, 2018, https://twitter.com/re_sieber/status/1012384579100037120.*

18 *Thomas Streeter, "The Moment of Wired," **Critical Inquiry**, 2015, doi:10.1086/444514; see also an issues of **Dialogues in Human Geography** edited by Mark Graham and Taylor Shelton, "Geography and the Future of Big Data, Big Data and the Future of Geography," **Dialogues in Human Geography** 3, no. 3 (2013): 255–61.*

19 *Trevor J. Barnes, "Placing Ideas: Genius Loci, Heterotopia and Geography's Quantitative Revolution," **Progress in Human Geography** 28, no. 5 (2004): 565–95, doi:10.1191/0309132504ph506oa; David O'Sullivan, Luke Bergmann, and Jim E. Thatcher, "Spatiality, Maps, and Mathematics in Critical Human Geography: Toward a Repetition with Difference," **The Professional Geographer** 70, no. 1 (2018): 129–39, doi:10.1080/00330124.2017.1326081.*

20 *Douglas Lee, "1973_Douglas Lee.Pdf," **Journal of the American Institute of Planners** 39, no. 3 (1973): 163–78; Brendan Gleeson,*

disciplinary norms. We could point to the MIT planning department known by Donald Schon, and the disciplinary influence of his insistence on reflexive ethics in practice.[21] Or we could point, more recently, to its realization of the seemingly impossible: seeing its sociology department skyrocket to the top of a *Center for Public Anthropology* ranking of "Faculty Media Impact": this was in spite of the fact that MIT has no sociology department.[22]

The point is that within an institution holding unusual clout, we have a responsibility to hear our critics and to remember our history. We have been here before; this is demonstrated by histories of urban media[23] and urban computational expertise[24]... though, as usual, 'here' is different than it once was. Frederic Jameson's somewhat paradoxical reminder to 'always historicize'[25] cannot be taken to imply that historicizing always makes the same demands.[26] It does not imply that the present always looks the same in the light of history. But it does suggest that history might be the best method for insuring that a turn towards urban science does not erode our commitment tothen anti-technocratic politics that is the planning discipline's hardest-won inheritance from the second half of the twentieth century (even if the victory was always far from complete).

Seminars and Slowness

This mess of words before you is the product of one semester spent taking time to remember our history and think through the implications of the work we do. We gathered together in a space structured according to the hoariest academic format: the seminar. We took as our starting point Shannon Mattern's essay 'A City is Not a Computer,' which analyzes the most recent renewal of computational language in city planning and professional urbanism, placing it in a longer (and medially far richer) historical arc.[27] Beyond the nevertheless important reminder that what appears new rarely is, Mattern's piece holds that responsible political life keeps in mind **both** the frailty and the force of its models. "[The practice of debunking metaphors] matters because the metaphors give rise to technical models, which inform design processes, which in turn shape knowledges and politics, not to mention material cities."[28] Obviously false, but nevertheless effectual. Our words matter and materialize. And our descriptions of our actions, of our disciplines, and of our projects are not innocent or inactive. Describing the world in a certain way can make it so. Holding a statement to be true has effects.[29] Describing populations makes new people.[30] Creating a category changes the world.[31] Describing our cities computationally has a way of orienting our practices of governance and design towards calculability.

In short, we spent half of an academic year repeatedly encountering the confounding problem that our technologies are both less efficacious than the technologist would have us believe, and far more impactful than the scientist would represent. Our technologies are both **powerful** and ***inadequate***, having effects even as these are not equivalent to their inputs.[32] Given the wide remit of this animating problematic, it should not be a surprise that the essays and projects cover a great deal of ground, drawing on primary source research, visual and archival methods, and a broad collection of theoretical

"What Role for Social Science in the 'Urban Age'?" ***International Journal of Urban and Regional Research*** *37, no. 5 (2013): 1839–51, doi:10.1111/1468-2427.12058.*

21 *Donald A. Schon,* ***The Reflective Practitioner: How Professionals Think in Action*** *(New York: Basic Books, 1984).*

22 *Kieran Healy, "MIT Sociology,"* ***Kieran Healy****, October 8, 2013, https://kieranhealy.org/blog/archives/2013/10/08/mit-sociology/; Dan Berrett, "The New Rankings Frontier: Mentions in the Media,"* ***The Chronicle of Higher Education****, October 8, 2013, https://www.chronicle.com/article/The-New-Rankings-Frontier-/142197.*

23 *Shannon Christine Mattern,* ***Code + Clay... Data + Dirt: Five Thousand Years of Urban Media*** *(Minneapolis: University of Minnesota Press, 2017).*

24 *Jennifer S. Light,* ***From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America*** *(Baltimore: Johns Hopkins University Press, 2003).*

25 *Frederic Jameson,* ***The Political Unconscious: Narrative as Socially Symbolic Act*** *(Ithaca: Cornell University Press, 1981).*

26 *Rita Felski,* ***The Limits of Critique*** *(Chicago: University Of Chicago Press, 2015).*

27 *Indeed, I borrowed the title of the seminar from this article, finding in my own reserves no better means of articulating the problem.*

28 *Shannon Mattern, "A City Is Not a Computer,"* ***Places Journal****, 2017, doi:10.22269/170207, n.p.*

29 *John Dewey,* ***The Quest for Certainty: A Study of the Relation of Knowledge and Action****, Gifford Lectures (New York: Minton, Balch & Co., 1929).*

30 *Michel Foucault,* ***Security, Territory, Population: Lectures at the Collège de France, 1977–1978****, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2007); Ian Hacking,* ***Historical Ontology*** *(Cambridge: Harvard University Press, 2004).*

31 *Geoffrey C. Bowker and Susan Leigh Star,* ***Sorting Things Out: Classification and Its Consequences*** *(Cambridge: The MIT Press, 2000).*

32 *Matthew W. Wilson, "Map the Trace,"* ***ACME*** *13, no. 4 (2014): 583–85.*

resources and case studies drawn from human geography, science and technology studies, and cultural theory.

- **Daniel Engelberg** presents us with a social and legal history of land use and transportation interaction models, arguing that we can look to their presence in the legal record for evidence that boundary objects provide usefully shifting ground for conflict and contestation.
- **Adrianna Boghozian** examines citizen sensing and mobile alert systems, engaging with questions of attention and efficacy to articulate a vision for dispersed alert systems that meaningfully shift individual action in response to environmental hazards.
- **Jay Dev** seeks to distill a framework for meaningful participation into parts of the data life cycle that often go untouched by discourses of democratization–namely, analysis–teasing out wisdom from case studies and aligned disciplinary experiments in participatory methods.
- **Maia Woluchem** asks after the alternative ontologies enabled by legislative and policy change, subsequently asking the more difficult question: even when categories change our political imagination, how are these imaginations constrained by the power to make information actionable?
- **Arianna Salazar Miranda** creates a graphic representation of the professional networks growing up around cybernetic expertise, particularly as its influence began to infiltrate the design disciplines in the postwar era.
- **Agnes Cameron** issues something of an ethical manifesto for computational care, arguing that the internet could be more like a garden - something to tend, maintain, and attend to by cultivating its idiosyncratic places as objects of care.
- **Dylan Halpern** constructs an index of contemporary motifs for our pervasively mediated and monitored present, producing a suggestive diagram of our discourse that rearticulates common and uncommon language in an effort to make it slightly stranger and more hyperactive in its associations.

These essays, taken together, should remind us of both the peril and the prospect of urban computation, its history and its present, its power and its fragility. As Daston and Galison remind us, to place modes of knowledge production in a historical context is not to suggest that they produce falsehoods or idealogical masks; it is to grant them a richer life in our political and disciplinary imaginations, to allow us to be differently responsible to their maintenance and care.[33]

Conclusion

At the end of the semester, I placed all of the writing produced by seminar participants into a training dataset and fed it to a neural network. The title of this volume, and of this short essay, is drawn from a passage produced by a machine doing its best impression of our work together. The training dataset was relatively small (37,732 words), so forgive its difficulty with the rules of grammar and punctuation. I draw it because I hold it to be evocative of what is at stake. Data plays… and plays out. Louise Amoore points out that though debates around 'big data', 'dataveillance', and the like tend to cluster around the language of privacy, violations of this type are not the greatest danger. Rather, it is that decisions are made on the basis of poor models constructed from discriminatory representations of individual actions. It's not the individual that is the target of contemporary surveillance; it is the dividual, the data derivative, the shadow of the self that governing bodies create - data left to play.[34]
On the other hand, play is, I'd like to think, a good working description of our time together this semester. We rolled ideas back and forth; we dared to toss around fragile concepts; we gave notions time and space to wander; we toyed with textual evidence (which, lest we forget, is data, too), evaluating arguments for and against the efficacy of computational methods in the urban disciplines. If only for two hours every week, we allowed ourselves a bit of slowness in which our current moment could play with the past. We thought about how we might enact our projects differently having taken a longer view than often feels permitted within the professionalized university (or to succumb to a critical-theoretical temptation: the neoliberal university). The Data plays for a day, and my hope is that this play reverberates; at the very least, we take the step of recording it in this artifact, an archive of positions taken during a small amount of time spent pausing and playing, together.

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33 *Lorraine J. Daston and Peter Galison,* ***Objectivity*** *(New York: Zone Books, 2010).*
34 *Louise Amoore,* ***The Politics of Possibility: Risk and Security Beyond Probability*** *(Durham: Duke University Press, 2013); Gilles Deleuze, "Postscript on the Societies of Control,"* ***October*** *59, no. Winter (1992): 3–7.*

MODEL AS BOUNDARY OBJECT: COMMUNICATION AND CONTESTATION

Daniel Engelberg

Keywords:
Boundary Objects, Land Use Modeling, Urban Modeling, Negotiation, Clean Air Act, Transportation Planning

Douglas Lee's 1973 academic masterpiece *Requiem for a Large Scale Model*[1] has been credited for the nearly two decade retreat in large scale urban modeling. Introduced with an Alice in Wonderland‡ and sprinkled with John Tenniel llustrations from the original Alice publishing, the article itself is a logical and technical argument for why large scale models have failed to achieve their stated goals and why there is reason to believe that they never will achieve such goals. Where a generation of would be land use modelers failed to revive their trade by countering the specific arguments presented in Requiem, social and political events beyond the academy set the groundwork for the eventual reemergence of land use modeling. The 1977 Clean Air Act Amendments (1977 CAAA) set the course for later legal action, *Citizens for a Better Environment v. Deukmejan et al* (*Citizens v. Deukmejan*), which would enshrine the social and legal importance of land use models. It is the intention of this paper to demonstrate how land use and transportation interaction (LUTI) models are deeply embedded within and influenced by social and political requirements.

My story is inspired in part by Jennifer Light's *Welfare to Warfare*, which documents the emergence of military contractors and associated approaches for decision making within the urban realm. Among other tools, organizations such as RAND brought with them simulation modeling as an approach for understanding complex dynamic systems. This history put much of my own research using land use models into a new light.

Consider Ira Lowry. One of the servers I worked on at the University of Maryland is playfully named Lowry in recognition of his pioneering work in urban systems modeling. Light's book also highlights his role as a RAND consultant and employee who brought military computer simulation to planning and helped to forge linkages between the two worlds. Light's research highlights the manner in which models served the social interest of assembled parties:

> *Defense and aerospace executives and engineers found new employment as consultants to cities and federal urban programs. Think tanks and aerospace companies found new civil systems contracts. University scholars found military sponsorship for urban research. City administrators, both Democrats and Republicans, found new approaches to management. Yet average city dwellers found few visible effects.*
> *Jennifer Light 2003, pg. 8*

1 *Douglas Lee, "1973_Douglas Lee.Pdf,"* ***Journal of the American Institute of Planners*** *39, no. 3 (1973): 163–78.*

Though my own study puts aside Light's argument regarding the effectiveness of modeling efforts, my story picks up, in many ways, where Welfare to Warfare left off. Where Light explains the social interests at play in the initial emergence of urban simulation modeling, from the early 1960s to the 1970s, I intend to similarly account for the specific social interests at play in its later reemergence in the 1990s.

In placing LUTI models into the social circumstances, I employ the concept of boundary objects as developed in the discipline of science and technology studies (STS). Boundary objects are "those scientific objects which both inhabit several intersecting social worlds… and satisfy the informational requirements of each of them."[2] Such objects have different meaning to each social group involved, but nonetheless allow for communication between groups. The existing literature on boundary objects has focused primarily on their use in voluntary cooperation between parties that recognize aligning interest. The case of LUTI models, however, introduces their potential as a device to facilitate negotiation between antagonistic parties. Working with the models as boundary object, I will also utilize the concept of a broker, a person or group of people charged with facilitating communication.[3] Though boundary objects are collective social constructions, Brokers often play outsized roles in their contour.[4] Predicting the demise of land use modeling was indeed premature. As I will show, LUTI models have secured their place for future development and articulation not via abstract scientific value but via their specific value as boundary objects. In the next section, I will review the literature on boundary objects, indicating that they have not yet been sufficiently explored as tools for negotiation. Subsequently, I

2 *Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39,"* ***Social Studies of Science*** *19, no. 3 (August 1989): 387–420, doi:10.1177/030631289019003001.*

3 *John Seely Brown and Paul Duguid, "Orgazing Knowledge,"* ***California Management Review*** *40, no. 3 (1998): 90–110.*

4 *Chris Kimble, Corinne Grenier, and Karine Goglio-Primard, "Innovation and Knowledge Sharing Across Professional Boundaries: Political Interplay Between Boundary Objects and Brokers,"* ***International Journal of Information Management*** *30, no. 5 (2010): 437–44.*

introduce the *Citizens v. Deukmejan* court case and review the role it played in the future of urban modeling. Finally, I draw conclusions about the power of models generate claims of authority and exclusion, but also provide points for contesting such exclusion.
Before exploring the literature on boundary objects, it will be helpful to further explain what LUTI models are so as to highlight their potential as boundary objects. Travel demand models, built initially in the 1950s for highway network planning, project overall regional transportation demand utilizing projections of regional household and employment growth, then translate that demand into actual network use. As actually built highways filled up faster than expected, some planners and engineers realized that highways fundamentally changed the structure of demand by making development in far away locations more attractive. Starting with the Lowry models in the 1960s, modelers developed land use components that provided transportation-sensitive projections of land use. Since their inception, the models have become more realistic and grounded in economic and sociological theory.[5]
Though often black boxes that take hours to run, their very complexity allows for multiple points of communication. Where one might declare a simpler model wholly right or wholly wrong, LUTI models provide a flexible platform to contest various elements of the real system by way of reference to its digital representation.[6]

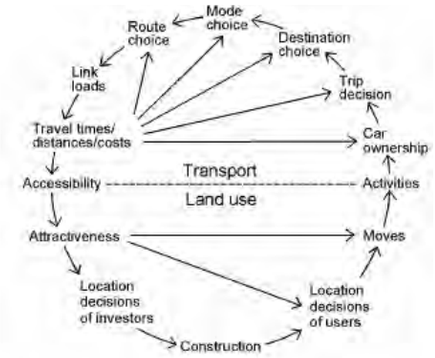


Figure 1. The 'land-use transport feedback cycle'.

Boundary Objects and Their Use

Star and Griesemer introduce boundary objects to deal with the problem of scientific cooperation among groups with different viewpoints yet aligning interests. Their work builds on the actor-network theory of Callon, Law, and Latour, which explains how scientific progress requires the recruitment of a wide variety of both human and non-human actors.[7] What interests Star and Griesemer is how so many parties might be brought to cooperate in the scientific endeavor given that the direct interests of scientists, such as the generation of new academic theories and papers, often does not align with those of their allies. They thus propose boundary objects as essential, collectively constructed tools for facilitating communication. Boundary objects are flexible for social use but strongly structured within the context of a specific social group.

Star and Griesemer illustrate how standardizing collecting procedures at the nascent Museum of Vertebrate Geology acted as boundary object, allowing all parties to advance their own social aims while serving functions that enhance the research goals and authority of the Museum.[8] Joseph Grinnell, the museum's first director, acquired specimens of sufficient quality and documentation to develop his evolutionary biology hypothesis. Annie Alexander, the museum's backer built a collection to demonstrate the potential of conservation and garner greater support for it amongst the public. The University promoted its reputation as it sought national recognition, amateur collectors sought to legitimize their efforts and interest in conservation, and trappers sought a new, well-defined market. With reference to standardized collecting procedures, the various communities could align their efforts, the advancement of science complimenting their own personal aims.

The concept of a 'boundary object' encounters that of 'broker,' a party tasked with facilitating communication among cooperating groups.[9] Brokers are most effective when their social interest aligns with the declared goal of the larger project. Guiding the creation of boundary objects is an effective means for a broker to facilitate communication

5 *Michael Wegener and Franz Fuerst, "Land-Use Transport Interaction: State of the Art,"* ***SSRN Electronic Journal****, 2004, doi:10.2139/ssrn.1434678.*
6 *Ibid.*

7 *Michael Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay," in* ***Power, Action, and Belief, Sociological Review Monograph****, ed. John Law, 32 (London: Routlage & Kegan Paul, 1985), 196–230; John Law, "Technology, Closure and Heterogeneous Engineering: The Case of Portuguese Expansion," in* ***Social Construction of Technological Systems****, ed. Wiebe Bijker, Trevor Pinch, and Thomas P. Hughs (Cambridge: MIT Press, 1987), 111–34; Bruno Latour,* ***The Pasturization of French Society*** *(Cambridge: Harvard University Press, 1988; Bruno Latour,* ***The Pasturization of French Society*** *(Cambridge: Harvard University Press, 1988).*
8 *Star and Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects."*
9 *Brown and Duguid, "Orgazing Knowledge."*

when parties agree on the potential of cooperation.[10] Kimble et al elucidates broker guided boundary objects with examples from the development of a content management system and a health care network in France, emphasizing that brokers are most effective when their social interest aligns with the goals of the collective endeavor. Much of the literature on boundary objects has drawn from situations in which they either served to harmonize desperate parties in the collective endeavor or allow parallel groups to utilize related technology. In Star and Griesemer, the museum president acts as a broker–carefully crafting procedures to align disparate parties to their interest.[11] Kimble et al. describes two situations in which groups knew that the rewards of communication were worth the difficulties, as exemplified by the establishment of a health network to seek federal funding.[12] In a study of GIS technology, Harvey and Chrisman argue that individual planning agencies work in parallel but have a shared interest in technological claims to authority.[13]

The case of LUTI models will demonstrate their use as boundary objects in cooperative settings but also their use in the combative environment of the courtroom. I look to Harvey et al.: "[t]his constructed arrangement provides coherence for multiple participants and plays out various forms of power relations. The arrangement simultaneously includes some groups and excludes others"[14] (pg. 1687). The parties present in the creation of boundary objects pursue these exclusions intentionally, in an effort to create defensive barriers around valued forms of expertise or favored paradigms. Credentials within professional fields provides an example. As boundary objects between government and practitioners, the government establishes means to ensure quality and hold practitioners accountable. In exchange, the professionals receive official recognition and exclusion of competing practices.

The use of boundary objects in the creation of new boundaries also

10 *Kimble, Grenier, and Goglio-Primard, "Innovation and Knowledge Sharing Across Professional Boundaries."*
11 *Star and Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects."*
12 *Kimble, Grenier, and Goglio-Primard, "Innovation and Knowledge Sharing Across Professional Boundaries."*
13 *F Harvey and N Chrisman, "Boundary Objects and the Social Construction of GIS Technology,"* ***Environment and Planning A*** *30, no. 9 (1998): 1683–94.*
14 *Ibid.*

places those objects in precarious social and, as in my case, legal positions. In order to attack the exclusionary structure, outside parties can attack the boundary object. If the outsider community succeeds in upsetting the existing scientific and social alliances, they are again left with a situation of challenged communication between parties. This might lead to the generation of new boundary objects or the redefinition of old ones such that they provide grounds for including the new community. The case presented here is an example of the latter.

Citizens for a Better Environment v. Deukmejan et al

The 1977 Clean Air Act Amendments (1997 CAAA) is an unlikely ally of LUTI modeling. The 1977 CAAA does not explicitly direct any party to consider the implications of land use on air quality. However, following on building concern with growing air pollution from the transportation sector, the 1977 CAAA instructed the Environmental Protection Agency, the Department of Urban Development, and State and local officials to produce guidelines. This required enhanced methods to identify and evaluate alternative pollution control measures.[15]

In total, the 1977 CAAA set air quality standards and required that states develop plans for both stationary and transportation-related sources. This allowed leeway for local governments to develop their own pathways towards compliance so long as they demonstrated their capability to meet the standards. Within the transportation sector, Metropolitan Planning Organizations (MPOs), as the federally designated regional transportation planning authority, adopted much of the responsibility for planning. The 1990 Clean Air Act Amendments (1991 CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) would expand and place more teeth into these requirements, but by that time, *Citizens v. Deukmejan* had already established the enforceability of such standards and centralized the role of modeling in such work.[16]

15 ***Clean Air Act Amendments of 1977, 91 Stat. 685,*** *1977.*
16 *Mark Garrett and Martin Wachs,* ***Transportation Planning on Trial: The Clean Air Act and Travel Forecasting*** *(Thousand Oaks, Calif: Sage Publications, 1996);* ***Clean Air Act Amendments of 1977.***

TRANSPORTATION PLANNING AND GUIDELINES

SEC. 105. Section 108 of the Clean Air Act is amended by adding the following new subsections at the end thereof: Federal, State, and local agencies, consultation. Publication.

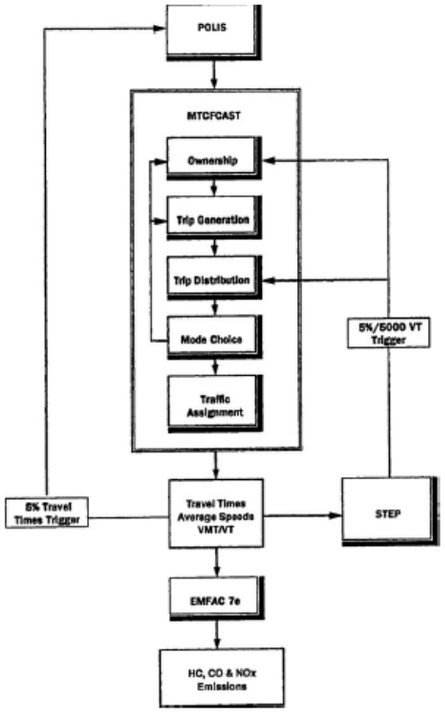
"(e) The Administrator shall, after consultation with the Secretary of Transportation and the Secretary of Housing and Urban Development and State and local officials and within 180 days after the enactment of this subsection, and from time to time thereafter, publish guidelines on the basic program elements for the planning process assisted under section 175 of part D. Such guidelines shall include information on— *Post*, p. 746.

"(1) methods to identify and evaluate alternative planning and control activities; Contents.

Though land use modeling had largely retreated to academic circles, large scale modeling of the transportation sector (as promoted within engineering) had continued unabated.[17‡‡] Regional MPOs had been utilizing models to assess the performance of proposed highway networks. With the 1977 CAAA requiring assessment of air quality impacts from the transportation sector, MPOs reasonably built extensions of their existing tools rather than building new models. These extensions assumed fleet composition to determine emissions coefficients and applied them to the traffic flow outputs of four step transportation models.[18] These models provided MPOs with lower-cost solutions to their new planning and compliance requirements, while conferring the EPA and other agencies a semi-standardized means to assess the planning taking place.

This arrangement proved perilous when many regions failed to meet air quality standards. Emissions from the transportation sector were increasing in spite of state requirements for cleaner vehicles. In this context, two lawsuits were brought against the parties responsible for air quality in the Bay Area: 1) the aforementioned *Citizens v. Deukmejan* and 2) *Sierra Club v Metropolitan Transportation Commission, et al* which was eventually rolled into *Citizens v. Deukmejan* by the presiding Judge Theodore T. Henderson. Though there were multiple issues in the case, I will focus in on the role of the transportation model run by the Metropolitan Planning Commission (MTC), the local MPO.

The Sierra Club raised three central contentions. First, that the existing modeling procedure only projected emissions at a single end date and that was insufficient to ensure continuous drawdown in emissions. Second, they reasoned that conformity should be assessed on a project basis relative to absolute reduction required rather at the network level relative to the 'business as usual' future. Finally, they argued that the Projective Optimization Land Use Information System (POLIS) model in use by the MTC did not fully account for the impacts of new transportation infrastructure. In response, the MTC argued that the first requirement would prove too arduous, that project-based assessment is meaningless, and that POLIS provided sufficient assessment of land use impacts via travel time feedbacks. Given the technical, model-specific issues raised by the plaintiff, Judge Henderson took an unusual interest in the substance of the model, requesting court appointed transportation planning expert Martin Wachs, to aid in the negotiating a new modeling approach.[19]



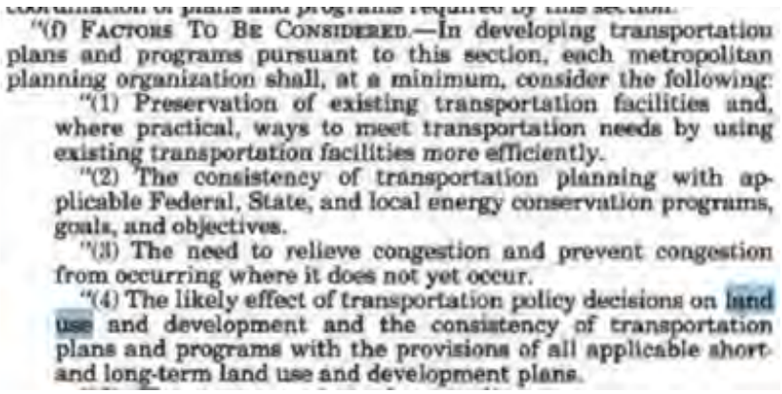
The judge ordered the parties to settle on the future of Bay Area transportation modeling and each side requisitioned the support of transportation modeling experts to support their case. More specifically on the topic of land use, the hired transportation expert for the Sierra Club, Dr. Peter Stopher, argued that the procedures embedded in the POLIS model did not account for the latent demand, trips not taken because the model did not adjust for overall travel demand changes, and would thus underestimate inter and intra urban household location changes due to the convenience or inconvenience of the transportation network. The MTC expert, Harvey Supp, countered that there existed no proof that changes in transportation network impacted overall growth levels and that no such model existed in practice to determine such impacts.[20]

The negotiated settlement did not require that the MTC adjust its procedures for modeling land use but the court did acknowledge

17 *Wegener and Fuerst, "Land-Use Transport Interaction."*
18 *Garrett and Wachs, Transportation Planning on Trial.*
19 *Ibid.*
20 *Ibid.*

land use as a legitimate matter of transportation and emissions planning. National decision makers took notice and incorporated the linkage into the ISTEA, which addresses land use and transportation together at thirteen times throughout the legislation, making clear the requirement to include it in planning, and hence modeling. The federal government also established the Transportation Model Improvement Program with land use modeling included as a primary component.

Though Judge Henderson's written ruling does not mention the model methodology directly, his power to guide to judicial process affirms transportation modeling as the means for evaluating compliance with plans. Further, the judge could have ruled on the legal merits of the plan outside of the modeling framework, but decided to make an issue of the technical details, thus forcing parties to move towards consensus on a modeling framework. The ruling went so far as to threaten the delay of major transportation projects should projections indicate that they will fail air quality standards, thus implicating the essential importance of determining how the modeling must take place.[21]


"(f) FACTORS TO BE CONSIDERED.—In developing transportation plans and programs pursuant to this section, each metropolitan planning organization shall, at a minimum, consider the following:

"(1) Preservation of existing transportation facilities and, where practical, ways to meet transportation needs by using existing transportation facilities more efficiently.

"(2) The consistency of transportation planning with applicable Federal, State, and local energy conservation programs, goals, and objectives.

"(3) The need to relieve congestion and prevent congestion from occurring where it does not yet occur.

"(4) The likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans.

LUTI Models and Contested Boundary Objects

Before returning to the role of the transportation model within *Citizens v. Deukmejan*, it's important to emphasize that the model already existed as a boundary object. In fact the model had two prior lives. Before the 1977 CAAA, the MTC had developed a four-step

21 *Intermodal Surface Transportation and Efficiency Act of 1991, 105 Stat. 1914, 1991.*

transportation model for highway planning. This model served as boundary object between the MTC, other regional agencies, and the US Department of Transportation (USDOT). Without denying that the model may have provided decision makers with some real analytic power, I note that the model lends authority to MTC decisions while providing the USDOT a standardized but flexible framework for assessing the transportation investment intentions of states and regions.

When the 1977 CAAA arrived, the MTC had good reason for adopting a similar approach in their relationship with the EPA. In fact, they argued in court that the transportation plans approved by the EPA be thought of as guidelines, not requirements. This aligned with planning approaches of the day and also expresses the necessary relationship between large scale transportation models of that vintage and the plans modeled through them. In the second life of the transportation model the EPA became a partner as well. Just at with USDOT, the model provided a common ground to facilitate oversite. Model-enhanced claims of expertise can be used towards exclusionary ends. By utilizing a complex 'black box' model, MTC and MPOs around the country buttressed the argument that transportation planning is too complex for lay oversight. USDOT and EPA approval in the use of the model further justifies such exclusivity. This all implies that any failure and future improvements are matters to be negotiated between the EPA and MPOs. In fact, the EPA had already declared the Bay Area out of compliance and was in the process of developing guidelines for a new plan.The MTC frequently referenced this development in court, claiming that the citizen groups were interfering with an ongoing process.[22]

Building claims of authority on a boundary object also provides a leverage point which outsider communities may target to bring themselves into conversation. In targeting the model, the plaintiffs targeted an object through which they could express claims grounded by common understanding. Arguments regarding how the model ought to work or how results should be interpreted demonstrate an attempt to establish communication in a location that allows for clear negotiation and resolution. The judge and Martin Wachs acted as specially selected brokers. By the conclusion of the case the judge was adjudicating the future of a LUTI model in order to address the

22 *Garrett and Wachs, Transportation Planning on Trial.*

future of transportation emissions management.

We see a LUTI model (as boundary object) acting as a tool for negotiation rather than collaboration. The tool still serves the purposes of communication; however, rather than simply translating the viewpoints into a flexible object of interest, it translates demands. Arguing for the model to better simulate the impacts of transportation on the locations of households is more compelling and graspable for the MTC than vague accusations of failure to consider land use. In the actual structures of model simulation, the plaintiffs can make clear exactly the manner in which they understand this relationship. This will never fully reconcile perspectives but the model provides a text which both parties can read and edit.

The role of a broker changes in such a setting. When brokers are expected to foster collaboration, it is sufficient to find an individual within the social arrangement whose personal goals are largely aligned with the collective goals that brought groups together. In the case of negotiation, a trusted broker must occupy a presumably disinterested role. While the plaintiffs attacked the original use of the model as a boundary object, they were able to use it constructively in negotiation once the judge took up the task of facilitating changes to its form.

Conclusions

In the conclusion of the case, the plaintiffs, the MTC, and the judge negotiated changes to the transportation model, but this didn't include adjustments to the land use component. The subsequent enactment of the ISTEA and the creation of the Transportation Model Improvement Program, nonetheless, make it clear that the plaintiffs were successful in demanding that transportation and emissions planning better account for the feedback between transportation and land use. This led to a rebirth in LUTI modeling and, of course, many new boundary object LUTI models facilitating communications between MPOs, federal agencies, and (one also hopes) engaged citizens.

At a broader level *Citizens v. Deukmejan* presented a different potential for boundary objects: they can translate not only amicable conversations amongst allies but also demands and counterarguments amongst competing parties. When parties remain far apart or have incompatible perspectives, they might turn to boundary objects to engage in a proxy war. Complex computational models provide an excellent object for such a negotiation because they allow parties to discuss the system in question without actually talking about the system – to be specific in complaints when actually discussing abstraction. If LUTI modelers feel threatened by the ghosts of Lee, they should feel assured that their tools will likely remain socially useful without reference to their accuracy.

Endnotes

‡ "That is not said right," said the Caterpillar. "Not quite right, I'm afraid," said Alice, timidly, "some of the words have got altered." "It is wrong from beginning to end," said the Caterpillar, decidedly, and there was silence for some minutes Alice in Wonderland Ch. V. Advice from a Caterpillar, Lewis Carroll

‡‡ Douglas Lee's seminal paper indicates that he had been working on a land use model in the San Francisco Bay Area, where Citizens v. Deukmejan et al case would question land use modelling procedures

ALERT! THE POTENTIAL BEHAVIORAL EFFECTS OF ENVIRONMENTAL CITIZEN-SENSING INITIATIVES

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Keywords:
Air Quality, Sensors, Alert, Behavior

In the next century, planet earth will don an electronic skin. It will use the Internet as a scaffold to support and transmit its sensations. This skin is already being stitched together. It consists of millions of embedded electronic measuring devices: thermostats, pressure gauges, pollution detectors, cameras, microphones, glucose sensors, EKG's, electroencephalographs. These will probe and monitor cities and endangered species, the atmosphere, our ships, highways and fleets of trucks, our conversations, our bodies–even our dreams.

— Neil Gross, 1999, on the Internet of Things[1]

In the almost twenty years since Neil Gross's prediction, society has made significant progress towards bringing the highly connected world he summarized into reality. The ubiquity of low-cost digital technologies has in many ways democratized the collection of environmental data, enabling everyone from data scientists to concerned citizens to monitor what was previously only in the purview of the government. According to Shannon Mattern, claims that the collection of this data can bring about solutions to complex societal problems (such as air pollution) have greatly increased (though she is largely skeptical of its promise). Mattern discusses trends of "data fetishism" and the "aestheticization and idolization of method" that she sees cities moving toward in an attempt to tackle some of society's "stickiest urban problems."[2] In her book Program Earth, Jennifer Gabrys further explains, "it is through collecting data that everything from enhanced participation in environmental issues to changes in policy are hoped to be achieved."[3] This follows from the belief that data enables more effective modes of action in response to environmental problems. "Data are intertwined with practices, responses to perceived problems, modes of materializing and evidencing problems, and anticipations of political engagement."[4] Thus it is through environmental monitoring and the dissemination of data to the public that environmental problems are understood to be more readily and effectively addressed.

1 Neil Gross, "The Earth Will Don an Electronic Skin," **Business Week**, August 30, 1999, https://www.bloomberg.com/news/articles/1999-08-29/14-the-earth-will-don-an-electronic-skin.
2 Shannon Mattern, "Methodolatry and the Art of Measure," **Places Journal**, 2013, doi:10.22269/131105.
3 Jennifer Gabrys, **Program Earth: Environmental Sensing Technology and the Making of a Computational Planet** (University of Minnesota Press, 2016), p.159.
4 Ibid.

This essay aims to explore not only the intended purpose of environmental monitoring and alert systems but the potential gap between their presumed and actual effects on human behavior. The first section summarizes the history of air quality monitoring along with the rise of ubiquitous sensor networks and citizen sensing initiatives, with an eye towards evaluating how well they promote citizen engagement and action. The next section focuses on federal air quality alert programs and recent evaluations of their effectiveness as far as public health is concerned. The essay concludes by attempting to expand the insights from these evaluations to citizen science initiatives, while highlighting potential areas of improvement.

Building a Network

Widespread environmental monitoring came about in the nineteenth century during the establishment of scientific observatories. Initially focused on astronomy, the observatories expanded to include "precision measurement, numerical data processing, and the representation of scientific information on a global or cosmic scale."[5] Air became a topic of increased attention following the expansion of coal-fired manufacturing, culminating in historic air pollution events in the middle of the twentieth century.[6] Western governments responded to the perceived public health fears by drafting Clean Air Acts, such as those in the United Kingdom (1956)[7] and the United States (1963)[8]; establishing federal programs aimed at regulating and controlling hazardous air pollutants. These laws further legitimized environmental monitoring efforts and drew heightened attention to the potential dangers that existed in the environment citizens interacted with daily.

There are many different types of air pollution, each with varying effects on human health. In order to more holistically understand air quality monitoring, it may be helpful to review what is actually in the air. Our atmosphere includes a combination of gases: nitrogen (78%), oxygen (21%), argon (0.93%), and carbon dioxide (0.04%) as

5 David Aubin, Charlotte Bigg, and Otto Sibum, **The Heavens on Earth: Observatories and Astronomy in Nineteenth Century Science and Culture** (Durham, N.C.: Duke University Press, 2010).
6 "Changing Air Quality | Clean Air Acts | Great London Smog," accessed December 14, 2018, http://www.air-quality.org.uk/03.php.
7 **UK Clean Air Act**, vol. 4 & 5 Eliz. 2, 1956.
8 OAR US EPA, "Overview of the Clean Air Act and Air Pollution," Collections and Lists, **US EPA**, (February 27, 2015), https://www.epa.gov/clean-air-act-overview.

well as other trace minerals.[9] Pollutants are usually measured in ppm (parts per million) or ppb (parts per billion) molecules of air. Common harmful pollutants can be generally characterized as a mixture of small particles such as particulate matter (PM) – like dust, soot, or drops of liquid – which are further broken down into coarse (PM10, < 10 microns in diameter) and ultrafine (PM2.5, < 2.5 microns in diameter). Pollutants such as carbon monoxide (CO), nitrogen oxides (NO, NO2), ozone (O3), and sulfur dioxide (SO2) are also shown to be harmful.[10] The World Health Organization (WHO) labels ambient (outdoor) air pollution as a major cause of death and disease globally – attributing 4.2 million premature deaths from exposure to heart, lung, and cardiopulmonary disease, with the strongest evidence of public health concern linked to PM2.5 (especially deadly due to its invisibility to the human eye).[11] As Gabrys states, "Pollutants, in other words, are often present in seemingly miniscule quantities and yet are able to disrupt and remake environments, bodies, and ecological processes on local and global scales."[12] Institutional and governmental bodies set standards for air pollution monitoring based on what health research determines as evidence of the level of harm caused by specific pollutants.[13] Thus despite the wide range of pollutants found in the air, a smaller subset are the focus of monitoring, as well as management and mitigation efforts.

Nowhere are the effects of these pollutants felt more acutely than in densely populated cities – particularly cities in the developing world (where pollution controls are lacking). Whereas coal pollution was the primary focus during the initial drafting of air legislation, the major pollutant sources are now automobile traffic and energy usage, which directly release the colorless and odorless (and dangerous) PM and NO2. As one can imagine, the burden of disease within a city is not equally dispersed; with populations closest to major urban roadways affected disproportionately.[14] Even though air quality standards

9 *NASA, "Earth Fact Sheet," March 16, 2017, https://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html.*
10 *Environmental Defense Fund, "Health Impacts of Air Pollution," accessed December 14, 2018, https://www.edf.org/health/health-impacts-air-pollution.*
11 *World Health Organization. "Ambient Air Pollution: Health Impacts." WHO | Ambient air pollution: Health impacts, 2018. http://www.who.int/airpollution/ambient/health-impacts/en/.*
12 *Gabrys, **Program Earth**, p.163).*
13 *Ibid.*
14 *Silvana Di Sabatino and Riccardo Buccolieri, "Spatial Distribution of Air Pollutants in Cities," in **Clinical Handbook of Air Pollution-Related Diseases** (New York, NY: Springer Berlin Heidelberg,*

are determined by the effect of air pollution on human health, monitoring and enforcement of those standards can be lacking at the individual level. Currently, regulatory-grade monitoring stations are large and expensive, resulting in only small numbers scattered throughout major cities despite the fact that pollution levels can vary widely due to the effect of buildings, wind patterns, and weather on pollutant dispersion.[15] Furthermore, as individuals move throughout the city in the course of a given day, their compounded exposure levels can vary drastically, even though a monitoring station may find that pollution emitted from a distinct source may be within an allowed limit. Due to this effect, mitigation efforts have been focused on two primary strategies: emissions reduction (decreasing pollution from fixed sites) and exposure avoidance (encouraging individuals to monitor their exposure and take alternative routes through cities).[16]
The latter strategy, notably, offers an opportunity for "citizen sensing"

initiatives. These initiatives utilize the proliferation of low-cost digital sensor technologies and smartphones to crowdsource environmental data, making relevant information more immediately accessible

2018).
15 *Sabatino, Silvana Di, Riccardo Buccolieri, Prashant Kumar. "Spatial Distribution of Air Pollutants in Cities." Clinical Handbook of Air Pollution-Related Diseases. Springer Publishing, 2018, p.81. https://doi.org/10.1007/978-3-319-62731-1_5*
16 *Gabrys, **Program Earth**, p.164.*

to citizens as they move throughout the city. Networks of digital sensors deployed across an urban area allow for much richer spatial and temporal data than that captured by fixed, high-cost monitoring stations, and proponents argue that this dispersed mode of data collection enables effective modes of action on part of the citizen. Many of these networks – such as London Air Quality Network, Safecast, Plume, Air Visual, and AirNow – offer smartphone apps on which citizens can view their exposure levels in real time as well as receive alerts whenever the air quality around them falls below a certain level. All of these initiatives espouse the belief in open environmental data as an agent for change – that allowing citizens to become more informed leads them to make better decisions in their daily lives.

When considering the potential impact of this shift towards more distributed and democratized air quality data, questions begin to arise regarding what specifically is the intended citizen response? Exactly how does arming citizens with more detailed information on air quality enable them to engage differently with their environment? Many of the initiatives listed above lack distinct instructions on what they advise citizens to do with the data they provide. Though there have been few studies regarding the effect of open source air quality data on citizen behavior, we can draw lessons from the implementation of an earlier (and still widely implemented) form of information dissemination: federal air quality alert systems. The following section delves into the empirical effects of providing this information and attempts to apply conclusions to these new citizen-driven initiatives.

Do We Heed the Alerts?

While ambient air quality has improved in many regions (specifically in high income countries), episodic spikes – which have the potential to trigger adverse health effects – remain common.[17] In 1968, the U. S. Environmental Protection Agency (EPA) created the Air Quality Index (AQI)[18 19] which is used to report daily air quality levels for cities

17 *Hong Chen et al., "Effect of Air Quality Alerts on Human Health: A Regression Discontinuity Analysis in Toronto, Canada," **The Lancet Planetary Health** 2, no. 1 (January 1, 2018): e19–e26, doi:10.1016/S2542-5196(17)30185-7.*
18 *US EPA, "AirNow: Air Quality Index (AQI) Basics," August 31, 2016, https://airnow.gov/index.cfm?action=aqibasics.aqi.*
19 *Many other countries have their own version of the EPA's AQI that operates similarly.*

across the U.S. For each city, the EPA calculates a value according to the levels of the five major types of air pollutants regulated by the Clean Air Act: PM, CO, NO2, O3, and SO2 collected from its monitoring stations. The AQI consists of six levels that range from Good to Hazardous (with a corresponding color scheme), depending on the potential health concern. State and local agencies are required to report daily air quality indexes for all U.S. cities with populations over 350,000.[20] The information is updated daily, and it is freely available on the EPA's website. On exceptionally bad days, it is disseminated through the media. There is also an option to automatically receive free air quality mobile alerts when high concentrations of dangerous pollutants are predicted in a citizen's area.[21] Additionally, cities may manage their own city-wide alert systems that, along with air quality, cover many different types of alerts including traffic, police activity, and weather. Many countries have very similar indexes and alert systems including Australia, Canada, China, India, Mexico, Singapore, U.K., and Europe.

These alert systems rely on similar assumptions as the citizen-fo-

cused air quality initiatives. Particularly, that by directing citizen attention to immediate environmental phenomena – whether it be through a smartphone app that is constantly monitoring the surrounding pollution or through a federal alert messaging system – citizens will adjust their behavior. This follows other digital information technologies such as electronic meters that modulate energy use

20 *Renee Cho, "What You Should Know About Air Quality Alerts," **State of the Planet**, June 26, 2018, https://blogs.ei.columbia.edu/2018/06/26/air-quality-alerts-pollution/.*
21 *OA US EPA, "Prepare for the Summer Smog Season with Free Air Quality Alerts," Speeches, Testimony and Transcripts, **US EPA**, (April 30, 2018), https://www.epa.gov/newsreleases/prepare-summer-smog-season-free-air-quality-alerts.*

or wearable fitness and sleep trackers that capitalize on the increasing trend of soliciting the attention of citizens in order to bring about behavior change.

While probing the nature of attention in digital media, Matthew Wilson draws on the philosopher Bernard Stiegler's criticisms of these technologies. While Stiegler suggests they can be thought of as powerful systems of care, he also argues that "contemporary power technologies no longer mainly aim at disciplining bodies or regulating life-processes, but at controlling and modulating consciousness"[22]; in other words, power acts through attention.
While Steigler is generally critical of these technologies and the new "economic system of attention", his insights can inform the design of such systems. For a more productive take, Wilson references the work of Katherine Hayles: "It is far too simplistic to say that hyper attention represents a cognitive deficit or a decline in cognitive ability among young people. . . . On the contrary, hyper attention can be seen as a positive adaptation that makes young people better suited to live in the information-intensive environments that are becoming ever more pervasive."[23] It is important then to understand how successful these technologies are at directing attention in order to stimulate some desired behavioral response.

Until recently, little evidence of the effectiveness of city-wide air quality alert systems existed. Earlier this year, Hong Chen et al. (2018) published what they determined was the first study to comprehensively evaluate the effect of air quality alert programs on a wide array of public health outcomes.[24] The study took place in Toronto, Canada, a region where air pollution levels are on par with other high-income countries. The research team employed a robust regression discontinuity design to study the public health outcomes of Toronto's city-wide air quality alert system on data from 2003 to 2012. The findings showed that though the alerts were related to some reductions in asthma-related emergency room visits on high pollution days, the system as a whole had no effect on mortality or cardiovascular disease. Overall, the researchers claim the alert program "yielded inadequate protection of the public from air pollution"[25]. Since Toronto's air quality alert program relies solely on information

22 *Matthew W. Wilson,* ***New Lines: Critical GIS and the Trouble of the Map*** *(Minneapolis: University of Minnesota Press, 2017), p.95–97.*
23 *Ibid.*
24 *Chen et al., "Effect of Air Quality Alerts on Human Health."*
25 *Ibid.*

campaigns – and thus emissions reduction is voluntary (rather than additionally requiring government action such as reducing traffic or shutting down factories[26]) – this study concludes that "interventions relying on information campaigns alone to encourage exposure avoidance and voluntary emission control could yield little benefit if not accompanied by mandatory actions."

Additionally, while studies in the U.S. have shown that smog alerts have reduced attendance in public parks in Los Angeles[27] and Atlanta[28], several other U.S. studies fail to link air quality alerts to behavioral change among the public.[29] In fact, there is sufficient evidence that behavior response decreases as successive alerts are issued.[30] A narrow study evaluating the behavioral impacts of air quality ozone alerts in Sydney, Australia on cycling behavior found that bicycling trips decreased by 25 percent in response to smog alerts. However, when alerts were issued over two consecutive days, there was no decrease on the second day. The study found larger impacts on the weekends compared to weekdays, suggesting that if cycling was utilized for commuting, there was less likelihood of substitution.[31]

What do these studies suggest for the future applications of citizen-sensing initiatives? The final section aims to draw conclusions from the empirical results in order to highlight how they may be best utilized in regard to citizen behavior.

26 *Like in Santiago, Chile or Delhi, India (source from paper, page e24)*
27 *Matthew Neidell, "Air Quality Warnings and Outdoor Activities: Evidence from Southern California Using a Regression Discontinuity Design,"* ***Journal of Epidemiology and Community Health*** *64, no. 10 (October 2010): 921–26, doi:10.1136/jech.2008.081489.*
28 *Douglas S. Noonan, "Smoggy with a Chance of Altruism: The Effects of Ozone Alerts on Outdoor Recreation and Driving in Atlanta,"* ***Policy Studies Journal*** *42, no. 1 (2014): 122–45, doi:10.1111/psj.12045.*
29 *Semenza JC, Wilson DJ, Parra J, et al. Public perception and behavior change in relationship to hot weather and air pollution. Environ Res 2008; 107: 401–11.;*
Bäck D, Kuminoff NV, Van Buren E, Van Buren S. National evidence on air pollution avoidance behavior. http://www.public.asu.edu/~nkuminof/BKVV13.pdf;
Tribby CP, Miller HJ, Song Y, Smith KR. Do air quality alerts reduce traffic? An analysis of traffic data from the Salt Lake City metropolitan area, Utah, USA. Transp Policy (Oxf) 2013; 30: 173–85.
30 *Joshua Graff Zivin and Matthew Neidell, "Days of Haze: Environmental Information Disclosure and Intertemporal Avoidance Behavior,"* ***Journal of Environmental Economics and Management*** *58, no. 2 (September 1, 2009): 119–28, doi:10.1016/j.jeem.2009.03.001.*
31 *Soodeh Saberian, "Behavioral Impacts of Air Quality Alerts: Cycling and Ozone Alerts in Sydney," November 6, 2014, 43.*

Bringing Behavioral Change to Bear

In an attempt to shed light on the potential of low-cost sensing initiatives, these evaluations provide possibly enough evidence to temper expectations related to changes in citizen behavior. If we are to apply the results of national air quality alert programs to citizen-driven initiatives, then we can deduce that there is some evidence to suggest that alerts trigger immediate citizen compliance, especially in regards to more at-risk populations. Though, overall it appears that large potential changes in behavior are less likely to occur, especially when citizens are asked to make more significant changes that may affect their daily lives (like changing their mode of commuting).

Yet, it is not entirely realistic to expect these new initiatives to function in exactly the same way as the government alert programs; the potential impacts could be more or less effective. With the ability to collect more fine-grained data and give personalized suggestions, low-cost monitoring offers a more granular approach to information disclosure. It may be interesting to consider an extreme example, such as Delhi, India (which coincidentally just rolled out its own city-wide alert system in October 2018[32]). Delhi is consistently ranked by the WHO as one of the world's worst cities for air pollution[33], with the capital city routinely setting mandatory bans on high polluting industry, construction activities, and heavy vehicles for days at a time when the air pollution reaches extreme levels.[34] Since air pollution is a regular aspect of daily life to Delhi's citizens, what does a city-wide alert system offer? In a city overcome with severe levels of air pollution up to months at a time, is it realistic to assume that citizens would adhere to city-wide recommendations that they stay indoors? At what point does the air pollution become deprioritized by the citizens who have to get on with living their lives? This may highlight the potential advantage of low-cost monitoring. Would citizens be more willing to abide by government suggestions if they were given

32 *Vishwa Mohan, "Govt to Launch Air Pollution Prediction System for Delhi on Oct 15," **The Economic Times**, October 12, 2018, https://economictimes.indiatimes.com/news/environment/pollution/govt-to-launch-air-pollution-prediction-system-for-delhi-on-oct-15/articleshow/66186671.cms.*

33 *Umair Irfan, "Why India's Air Pollution Is so Horrendous," **Vox**, May 8, 2018, https://www.vox.com/2018/5/8/17316978/india-pollution-levels-air-delhi-health.*

34 *"Ban on Construction, Entry of Heavy Vehicles in Delhi Extended till Monday," **NDTV**, November 10, 2018, https://www.ndtv.com/delhi-news/ban-on-construction-entry-of-heavy-vehicles-in-delhi-extended-till-monday-1945461.*

realistic, catered options in which to alter their behavior? What about if these systems enabled citizens to actively care more about their environment?

There is a broader opportunity for these initiatives to embrace the strategy of directing attention to what is happening in a citizen's environment. Where sensing up until this point has focused on the passive monitoring of the environment, these applications offer the opportunity to take a more active role in bringing about real behavioral change. As Wilson points out:

> *The point is to pay attention to attention as an object, to cultivate attention as care through technological engagements to confront what Stiegler considers a "systemic carelessness," or, more profane, where "I don't give a fuck" (je-m'en-foutiste) has become a persistent affect toward societal (human, environmental, cultural) challenges.*[35]

One can imagine a system in which *caring* about one's environment is the ideal behavioral change, specifically when advocacy is a vital

35 *Wilson, **New Lines**, p.113.*

component to addressing such sticky, complicated societal problems as air pollution. "[P]erhaps technological engagement requires an awareness of the conditions of thought-action, to better frame interventions with technology by being aware of the tendencies toward attention craft and control."[36] In order to bring about real action, these initiatives offer the ability to modify existing behavior by exploiting hyper attentiveness. William Connolly writes "[t]hinking is not merely involved in knowing, explaining, representing, evaluating, and judging.... To think is to move something. And to modify a pattern of body/brain connections helps to draw a habit, a disposition to judgment, or a capacity of action into being."[37]

Overall, there exists potential for citizen-based, low-cost monitoring to fill the gap left by city-wide alert programs. With planetary urbanization continuing apace[38], increasing the percentage of the world's population exposed to extreme health consequences of air pollution, networks of sensors and personalized applications suggest promising avenues for tackling our most pressing environmental problems.

36 *Wilson, **New Lines**, p.112.*
37 *Ibid.*
38 *Neil Brenner, ed., **Implosions/Explosions: Towards a Study of Planetary Urbanization** (Berlin: Jovis, 2013).*

CONSTRUCTING A FRAMEWORK FOR PARTICIPATORY DATA ANALYSIS

Jay Dev

Keywords:
Participatory Data Analysis, PAR, Open Data, Public Participatory GIS, PPGIS, Detroit Data Justice Coalition, Community Engagement

In a mission for self-awareness, cities have long sought to rationalize complex social problems through data, quantification, and the wisdom of academics and scientists. In the late-1950s and 1960s, there was budding optimism that cybernetics, a nascent field developed by, among others, MIT mathematician Norbert Wiener and Bell labs engineer Claude Shannon, could be adapted from the field of security intelligence and applied to the problems of cities.[1] Before long, planners began to push for a more scientific approach to process and analyze urban information systems. In response to civil unrest and racially-motivated violence in American cities in the late 1960s, the federal government formed the Kerner Commission, whose findings contributed to the creation and funding of a number of academic think tanks to better quantify and simulate the impacts of policy on welfare and housing. More recently, cities have been looking to private consultants from business intelligence and data management to help wrangle and analyze data in an attempt to make city services operate more smoothly. Each of these movement have reinforced the power of outsiders as having an unbiased, more rational image of the city.

However, in doing so, these external fields have pushed their priorities—such as uniformity, efficiency, and control by way of surveillance—onto urban planners and policymakers. There is concern that these values have competed against and, in some cases, overcome fundamental properties of American municipal governments, such as democracy and equity. While cities have long tried to balance citizen engagement and centralized decision-making, the emergent wave of data-driven governance threatens to enshrine privileged forms of knowledge, particularly that of experts and optimization models, and deligimate deprioritized knowledge, particularly local knowledge that city residents have derived from their lived experience.[2]
So far, most efforts to engage the public in data-driven policymaking have been focused on a few small steps.[3] Generally, participation ends when residents are captured within data, their lives or interactions with the government reduced to a completed survey questionnaire or entry in a case management system. In some cases, community members have been called upon to assist in the data collection process. Participation in data collection can be justified in a number of ways: to keep staff costs down, to improve the response rate by leveraging familiarity with other community members, or to empower citizens to voice opinions about how data is being captured, but this step alone does not fully ensure that residents are involved in decision-making processes.

At the same time, many cities have sought to be more transparent to both their residents and outsiders by making data more available through public online data portals. However, data transparency goes beyond just making data sets available; it requires the data to be legible to citizens. Towards that end, some cities have begun to operationalize data in the form of an accessory applications (such as performance tracking applications or live transportation feed), created by either the government itself or an interested third-party. But publication is not enough; without clear information about what data sets exist in such portals and sufficient data literacy to enable residents to meaningfully utilize them, we cannot be sure that publication does not itself advance obfuscation of critical information. Furthermore, as a city works to understand and analyze the social, physical, and economic reality that it's planning for, it may be missing critical pieces of information if it is not including citizens in the data analysis and interpretation process. On one hand, if the data that is collected is untimely or unrepresentative of more granular areas and subpopulations (particularly vulnerable ones), extrapolation from this flawed data threatens to inspire exclusionary or biased policy. On the other hand, municipal data often does not capture key components for effective policy making and implementation—such as social relationships, local power dynamics, and nuanced understandings of past benefits and harm – that are critical to building trust, buy-in, and workability of any proposed solutions.

To ensure that municipal governments continue to maintain and plan in a manner representative of the complexity of their cities, it is important to find better avenues through which conventional quantitative and qualitative data can be considered alongside local knowledge and lived experience. Thus far, few formal exercises in participatory data analysis have been initiated by city governments. This could be, in part, because a framework for such exercises does not exist. This paper will begin to articulate such a framework, looking to the guidelines set by related fields. The next two sections

1 *Jennifer S. Light,* ***From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America*** *(Baltimore: Johns Hopkins University Press, 2003).*
2 *Taylor Shelton, Matthew Zook, and Alan Wiig, "The 'Actually Existing Smart City'," Cambridge Journal of Regions, Economy and Society 8, no. 1 (2015): 13–25, doi:10.1093/cjres/rsu026.*
3 *Ibid.*

lay out guidelines drawn from Public Participatory GIS and the more contemporary Equitable Open Data Guidelines created by the Detroit Digital Justice Coalition. From these examples, I hope to extract critical components that participatory data analysis efforts must incorporate to facilitate equitable and democratic knowledge creation.

Public Participatory GIS

Big data analytics are opening new frontiers for modeling and predictive analysis; the rise of geographic information system (GIS) software similarly disrupted disciplinary convention in the field of geography in the 1980s and 1990s. The possibilities of new types of data, new forms of representation, and more complex analytical methods created excitement around a new form of credibility for the field. However, in the 1990s, a growing group of critics began to push back against the primacy of GIS. As more social theorists began to weigh in on what was becoming a new battleground in the 'science wars,' practitioners began to apply Participatory Action Research methods to GIS work. Hence, the field of Public Participatory GIS (PPGIS) was born.[4]

In the intervening years, a range of PPGIS projects were initiated to understand geographic issues around the world. Different projects took different approaches to defining scope, guidelines, and techniques, but according to Sieber, the field in general was co-produced across four major dimensions: place and people, technology and data, process, and outcome and evaluation. Sieber separates these dimensions into more specific considerations and actions (listed in Table 1) that have surfaced across PPGIS.[5] While some of these are field-specific, they combine to form a guide to the type of reflective practice that is critical in conducting equitable co-produced work.

4 *Nadine Schuurman, "Trouble in the Heartland: GIS and Its Critics in the 1990s," **Progress in Human Geography** 24, no. 4 (2000): 569–90, doi:10.1191/030913200100189111.*

5 *Renee Sieber, "Public Participation Geographic Information Systems: A Literature Review and Framework," **Annals of the Association of American Geographers** 96, no. 3 (September 2006): 491–507, doi:10.1111/j.1467-8306.2006.00702.x.*

Table 1. Sieber's Framework for a Co-Produced PPGIS

People and Place	
Context	PPGIS must take into account specific context, and the impact of geographic scale (local, national, international) on generalizability of results
Stakeholders and Other Actors	PPGIS must be mindful of which stakeholders are included in the project, who is omitted, and how relational dynamics will impact the proceedings. While a consciousness of position (e.g., socioeconomic position, relative standing within a research team, status as an insider or outsider to the community or topic at hand, among others) is critical to co-creating knowledge, sometimes we are unable to completely overcome structural differences in class, race, and gender that exist outside of our project.
The Public	PPGIS has had difficulty producing results for a general public. It may instead benefit from scoping out groups of stakeholders and responding to them specifically.
Technology and Data	
Extent of GIS Technology	PPGIS practitioners must be thoughtful of how technical or technologically-focused the engagement should be, and when GIS should be brought into the process. More accessible PPGIS projects generally separate community members from direct engagement with GIS software, instead encouraging them to provide input and evaluate output.

Accessibility of Data	Access to data is a critical component to the success of a PPGIS project. Clear processes to prioritize the publication of requested data and to protect individual privacy must be in place.
Appropriateness of Information	In the case that data does exist, the data must be appropriate for the work of the organization (in terms of topics, timeliness, granularity, ability to support action) and accurate (to maintain credibility of the findings).
Representation of Knowledge	Data must be representative of the various forms of knowledge found at the community-level. For that to happen, local knowledge must find a way into the work, and be transposed to fit native data structures. In the case of PPGIS, this means local knowledge must be paired with geographic points or areas.
Process	
System Implementation and Sustainability	Organizations must have continued access to GIS tools to ensure the project can continue to grow and adapt to the community's needs (especially as work continues without outside and/or academic researchers).
Participation and Communication in the Policymaking Process	The PPGIS process must acknowledge various levels of participation, and provide recourse for those unable to participate or those who are harmed in the participation process.
Decision-Making Structures and Processes	The structure of the PPGIS project influences its ability to allow for collective or transparent decision-making.

Outcomes and Evaluation	
Goals and Outcomes	The problem of setting goals and measuring results in PPGIS can be difficult to navigate. Goals may be wide-ranging across different stakeholder groups and, in some cases, may even oppose one another. But perhaps the best way to address these differing goals is by making them explicit.
Measurement and Evaluation	In service of reaching those goals (or at least to help the project team keep track of their progress), defining measures of success can be difficult – especially as causality can be difficult to pinpoint – but necessary. One measure mentioned was based on appropriateness of the project to the community-based organization's mission. Another proposes measuring empowerment through the level of participation (in the case that there is a positive relationship between the two).

Source: Summary of 'A Framework of for a Coproduced PPGIS' in Sieber, 2006, "Public Participation Geographic Information Systems."

While some of these issues are more deeply rooted or unique to the field of GIS, several lessons can be taken away from this framework. As a project is initiated, it is critical to understand the impact that the scope of the project and the stakeholders involved will have on its outcome. As a project progresses, a shifting context or evolving group of stakeholders can allow for a representative or useful final output. But rather than ignore or write out the original context or group of stakeholders, it is important to document the impact these stakeholders have on the process. For participatory data analysis, this could mean showing the same set of data to different sets of stakeholders, like neighborhood residents, business owners, elected officials, etc., to get a better understanding of how different groups contextualize the same pieces of information, and how their positions and interests may impact their perceptions. Alternatively, showing roughly the same group of stakeholders different data sets over time can help them reach the level of understand or goal that they seek to achieve, but the order in which those data sets are shown and

interpreted may have a bearing on how they understand future data sets.

Once the stakeholders and scope of the project are preliminarily defined, it is important to determine not only what tools, techniques, and data sets will be useful in the analysis, but how those tools, techniques, and data sets will be presented to the community researchers for their input and interpretation. In this stage, a level of capacity building may be necessary. As the project proceeds, it is important to build and implement strategies for making this work actionable, as well as sustainable, in the long run. This could entail creating a range of sessions that could be easily replicable so that the community members could continue to track and process data after any specific engagement is complete; as well as a range of tools that could be taught to others as communities change in an area, grow or shrink, or are moved.

Finally, it is important to constantly be comparing the process and its outputs to a set of shared goals, based on appropriate measures of progress. These must be decided upon collectively between the full research team (of both outside academic researchers and local community researchers), and must serve to ensure that the project is on track to reach its ultimate goal of being useful and useable by the community.

Detroit's Equitable Open Data Guidelines

The second, more contemporary example comes from two critical community-based organizations influencing civic technology and data policy in Detroit—the Detroit Digital Justice Coalition (DDJC) and Detroit Community Technology Project (DCTP). DDJC is a coalition of citizens and 15 organizations (ranging from activist organizations to recreation centers and maker spaces to organizations dealing more directly with data and technology) working to advance the right to communication through the principles of access, participation, common ownership, and healthy communities. The coalition was started by Allied Media Projects in 2009 around funding from the Broadband Technology Opportunities Program (a grant program affiliated with the American Recovery and Reinvestment Act out of the US Department of Commerce), has since received funding from the Digital Trust Foundation (a foundation which was started out of a class action lawsuit against Facebook in 2009) and the Ford Foundation, and has partnered heavily with DCTP in much of its work.[6]
In 2015, the City of Detroit enacted an executive order defining its open data policy, known as the Detroit GO DATA Initiative, alongside its Open Data Portal. The order mandates that all city "data and information, unless exempt from disclosure under State or federal law, will be available to the public, starting with an open data portal,"[7] seemingly a high bar for the city to meet. To enact this policy, the executive order creates an internal Task Force and an external Advisory Commission. Currently, that committee consists primarily of city residents (including a member of the DDJC).

While the order generally aims to create, "a more transparent, open, collaborative, participatory and accountable relationship between the City government and the people it serves,"[8] it sets out no specific direction for how this open data will open up pathways to collaboration or participation. In response to the creation of the data portal, DDJC and DCTP published a set of Guidelines for Equitable Open Data in Detroit. Through rounds of public surveys, scenario brainstorming, precedent research, and interactive educational workshops, DDJC and DCTP landed on the following principles:

1. Protect the people represented by the numbers
2. Do not retain personal information tied to accessing City services
3. Publish data about all City services, even for privatized "public" services
4. Prioritize the release of new datasets based on community interest
5. Increase transparency around how data sets are defined and processed
6. Engage residents offline about open data
7. Share what's coming next

While most of these guidelines set standards for privacy and security, transparency, and accountability, the sixth principle of 'offline engagement' seems key to community access and participation in using data. In their report, DDJC and DCTP identify digital inequity and limited access to broadband internet in the city as being

6 *Detroit Digital Justice Coalition, "About," 2018, http://detroitdjc.org/about/story/.*
7 *City of Detroit, "About | Detroit Open Data Portal," accessed October 21, 2018, https://data.detroitmi.gov/about.*
8 *Ibid.*

limiting factors to building awareness and open data literacy. They suggest that the city needs an accompanying engagement plan that "emphasizes community dialogue and in-person training sessions,"[9] potentially modeled off of DDJC's Data DiscoTech workshops. The DiscoTech model, short for 'discovering technology,' have been multimedia, interactive, and educational workshops meant to help city residents explore how technology and data may impact or benefit their communities. A series of Data DiscoTechs were specifically run around the formation of the Equitable Open Data Guidelines, providing stations on the Open Data Portal, the FOIA process, web mapping, connecting data to our bodies and lives, data visualization, and local apps.

We do not see specific mention of anything resembling collective data analysis, which is unsurprising considering that the gold standard that DDJC cites from their background research, the Sunlight Foundation's Open Data Guidelines, is missing any mention of how to support the use of public data once it is downloaded from a portal.[10] Yet, the Equitable Open Data Guidelines lay out a couple of important insights that would make such an endeavor possible. One is definition of a well-defined conversation and action space where such an endeavor would happen. In defining the problem, DDJC and DCTP suggest that the online tutorials on how to use the open data portal from Detroit's Department of Innovation and Technology (DoIT), the group responsible for maintaining the portal, are inaccessible to a number of community members who are likely to be affected by the availability of open data. As a response, in-person sessions are suggested to improve awareness and accessibility, particularly those that are offered in conjunction with local recreation centers and are centered around interactive learning.

To facilitate the knowledge creation process within these in-person workshops, it is critical to structure conversations around a combination of shared understanding, using techniques that encourage exploration and attempt to elevate embodied knowledge that comes

9 *Detroit Digital Justice Coalition and Detroit Community Technology Project, "Recommendations for Data Justice. Contribute to Datajustice/Report Development by Creating an Account on GitHub," 2017, https://github.com/datajustice/report/blob/gh-pages/downloads/DataJusticeReport.pdf.*

10 *Sunlight Foundation, "Open Data Policy Hub | Why Open Data?" accessed December 11, 2018, https://opendatapolicyhub.sunlightfoundation.com/why-open-data/.*

from lived experience. In the case of the Data DiscoTechs, these workshops began with creating a shared awareness of the prevalence and impact of data on our everyday lives, what information is available, and some of the tools available to understand it, as well as opening up practice spaces to learn how to utilize data. Participants were encouraged to interact with existing tools of analysis and action, explore data about their neighborhoods, and discern patterns and meaning from data by visualizing it using a range of approaches. It seems as though these workshops utilized both digital and analog forms of interaction, inviting participants from all ages and varying skill sets to find meaning in the data.

While these methods for enabling a broad population of city residents to access civic data were intended to inform policy recommendations, the key lessons outlined above are illuminating when viewed through the reflective and participatory lens of PPGIS. In fact, although the documentation of the Data DiscoTech does not include explicitly mention how these workshops could be used to build common understanding and elevate local knowledge in concert with the data that is being made available, a previous publication[11] from DDJC suggests looking to Participatory Action Research techniques to help bring data down to a human scale. One such resource comes from the Oakland-based DataCenter project for Research Justice[12], who highlight the importance of data to test against and potentially corroborate our personal experiences. Often times, data does not uncover "new knowledge," but instead provides evidence for well-known collective issues that may otherwise be difficult to organize around.

In addition, several other portions of the PPGIS framework could be applied to a workshop similar to the Data DiscoTech—one that is clearly situated within a community and both educates and invites participants to explore the data about their community. More clarity and intentionality about who is invited into the room and who is missing is critical, and perhaps something to respond to in future iterations of the workshop. In the case that the collective data analysis exercise is conducted within the context of a longer-run engagement, the appropriateness of the data and the format of the representation

11 *Kat Hartman, "Research Justice: Using Data at a Human Scale," **The Opening Data Zine**, 2017, https://www.alliedmedia.org/files/ddjc_zine-final-rgb.pdf.*

12 *DataCenter, "An Introduction to Research Justice," 2015.*

output can be further tailored to the needs and goals of the organization. Making those needs and goals explicit from the beginning of the engagement can also help identify appropriate evaluation criteria for the process. Finally, as the Data DiscoTech had a station devoted to teaching about the FOIA process (and generally teach action to request more data), a collective data interpretation exercise must be grounded in some form of follow-up action that can be taken to speak to power.

MUSINGS ON THE NATURE OF NAMING, POLITICS, POWER, AND IMAGINATION

Maia Woluchem

Today's understanding of categorization, organization, and order has been driven by a long history largely out of sight from our current conceptions of the world. Ian Hacking explores a definition of dynamic nominalism that underlies this concept, a doctrine by which human beings and human acts come into being once we define a way to name them.[1] If that is true, by whose naming of what and of whom did we come to know ourselves?

I'd argue that the arc of American history has given the privilege of naming bodies, circumstances, understanding of poverty and success, to a small group of individuals in political, economic and social power; thus creating a world that comes into being based on the decisions of those sharing a particular set of values, rather than essential truths. As self-evident as that may be, this concept is essential to our understanding—particularly because a close relationship to power has been a traditionally white, landowning endeavor. As Simone Browne writes in her book "Dark Matters", in regards to the branding of slaves by white masters:

> *"... branding was not only a mass corporate and crown registration of people by way of corporeal markers, but an exercise of categorization whereby those deemed most fit to labor unfreely, that being the "good and sound," were distinguished from others and imprinted, literally, with the mark of the sovereign. Here, African children, women, and men were violently made objects for trade. Slave branding was a racializing act. By making blackness visible as commodity and therefore sellable, branding was a dehumanizing process of classifying people into groupings, producing new racial identities that were tied to a system of exploitation.2*

This quote could be a shocking historical note were it not that control and power compound over time. And because they have, the idea of classification in this manner has persisted—at times for exploitation, at times to exert control, and always by recommending itself as the best way to understand the issues in our society.

1 *Ian Hacking, **Historical Ontology**, First Edition edition (Cambridge, Mass.: Harvard University Press, 2004).*
2 *Simone Browne, **Dark Matters: On the Surveillance of Blackness** (Durham: Duke University Press, 2015).*

Today many of our urban issues still exist to be measured by a system of characterization laid first by the small circle of white, landowning elites who set our foundation, and societal forces that have grown into existence in their wake. As an example, the legacy of conceptualizing land as property is foundational to how we consider the affordable housing crisis today. Similarly, a Census-driven categorization of race drives our understanding of ethnicity, nationality, and community cohesion.[3] In short, today's built and social environments are often framed around the broad historical arcs laid first by those in power, and perpetuated by our relative inability to contest those categorizations without significant political and legal action. These epistemologies have driven a particular kind of lived experience, one that elevates what we can adequately describe, and stymies what we cannot see or describe well.

To elevate an alternative ontology takes an act of extraordinary creativity and political bravery—as was the case with our first community land trust, or the push to diversify our understanding of gender. These alternatives have deeply historical roots, existing in the margins long before their emergence in the mainstream understandings of society. To do the work of bringing them mainstream, these ideas all necessitated a 'quorum' or an act of bravery by a group of individuals willing to sacrifice to push these new frameworks. In absence of these extraordinary efforts, we're living in a world that's inherently political–driven foremost by a deeply historical, partial, and frayed ability to see, count, and describe our experiences.

And so, an essential question: what is the relationship between concentrated historical power and our ability to see and understand our own personhood and our own stories today? In my opinion, the two are intractable. Characterizations of our legitimacy are everywhere—in our understanding of what we consider undocumented migration, subaltern spaces, and informal economies—all stemming from power dynamics that, unless recent, are difficult to capture. For those who are in marginal, unseen spaces or identities (though this framing begs the question—unseen by whom?), this ability to fit into narratives about validity written long ago underlie so much of what it means to participate in the world.

3 *David I. Kertzer et al., **Census and Identity: The Politics of Race, Ethnicity, and Language in National Censuses** (Cambridge University Press, 2002).*

Today, considering and questioning prevailing notions of validity is an urgent necessity as it is a fundamental motivation of our drive towards data. This is true not just because data is valuable in an epistemological sense, but because it is also now so deeply embedded in our policy decisions, our governmental programs, our understanding of neighborhood dynamics, and the ways in which we're able to categorize ourselves. This data is also increasingly ever more complete—representing all aspects of ourselves that had been largely out of sight for generations.[4] In short, data is our political, social, and interpersonal activities made legible. That nature of data is as promising as it is insidious. And without the extraordinary imagination and drive to create new frameworks, it can similarly recreate the narrower conceptions of the world that we see in political spaces.

Therefore, the need for greater political imagination is extremely urgent—not only due to the increasingly ubiquitous nature of data, but the changing nature of our communities. In neighborhoods across the country, harmful federal rhetoric about ethnic minorities, undocumented families, and many other vulnerable communities has slowly pushed some of our more marginalized people to the shadows while elevating the safer, most palatable understandings of ourselves.[5] But regardless of this denial, our neighborhoods are still changing, our world becoming more diverse and more complex with each passing day. Without harnessing our political and legal power, the data seen around us will reflect a power structure that does not fit this complexity, erasing our ability to see and understand our particular selves and the specificities of our cities.

This paper intends to understand this tension. What happens when concentrated power (manifesting through data) meets the complex, diverse urban spaces we now live in today? As with the political imagination that creates the community land trust in order to push back on considerations of property rights, can a more creative political imagination push the boundaries of community self-representation in our world? And should we even be aiming for more expansive notions of legibility when there are inherent benefits in remaining

4 *Kate Crawford, "The Anxieties of Big Data," **The New Inquiry**, May 30, 2014, https://thenewinquiry.com/the-anxieties-of-big-data/.*
5 *Keith Eddings keddings@eagletribune, "Climate of Fear: Deportation Push Is Driving Some Immigrants into Hiding," **Eagle-Tribune**, accessed December 10, 2018, https://www.eagletribune.com/news/merrimack_valley/climate-of-fear-deportation-push-is-driving-some-immigrants-into/article_c979042a-61f9-5e71-9193-0454fb1d209f.html.*

uncaptured and "invisible", especially at this politically fraught time? This paper explores two pre-existing examples of pushback to federal paradigms in order to highlight cases where our collective ability to see ourselves through data has expanded by pushing back on concentrated power. It aims to bring dynamic nominalism to a more practical application, illustrating that the next dynamic shift could and should be in the hands of whoever is bold enough to take it.

A Federal Adventure in Creating New Paradigms—What Can Be Gleaned from Trying New Things?

The Fair Housing Act of 1968 was intended to do a number of things, but is remembered primarily as an attempt to codify some of the aims of the concurrent Civil Rights movement: addressing the segregationist policies upheld by brokers, the federal government, and individual actors in housing provision. The Act was born out of a moment of deep legislative conflict between Congressional liberals and Southern conservatives who disagreed on Congress's role in legislating the seemingly independent choices of individual homeowners. Many were also pained by the expediency of the moment, as the Act was passed within a week of Dr Martin Luther King's passing.[6] Nonetheless, the Fair Housing Act was born from a moment of major tension, highlighting the ever-present struggle between prescribing equitable policy decisions to a polity or leaving the individual bodies of the autonomy to figure it out for themselves.

As was noted in 1969, the case for fair housing legislation included "psychological significance to blacks who will be able to escape the ghetto and the increased opportunities for employment and for decent education."[7] As expected, the conservative argument drew much of its fervor from a fear of losing both power and economic value. At the time, tensions were particularly high related to the perceived loss in white housing value, should black people be allowed into these traditionally segregated neighborhoods. This argument

6 *Jean Eberhart Dubofsky, "Fair Housing: A Legislative History and a Perspective Symposium on Civil Rights and the Law," **Washburn Law Journal** 8 (1968–1969): 149–66, https://heinonline.org/HOL/P?h=hein.journals/wasbur8&i=167.*
7 *Ibid.*

between mobility and place-based effects is still alive and well today.

Though contentious, the Fair Housing Act of 1968 was passed months after this initial battle, ushering in new legacies by the prohibition of discrimination based on race, color, religion and national origin. However, the legislation was still illustrative of these initial tensions and hesitant to prescribe Congressional policy decisions regarding fair housing, no matter the urgency. Within the Act was a phrase that would come to haunt the world of fair housing from thenceforth, urging actors to work on "affirmatively furthering fair housing", but remaining vague on the details. The first semblance of any inclination to make good on that promise was language about affirmative fair housing marketing plans, then ascribed to those accessing funds through the now-defunct Farmer Home Administration (FmHA). As the language of the Act says, "An Affirmative Fair Housing Marketing Plan is required to be prepared and submitted to FmHA or its successor agency under Public Law 103-354 by the contractor...using form HUD 935.2"[8], to be reinforced through review by the federal Department of Housing and Urban Development.

The Fair Housing Act of 1968 was largely unenforceable because of the looseness of this phrasing, which asked for little data or metric capacity to operationalize these arguments and was fairly vague about what a fair housing marketing plan should entail. In fact, Form 935.2 (now Form 935.2a) still exists today and is relevant to anyone advertising a multi-family building with HUD funding, which incidentally is most of our multi-family stock today. Though the form has surely undergone some edits since its initial release, even its current iteration is entirely opaque on the metrics needed to operationalize that dream—a legacy drawn upon the initial desire to obscure the contentious issue of fair housing and limit its effects.[9]

As a result, the Fair Housing Act was a concentrated effort that in some cases unfortunately beget complacency in the realm of fair housing. By remaining purposefully vague about the need for performance metrics and data to measure and actively fight for fair housing, authors of the Act inadvertently (or perhaps not so inadvertently) enabled cheating in the housing market, provided relatively few

8 *42 U.S.C. Â§ 3608(D) (n.d.).*
9 *U.S. Department of Housing and Urban Development and Office of Fair Housing and Equal Opportunity, "Affirmative Fair Housing Marketing Plan (AFHMP) - Multifamily Housing," accessed November 27, 2018, https://www.hud.gov/sites/dfiles/OCHCO/documents/935-2A.pdf.*

universal tools with which to reinforce integration, and underwrote growing resentment by those who rejected the state's infraction on their ability to live in communities that they felt autonomy over. As noted already, power compounds, and the legacy of these poor housing policies is significantly more marked today. Current wealth disparities by race are as expansive as they are largely due to this inability for blacks initially locked out of homeownership and place-based opportunity to find housing that is safe, stable, affordable and in good, well-resourced neighborhoods.[10]

In 2015, the Obama Administration took incredible aims to address the problem—capitalizing upon a particularly favorable political tone to bring metrics and data to the then-vague question of fair housing. The Affirmatively Furthering Fair Housing rule (AFFH) was implemented in 2015, tying real strategy, data reporting, and collection requirements to the communities applying for federal funding for housing.[11] In order to receive funding from HUD for their projects, entitlement communities were required to submit an Assessment of Fair Housing, mandating them to enumerate goals for expanding fair housing in their communities, and a number of metrics by which they would measure these goals. They were also each required to submit profiles of their communities, using some metrics set forth by HUD itself. Each Assessment was subject to review and refusal—and of the 49 submitted, 17 were roundly rejected for the failures of their metrics to demonstrate actionable results.[12]

Interestingly and most importantly, a new concentration of power beget a new set of tools, born of creative imagination and the political will to do so. Insurgency-lite, if you will. At the time, the administration was in a particularly favorable moment to push for new ways of measurement—instituting tools that addressed our more nuanced understandings to give weight to the issues of segregation. One such tool is the Dissimilarity Index, first proposed by Drs. Massey and Denton in 1988 to measure the evenness in opportunity among

10 *Ta-Nehisi Coates, "The Case for Reparations," **The Atlantic**, June 2014, https://www.theatlantic.com/magazine/archive/2014/06/the-case-for-reparations/361631/.*
11 *"Affirmatively Furthering Fair Housing Rule | HUD USER," accessed November 26, 2018, https://www.huduser.gov/portal/affht_pt.html#final-rule.*
12 *National Fair Housing Alliance et al., v. Benjamin Carson Sr., M.D., In his official capacity as Secretary of Housing and Urban Development, et al. (n.d.).*

varying communities of color.[13] Others were proposed by the cities in their own Assessments, like in Seattle (which has a strong legacy of commitments to racial equity and justice), through its Race and Social Justice Initiative and questioned the very notion of white supremacy's overlay in this context.[14] In their Assessment, they noted:

> *"Finally, members of Seattle's Race and Social Justice Equity Change Teams challenged HUD's prioritizing of integrated neighborhoods in high opportunity white communities as potentially biased toward the dominant culture in and of itself. Many communities struggling with the Assessment of Fair Housing will have to deal with a lack of consensus regarding placing high value on integrated communities while respecting individual choice to reside in communities of affinity whether by race, religion, immigrant status, or community history."15*

As a result, their discussions of goals and metrics were slightly more subversive, using these frameworks to institute more nuanced policy at the local level. In all, the introduction of data and metrics to fair housing has allowed communities to enact the measurable change we want to articulate, much more than any previous articulation of fair housing legislation. This is true for many of the jurisdictions among the 49 cities, like Temecula, CA, where leaning into specificity allows for policies like the following:

> *"Adopt an Affordable Housing Overlay (AHO) Program by Amending Title 17 of the Municipal Code (Zoning Code) to accommodate Temecula's regional housing need for 2,007 affordable units for lower income households. The City will establish an AHO on at least 100 acres. After the establishment of the AHO, sites identified will require:*
> - *Minimum densities of 20 units per acre*
> - *50% of need (1,003 units) will be on sites allowing exclusively residential uses*
> - *Multi-family uses at the densities established under the AHO will be allowed by right, without a conditional use permit*

13 *Daniel H Weinberg and Erika Steinmetz, "Racial and Ethnic Residential Segregation in the United States: 1980-2000," n.d., 151.*
14 *"Race and Social Justice Initiative - RSJI | Seattle.gov," accessed November 18, 2018, https://www.seattle.gov/rsji.*
15 *City of Seattle, **2017 City of Seattle and Seattle Housing Authority Joing Assessment of Fair Housing** (Seattle, 2017).*

> - *Affordable Housing Overlay expected adoption by City Council by June 30, 2018. (CF 1A)"*

As it were, the need for greater political imagination in this space is infinitely more urgent, now that power has once again taken back our ability to name, measure, and therefore affect our local policies and built environment. Upon his entrance to the Cabinet, new HUD Secretary Ben Carson suspended the AFFH rule, though many cities across the country are still carrying out plans under its auspices.[16] Once again, the narrative shift by those of a particular persuasion strikes back, but the momentum that began by offering alternative ways of seeing is now deeply affecting the lives of those at the city level. Despite Ben Carson, we are still celebrating the fiftieth anniversary of the Fair Housing Act this year. By even allowing municipalities to enter into a conversation bringing new data to the forefront, the AFFH rule has ushered in 49 different ways of seeing and naming the world, the aftereffects of which are still to be measured.[17]
What is the lesson here? I'd argue that the lesson is in regarding new framings as particularly beautiful moments of generation. Data is just a starting point towards a new way of granting legitimacy and providing a new way to see and affect change in our world. However, doing so requires a particularly rare combination of magic—the political will to act, and the ability to really count the things we want to see.

HMDA – Bringing out New Versions of the World

Though the policy prescriptions in the previous example are most related to the powers that be, there are others that drive from grassroots power. The Home Mortgage Disclosure Act came from one such movement. Initially, the Act was conceived as a method to end redlining in communities across the country.[18] The Act requires financial institutions to disclose information about their individual

16 *Glenn Thrush, "Under Ben Carson, HUD Scales Back Fair Housing Enforcement - the New York Times," **The New York Times**, March 28, 2018, https://www.nytimes.com/2018/03/28/us/ben-carson-hud-fair-housing-discrimination.html.*
17 *"Assessments of Fair Housing by State | Furthering Fair Housing," accessed November 18, 2018, https://furtheringfairhousing.mit.edu/assessment-fair-housing-city.*
18 *Richard D Marsico, "Looking Back and Looking Ahead as the Home Mortgage Disclosure Act Turns Thirty-Five: The Role of Public Disclosure of Lending Data in a Time of Financial Crisis" 29 (n.d.): 49.*

loan activities to the public—which at the time of its passing, was essential information for those looking to track nefarious behavior by financial institutions. Since, it has been an incredible tool for anti-discrimination work: allowing anyone who access the data to sunlight the issues that are affecting housing provision in any community in the United States.

The Home Mortgage Disclosure Act (HMDA) grew out of several years of strong activism from community organizers, looking for verifiable proof to address the pains of redlining in their communities. Organizers like Chicago's Gale Cincotta used a wide range of tactics (not least of which included searching public property records), forcefully confronting lenders at their offices and organizing collaboratively across communities to prove the existence of redlining throughout the country. Figures such as Cincotta were instrumental to galvanizing the groundswell needed to bring national attention to the issue. (In doing so, she once flirted with nailing a "Loan Shark" sign to the door of the Federal Reserve).[19] Though the shield was diverse, the hammer came through Senator William Proxmire of Wisconsin—who championed the controversial bill through Congress, where it was hard-won.

Like the Fair Housing Act fight before it, the competition between the opposition was an ideological one. The former was interested in the means—addressing the pervasiveness of redlining in communities. The latter, the lending industry and federal regulators, were interested in engaging with the topic minimally but unwilling to do the work of assigning data and metrics to do it or prove it. On the heels of action by community organizers, Senator Proxmire opened the discussion on the floor with the fact that lenders "should not arbitrarily reject loan applications from sound credit risks on sound houses simply because he does not like the neighborhood, or because he fears it may at some future time decline."[20] The racist underpinnings of the lenders' arguments unveiled themselves further through the statements of other Congresspeople, who noted the irony of bank business that often took investments of redlined communities to invest in housing in the suburbs.

19 *Douglas Martin, "Gale Cincotta, 72, Opponent of Biased Banking Policies," **The New York Times: U.S.**, August 17, 2001, https://www.nytimes.com/2001/08/17/us/gale-cincotta-72-opponent-of-biased-banking-policies.html.*
20 *Marsico, "Looking Back and Looking Ahead as the Home Mortgage Disclosure Act Turns Thirty-Five."*

Senator Proxmire and his contemporaries released a series of increasingly damning criticism while offering many reasons why HMDA's passage was imperative for the people and communities who had already put years of work into this issue on the ground. Highlighting the importance of HMDA's disclosure mandate, Senator Edward Brooke of Massachusetts noted that community residents, many of whom had already been significantly involved in the efforts to unveil redlining locally, could use this information to divest from banks that did not lend in their neighborhoods, among other actions that would keep lenders accountable. Ultimately the critical partnership between the invested Congresspeople was best used to highlight the ways disclosure of this data galvanizes the public, those already working on this issue in their communities. In the end, community organizers won, ushering in one of the landmark legislations in the greater effort to fill gaps in public knowledge.
The essential tenets of the Home Mortgage Disclosure Act are now to provide the public with yearly home loan data at the transaction-level. HMDA data describes the contours of each loan (including the amount, type, whether it was approved or withdrawn), descriptive statistics about the race, ethnicity and gender of the applicant, and a wide range of other variables most important to the communities looking to answer questions. Though it can illuminate the intrusiveness of redlining and give consumers a way to regulate nefarious lending practices, it also is an essential tool to understand the nature of our built environments.

As an example, this data has been used to understand the lack of penetration of homeownership in communities of color, and highlight difficulties in addressing income inequality.[21] It has just as often been used by financiers, to assess the market they're entering into. Ultimately its use depends purely on the case, though its prominence in our ability to drive new policy and change is purely a result of the bravery and work of the disperse communities among us who demanded their issues be seen.

Similarly, moments of direct community action inspiring real data have been evidenced in a wide range of topic issues, not least of which include recent interest in the count of evictions through the Anti-Eviction Mapping Project, and Sam Sinyangwe's effort to quan-

21 *Urban Institute, "An Interactive View of the Housing Boom and Bust," accessed November 29, 2018, http://urbn.is/MortgageByRace.*

tify police violence.[22];[23] By building upon existing group-momentum and a strong political interest in building more equitable futures, efforts to quantify the previously unknown can also grant power to the unseen from mere legibility. Thus, I'd argue an addendum to the former—though power does truly underlie our ability to see what is in front of us, power in certain circumstances can be dispersed and it can be resolute. Actors in each of these spaces have benefited tremendously from having a unified mission in obscuring, defining, or elevating the truth, and have been in a particularly opportune moment and position to do so. Thus, as we consider more diverse conceptions of power and who can levy it, I'd hazard a guess that the outcomes and future representations of our world will also expand in kind.

Why Do We Care In the First Place?

An alternative reading of this piece could beget a pessimistic undertone. "Cool, but also isn't this kumbaya? Or overdramatic? Isn't it too late? Who cares?". The answer is probably all of the above, honestly. However, I'd argue that the relationships between numeracy, power, and the political moment is an incredibly urgent connection for us as a polity to consider.

Today's political heavyweights rarely consider data a part of any conversation, and are swift to move on policies driven by the passion of the moment and a brazen misunderstanding of the problem.[24] However, some critical readings of ontological practices will tell us that naming something gives us a particular power to see and affect that thing. By avoiding a conversation about how to quantify and name police brutality, discrimination, or segregation, we're missing a major part of our cities. Similarly, by naming a vast and unexplainable problem by falsehoods and poor metrics, we are overemphasizing a particular lens in favor of those policies. As Trump incorrectly stated in late 2018 in regards to the migrant caravan on the border: "But I would say the violence is very strong. We have over 500 people that are serious criminals and gang members. And it's a tough situation. We just don't want that in our country. And we're keeping it in Mexico."[1] Truth be told, nobody has those actual numbers, but only a few people are in a position to wield the political power necessary to make them actionable. And should they, perhaps that again alters the nature of what we're able to see, manage, and control—in ways which are harmful to our communities and who we want to be as a society.

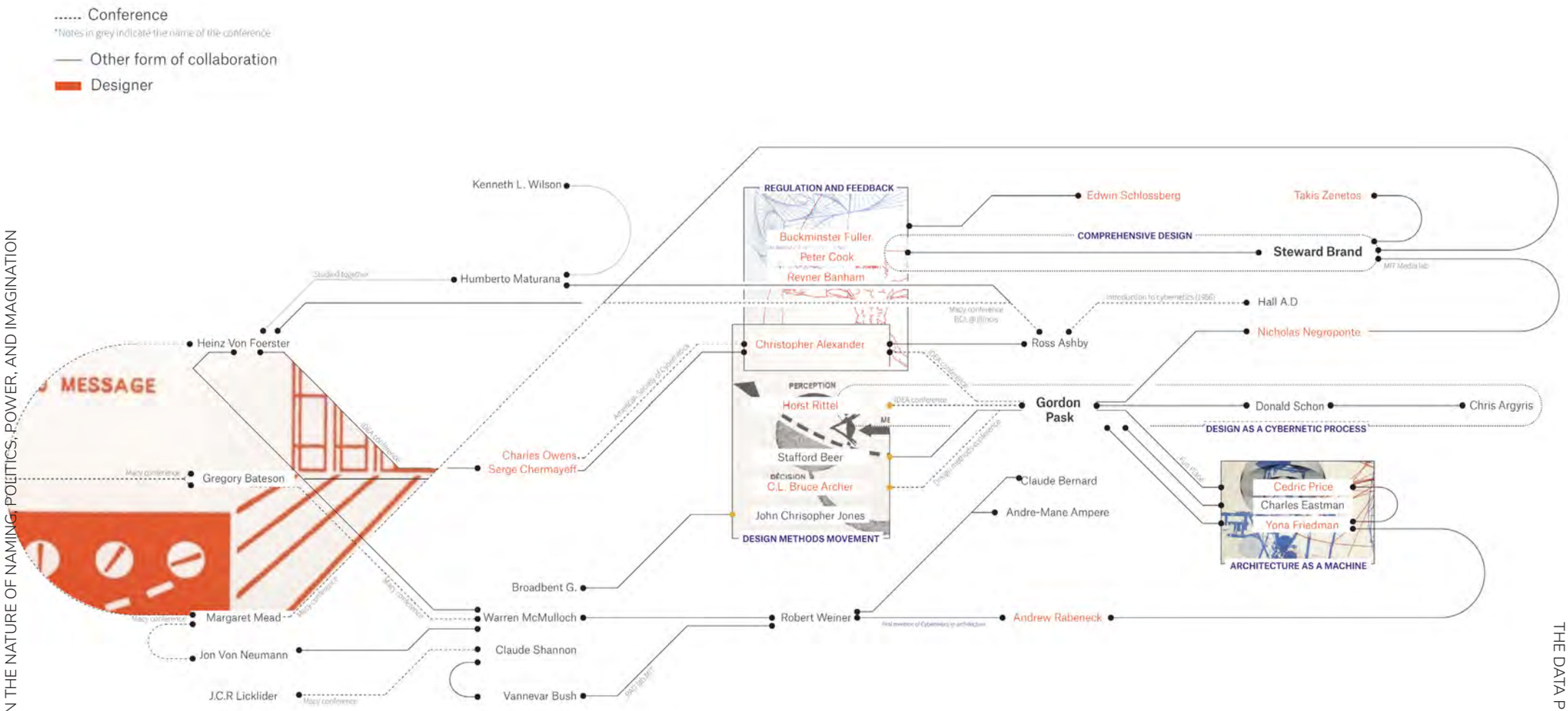
I'd argue that political imagination is imperative to our understanding of cities. They're mechanisms by which we can draw boundaries, blur lines, and leverage metrics and data by which we wield real, actionable change. They make the unseen legible, and the legible into a moveable piece of our society. Ultimately, data is a consequence of power, which is itself a consequence of the moment. Though the city is not a computer, it can be made in the image of one for better or worse, a manifestation of our values in computational form.

22 *Manissa M. Maharawal and Erin McElroy, "The Anti-Eviction Mapping Project: Counter Mapping and Oral History Toward Bay Area Housing Justice,"* ***Annals of the American Association of Geographers*** *108, no. 2 (March 4, 2018): 380–89, doi:10.1080/24694452.2017.1365583.*
23 *"Police Have Killed 852 People in 2018."* ***Mapping Police Violence,*** *accessed November 25, 2018, https://mappingpoliceviolence.org/.*
24 *"Donald Trump: Ban All Muslim Travel to U.S. - CNNPolitics," accessed November 18, 2018, https://www.cnn.com/2015/12/07/politics/donald-trump-muslim-ban-immigration/index.html.*

1 *"Fact Check: 7 Things Trump Got Wrong About the Border and Immigration,"* ***NBC News,*** *accessed November 25, 2018, https://www.nbcnews.com/politics/politics-news/fact-check-7-things-trump-got-wrong-about-border-immigration-n940516.*

CYBERNETICS & DESIGN

Arianna Salazar Miranda



Cybernetics is a discipline that seeks to understand the role of communication in controlling social, biological, and technical systems. The discipline became prominent by developing successful solutions to problems having to do with gunfire control and missile guidance during the American war effort in World War II. However, these innovations did not remain confined to the defense sector. Instead, they spread, seeking civilian applications in both the private and public sector.[1]

One of the pathways through which Cybernetics influenced design was generative architecture. An approach to architectural design that was itself a process, and resisted a specific form or representation as the end goal. This new approach to architecture combined cybernetics, artificial intelligence, graph theory, cognitive psychology, and computer science.

The goal of this project is to map actors in the field of cybernetics in order to show their relationship and influence on design. I use a social graph to illustrate the connections. Subjects are connected to each other if they 1) co-authored together (by way of either remote collaborations or working together in the same university or laboratory), or 2) presenting work at the same conference (occasional event). This approach has also been used by,[2],[3] and[4] to study connections between scientists, architects, and designers, respectively. My resulting network combines the subset of these networks that is relevant for cybernetics and its relationship to design with complementary sources in a comprehensive way.

To draw the social graph, I combine two primary sources of data. First, I use data on publications collected by the University of Illinois to identify the key players in the network.[5] In particular, I use the digitized data on collaborations published by Heinz von Foerster, W. Ross Ashby, Warren S. McCulloch, and Norbert Wiener — four founding members of cybernetics. These data include four categories: 1) the cybernetic subjects extracted from the texts, 2) the associated person (cyberneticians, scientists, and other individuals important to the cybernetics community), 3) cybernetic classification (a broad category), and 4) the certainty or likelihood that the text belongs in that category. Second, I use digitized records from historical exhibitions, magazines, and newspapers to identify relevant events where cyberneticians exchanged ideas and, conceivably, influenced each other directly.[6] By combining these two sources of data, I map individuals according to their conference attendance, and get a sense of which influential ideas they might have exchanged at these conferences.

Interesting relationships emerge between individuals from different intellectual camps. Scientists like Steward Brand, for example, played an important intermediary role, bridging scientists and designers like Nicholas Negroponte, Christopher Alexander, and other architects such as Buckminster Fuller, Peter Cook, and Reyner Banham that were part of the regulation and feedback movement. In particular, there are a handful of key scientists that had ties with design scholars at the time. For example, scientists like Norbert Wiener and Heinz Von Foerster had the greatest number of ties with designers. This might be explained by the fact that Von Foerster, for example, presented to designers at important design conferences such as the Industrial Design Education Association (IDEA) and the 1962 Aspen Design Conference.[7] Important design figures that were part of the American Society of Cybernetics, such as Serge Chermayeff—who taught architecture at Harvard and Yale, and published with Christopher Alexander—also spoke at the IDEA conference.

The Macy Conferences also played an important role, disseminating knowledge in a wide range of subject areas. As far as cybernetics were concerned, this series of conferences sought to lay the foundation for the discipline by fostering interdisciplinary research among a community of scholars and researchers. Overall, Macy Conference participants shared an approach to science that was founded on

1 *J S Light, **From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America**, vol. 24, 2005, doi:10.1109/MTAS.2005.1442381.*
2 *Bethany G. Anderson et al., "The Cybernetics Thought Collective Project: Using Computational Methods to Reveal Intellectual Context in Archival Material," in **2017 IEEE International Conference on Big Data (Big Data)** (IEEE, 2017), 2213–8, doi:10.1109/BigData.2017.8258171.*
3 *Jeremy Till and Tatjana Schneider, "Invisible Agency," **Architectural Design** 82, no. 4 (July 2012): 38–43, doi:10.1002/ad.1426.*
4 *Hugh Dubberly and Paul Pangaro, "How Cybernetics Connects Computing, Counterculture, and Design," E-mail, (2015), http://www.dubberly.com/articles/cybernetics-and-counterculture.html.*
5 *Anderson et al., "The Cybernetics Thought Collective Project."*
6 *Eliza Pertigkiozoglou, "The Architectural Relevance of Cybernetics," E-mail, (2017), https://medium.com/design-science/1962-e244baacb9d0.*
7 *P Pangaro, "The Past-Future of Cybernetics: Conversations, von Foerster, and the BCL," **An Unfinished Revolution? Heinz von Foerster and the Biological Computer Laboratory BCL 1958–1967**, 2007, 1–27.*

interdisciplinary discussion. The conferences brought together participants from a wide range of fields that included physicists, mathematicians, electrical engineers, sociologists, and cultural anthropologists. For example, many scientists participated in the 1950's series of cybernetics conferences; attendees included Gregory Bateson, J.C.R. Licklider, Warren McCulloch, Margaret Mead, Ross Ashby, and Claude Shannon.[8]

Another pivotal cybernetician was Gordon Pask, whose work would help to set the foundations for thought around dynamic, responsive and interactive environments. He envisioned buildings and cities that could adapt over short periods of time and interact with the people who inhabit them. His rationale was that architects were "system designers who had to take interest in the organisational system properties of development, communication and control."[9] Pask had close collaborations with the architects Cedric Price and Nicholas Negroponte, and also to scientists like Stafford Beer, Horst Rittel, and Donald Schon. Most of the connections between scholars in science and design fell under his influence (see diagram). Gordon Pask's pivotal role may be explained by the nature of his work, which unlike traditional scientific approaches, was highly interdisciplinary.[10] Architects and designers were influenced by cybernetics in ways that went far beyond the initial wartime applications of the discipline. This project outlines some of those relationships through which cybernetics might have influenced design and points at a handful of actors and events that were pivotal to how individuals from different fields came together.

8 *Claus Pias and Heinz Von Foerster,* ***Cybernetics : The Macy Conferences 1946–1953 : The Complete Transactions****, 2016, https://www.press.uchicago.edu/ucp/books/book/distributed/C/bo23348570.html.*
9 *John Frazer, "The Architectural Relevance of Cyberspace,"* ***Architectural Design****, no. 65 (1995): 76–77.*
10 *John Hamilton Frazer, "The Cybernetics of Architecture: A Tribute to the Contribution of Gordon Pask,"* ***Kybernetes*** *30, no. 5/6 (July 2001): 641–51, doi:10.1108/03684920110391896.*

CYBERNETIC MAINTENANCE: CARE FOR THE COMPUTER

Agnes Cameron

"My website is a shifting house next to a river of knowledge. What could yours be?"
— Laurel Schwulst[1]

Where the internet was once a lively proliferation of different websites, 70% of web traffic is now routed through sites belonging to Facebook and Google.[2] Much of the computation performed on our phones and computers is mediated by apps, the operation of which is often obfuscated and proprietary, the privacy settings murky. Tech monopolies are moving computation rapidly into physical space: from Amazon's Alexa robot, a recent patent for which included a detector for 'abnormal physical or emotional conditions' as a marketing tool,[3] to Google's Sidewalk Labs, whose promise to craft a city 'from the internet up', powers a vast private data collection programme.[4] These systems blur the line between public and private, the commons and the corporate, using the language of openness and democracy whilst embodying neither[5]. Moreover, the underpaid, and difficult maintenance work that maintains these systems – sanitation workers, Amazon's fulfillment centre staff, Facebook's content moderators, employees at Google's vast server farms, factory workers in Shenzhen – are increasingly obscured from view.

A system cannot remain a black box if one is to care for it. As black-boxed and opaque computational systems increasingly permeate public space, what tools do we have to change that space through changing computation? How do we make legible the maintenance work required to regulate these systems, and come to engage with it ourselves? What other possibilities are offered in computing history, and how might we construct a different future?

1 *Laurel Schwulst, "My Website Is a Shifting House Next to a River of Knowledge. What Could Yours Be?" May 21, 2018, https://thecreativeindependent.com/people/laurel-schwulst-my-website-is-a-shifting-house-next-to-a-river-of-knowledge-what-could-yours-be/.*
2 *Andre Stalz, "The Web Began Dying in 2014, Here's How," accessed December 5, 2018, https://staltz.com/the-web-began-dying-in-2014-heres-how.html.*
3 *Huafeng Jin and Shuo Wang, "United States Patent: 10096319 - Voice-Based Determination of Physical and Emotional Characteristics of Users," patent, (October 9, 2018), http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&u=%2Fnetahtml%2FPTO%2Fsearch-adv.htm&r=1&p=1&f=G&l=50&d=PTXT&S1=10,096,319&OS=10,096,319&RS=10,096,319.*
4 *Shannon Mattern, "Instrumental City: The View from Hudson Yards, Circa 2019," **Places Journal**, April 26, 2016, doi:10.22269/160426.*
5 *Nick Srnicek, **Platform Capitalism** (John Wiley & Sons, 2017), @shaw_informational_2017.*

In this essay, I trace ideas of the computer in its relation to the city in terms of care and maintenance, and the collective production of space. Here, I take 'the computer' to refer to what media theorist Alexander Galloway calls the 'informatic machine'[6], an infrastructure, or set of processes that deal with "information": "any difference which makes a difference in some later event"[7]. This definition is intentionally broad, ranging across the global (the internet), the local (your mobile phone), the abstract (neural networks), and the mechanical (the loom).
From this definition, I will first explore some alternate histories to the computer as a 'control system'. Second, I will focus more specifically on the cybernetic ideal of self-regulation, and tie it to concurrent narratives of maintenance and care. Third, I will consider computational ideas of participation within urban systems. Ultimately, I want to move beyond the critique of ideas of 'the city as computer', and look instead at how we might open up computation to include the kinds of labour so lacking in the 'cybernetic ideal' Google invites us to inhabit.

war machines / warm machines

control systems

"contrary to media theorist Marshall McLuhan's insistence that media is an extension of man, the internet—a paradigmatic example of media—has become an extension of control."
— Zach Blas[8]

Many histories of computing centre on a narrative that cycles in a tight loop between military and corporate interests. This is, after all, an approximately linear and tractable route back from where we find ourselves today: a world that has seen the blossoming of corporate giants (Facebook, Amazon, Google, then Apple, Microsoft) built on innovation from utopian, partially DARPA-funded laboratories (Xerox PARC, the Media Lab, Bell Labs), which themselves were populated

6 *Alexander Galloway, "Anti-Computer," March 19, 2018, http://culture-andcommunication.org/galloway/anti-computer.*
7 *Gregory Bateson, **Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology** (University of Chicago Press, 2000).*
8 *Zach Blas, "Contra-Internet," June 2016, https://www.e-flux.com/journal/74/59816/contra-internet/.*

by many of the men and inventions that sprung from two World Wars' worth of military-industrial investment[9].

The field of Cybernetics has its roots in Norbert Wiener's design of an Anti-Aircraft gun, and Information Theory (a precursor to the modern science of communications) in Claude Shannon's work on wartime cryptography. The Internet itself was prefigured by ARPAnet, a military defence programme inspired by Viet Cong tactics of distribution and dispersal[10]. Jennifer Light traces a history of the 'smart city' to the mid-1960's, where these technologies were applied to the city to 'wage war' on domestic urban crises[11].

everything is deeply intertwingled

The narrative of the computer as a system of control is well-grounded in our present condition, subject as we are to corporate mass-surveillance, creeping automation, and the erosion of civil liberties. However, I argue that we're doing a disservice to computers, to their history (and, crucially to ourselves) if this is the only trajectory we chart. As Doreen Massey writes on globalisation in her book For Space: "the cosmology of 'only one narrative' obliterates the multiplicities, the contemporaneous heterogeneities of space", a pernicious 'sleight of hand' that convinces us of the inevitability of a particular path[12]. Indeed, as Sadie Plant notes in Zeroes and Ones, it is the very nature of computation that merits a non-linear history, based as it is in "a process which simultaneously assembles and dismantles the route back to the start, the end, the future, the past."[13]

Ted Nelson's Computer Lib/Dream Machines, published in 1974 (a year before the appearence of the first Personal Computer, and decades before the first webpage), forms a manifesto for a different kind of computation. "You can and must understand computers NOW!"[14], the cover insists. Nelson also introduced the idea of hypertext, the linking-together of digital text through references, coining the phrase "Everything is deeply intertwingled". Nelson imagined hypertext fundamentally as a '2-way, visible connection', an ideal he sees as betrayed by Tim Berners-Lee's eventual implementation of HTML in 1989 (which became the World Wide Web), in which connections between information are unidirectional. Jarod Lanier remarks that "It's a small, simple change in how online information should be stored that couldn't have vaster implications for culture and the economy."[15]

Over a century before that, Ada Lovelace had declared that "all and everything is naturally related and interconnected". Plant notes that her ideas are often thought of has coming far too early,"works of genius so untimely as to be more or less irrelevant to the course of machines". In fact, Plant observes that technical developments are "rarely simple matters of cause and effect". As Lovelace herself declared: "That Brain of mine is something more than merely mortal; as time will show.''

making a warm machine

> *"The computer is an incredible projective test: what you see in the computer comes right off the back wall of your psyche."*
> *— Ted Nelson*[16]

Bristol Robotics Lab might not, outwardly, seem like the place to be thinking about philosophy. The building is a huge warehouse next to an airport, decorated at the entrance with 2 ornamental robot arms, its interior divided into 3x3 metre cubes filled with machinery. The lab houses plenty of the things that you might expect (manufacturing, drone swarms) but it is also home to the Artificial Culture Project, which studies the emergence of culture among social robots. This project, and others, come out of the research of Alan Winfield, a professor of robot ethics who works on, amongst other things, a robot theory of mind. This intelligence is articulated in the 'consequence engine', a simulation-based internal model that builds an internal model of others around it[17]. In writing about this work, Winfield

9 *J S Light, **From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America**, vol. 24, 2005, doi:10.1109/MTAS.2005.1442381.*
10 *Sadie Plant, **Zeros + Ones: Digital Women + the New Technoculture** (Fourth Estate, 1998).*
11 *Light, **From Warfare to Welfare**.*
12 *Doreen Massey, **For Space** (SAGE, 2005).*
13 *Plant, **Zeros + Ones**.*
14 *Theodor H. Nelson, **Computer Lib ; Dream Machines** (Tempus Books of Microsoft Press, 1974).*
15 *Jaron Lanier, **Who Owns the Future?** (Simon and Schuster, 2014).*
16 *Nelson, **Computer Lib ; Dream Machines**.*
17 *Alan Winfield, "Alan Winfield's Web Log: When Robots Start Tellin Each Other Stories..." **Alan Winfield's Web Log**, July 24, 2012, https://alanwinfield.blogspot.com/2012/07/when-robots-start-telling-*

invokes a conversation with Neuropsychologist Richard Gregory: "when your robots start telling each other stories, then you'll really be onto something."[18]

Winfield's work seeks to understand intelligences as embodied and situated within agents, not in the service of humans, but for their own sake. This work plays on the distinction between 'The Machine' and 'Warm Human Being', a divide critiqued by Nelson as promulgated by 'rigid, narrow, and inflexible people', more a reflection of themselves than any strict idea of computation[19].

caring for and about machines

> *"Attention is care. And there is much to care about!"*
> *— Matthew Wilson*[20]

What, then, does it mean to care for a computer, or indeed any infrastructural system? Here, I take Wilson's definition of attention as a form of care, the act of caring being at its core an act of thoughtfulness. Larissa Belcic's project An Antidote to Loneliness outlines a set of 'practices for technological friendship' that seeks to pair human and non-human ecologies with parts of unloved electrical infrastructure. Much as Ada Lovelace regarded the Analytical Engine as a "friend"[21], Belcic advocates that technology be included as part of an ecology, rather than hidden: 'not to improve efficiency or function but for love, friendship and well-being'[22].

Artist Taeyoon Choi writes about hand-making a computer as an "act of love, love for the ideas that the computer has come to embody"[23]. Indeed, acts of craft and care in computational environments are not new: for the better part of computing history, people used computers by making them. The explosion of new sites in the early days of the

each-other.html.
18 *Alan Winfield, "Oral-History:Alan Winfield - ETHW," accessed December 5, 2018, https://ethw.org/Oral-History:Alan_Winfield.*
19 *Nelson, **Computer Lib ; Dream Machines**.*
20 *Matthew W. Wilson, "Towards a Genealogy of Qualitative GIS," in **Qualitative GIS**, ed. Meghan Cope (London: SAGE, 2009), 156–70.*
21 *Plant, **Zeros + Ones**.*
22 *Larissa Belcic, "An Antidote to Loneliness - Larissa Belcic," 2016, https://larissabelcic.com/An-Antidote-to-Loneliness.*
23 *Taeyoon Choi, "Open Circuit, Open City - Taeyoon Workshop," December 2016, https://taeyoonchoi.com/2016/12/open-circuit-open-city/.*

web is often the subject of nostalgia: the joy of maintaining one's MySpace or Geocities page, like tending to a garden. Of course, as Mattern reminds us, acts of care and maintenance are political, and not to be mistaken for altruism.[24] The choice of whether (or not) to care exists along gendered, racialised, social, and geographical lines, and in relation to a broad set of infrastructures.

cybernetic maintenance

> *"Move slow and fix things"*
> *— McKenzie Wark*

self-regulating systems

A foundational idea in cybernetics is that of "negative feedback as a fundamental mode of self-regulation", exemplified in William Ross Ashby's image of the homeostat, an electromechanical apparatus built as a demonstration of how an organism maintains 'homeostasis' — stability in light of environmental disruption. Homeostasis was originally a word applied only to living matter[25]; in Ashby's invocation of the homeostatic machine, this form of stability became something that one could design for.

This idea of self-regulation is a central aesthetic of computation, one that belies the constant upkeep required to maintain an appearance of seamless functionality. The 'clean', 'transparent' interface perfected by the iPhone, for example – a technology 'built to disappear' – displaces a deeply material reality. Jay Owens writes on this dissonance, tracing the physical 'dust' associated with the most apparently 'dustless' surfaces: from the toxic dust created by the fine milling of aluminium cases, to the suffocating smog of mountains of e-waste accumulated in Ghana, Thailand and Hong Kong[26].

This control-loop ideal — of cycles of perturbation and feedback response resulting in eventual stability — permeated a number of

24 *Shannon Mattern, "Maintenance and Care," November 2018, https://placesjournal.org/article/maintenance-and-care/.*
25 *Alise Upitis, **Nature Normative: The Design Methods Movement, 1944–1967**, 2008.*
26 *Jay Owens, "Digital Dust," **Jay Owens**, accessed February 11, 2019, https://medium.com/@hautepop/digital-dust-356172db322f.*

disciplines, not least that of architecture and urban design. The architect Christopher Alexander was particularly inspired by this ideal of homeostasis, expressing design problems as the "actions of a series of subsystems". As Keller Easterling put it, the projects of Alexander and his colleague Cedric Price were "on the threshold of designing an architecture that has become information"[27].

Perhaps one of the most striking historical visions of the smart city in its adherence to cybernetic ideals is the Architecture Machine Group's project SEEK, which sought to build a direct feedback loop between a set of urban inhabitants (a swarm of gerbils) and a benevolent automated environment. The system was made with the idea that the gerbil would learn how its behaviour affected the motion of the machine, and react accordingly. That the gerbils were none too amused with the system has remained something of a side note.[28]

urban homeostasis

Another meme of the self-regulating system is the black box: an abstraction of a system to a set of inputs and outputs, that renders opaque it's inner workings. URBAN 5, another of the Architecture Machine group's Computer Aided Urban Design tools, was termed by Jonathan Barnett "the most spectacular example of blackboxmanship"; pointing to an interface that abstracted away much of the 'friction of the real world.'[29] This idea has persisted: in a 2010 lecture, Alex Galloway declared that 'there is a new political posture today… with an acute black-box profile', a commentary on the extent to which political decision-making is obfuscated behind an appearance of simplicity[30].

In this sense, the city as computer becomes a useful metaphor. The idea that one can create a complex system based on an initially

27 *Keller Easterling, "An Internet of Things - Journal #31 January 2012 - E-Flux," January 2012, https://www.e-flux.com/journal/31/68189/an-internet-of-things/.*
28 *Felicity D. Scott, "DISCOURSE, SEEK, INTERACT: Urban Systems at MIT," in* ***A Second Modernism: MIT, Architecture, and the "Techno-Social" Moment****, ed. Arindam Dutta (Cambridge, MA: MIT Press, 2013), 342–93.*
29 *Ibid.*
30 *Alexander Galloway, "Black Box, Black Bloc,"* ***Critical Digital Studies: A Reader****, January 1, 2013, 218–26, https://nyuscholars.nyu.edu/en/publications/black-box-black-bloc.*

simple set of rules (Conway's Game of Life is perhaps the most widely-used example of this), starts to feed a notion that every complex system is reducible to a simple rule-set, if only that set of rules can be found. These images of self-regulation smoothly translate from the human-scale (the 'user' of the urban environment) directly into governance, feeding back and adjusting to suit the needs of urban inhabitants.

The actually-existing city, of course, regulates itself through different kind of feedback: the labour of postal workers, street cleaners, bus drivers, and traffic wardens. However, as Mattern reminds us: "we have to recognize that maintenance and repair have always been shaped by the political, social, cultural, and ecological contexts of technology."[31] As the city becomes 'smarter', this work does not disappear, but it is changed. Ted Nelson remarks: 'there is no such thing as "fully" computerized. There is always one more thing computers could do.'[32].

the girl in the machine

The tricky politics of maintenance and the interface plague the ideal of cybernetic governance. Stafford Beer's Cybersyn project — an attempt at data-driven, bottom-up socialism in Allende's Chile used, as a central image, a 'control room' that rendered Chile's production data legible and accessible to all. As Medina notes in her account of the project: "the clean, futuristic appearance of the control room obscured the vast network of individuals, materials, expertise, and information required to make economic management appear simple". Using the hidden labour of (female) graphic designers, complex charts were made navigable by a few buttons, eliminating the "girl between themselves and the machinery" — the female typist who would normally navigate this information.[33]

Sadie Plant remarks that "before their beginnings and beyond their ends, women have been the simulators, assemblers and programmers of the digital machines", She sees the work of computation as fundamentally linked to the practice of weaving, not just as a mode

31 *Mattern, "Maintenance and Care."*
32 *Nelson,* ***Computer Lib ; Dream Machines****.*
33 *Eden Medina,* ***Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*** *(MIT Press, 2014).*

of information processing (the loom as a processor, the fabric as memory), and as a physical precursor to mechanical computers, but also a practice that has created a set of social relations re-created by women in the service of digital systems today. In all these cases, the "means of communication begin to communicate with themselves."[34] This ideal of weaving as social computation comes up in multiple places. Bret Victor's Dynamicland project – a social computer that is programmed using paper and pens – evokes the knitting circle as a form of co-creation central to his vision of a 'new kind of computer'. Suzanne Lacy's artwork The Crystal Quilt uses the collective computation of quilting as a performance, bringing together 430 women over the age of 60 to share their views on ageing, while following a collective protocol that produced a patterned quilt.[35] These projects centre the kind of caring labour (for one another, for the system) that is normally ignored by the language of 'innovation', but happens all the same.

care, attention, repair

"After the revolution, who takes out the trash on Monday morning"
— Mierle Ukeles[36]

Maintenance is innovation made personal, it is also innovation made social.
— Ezra Teboul[37]

There are many places where the systems ideal of self-regulation disconnects with its 'real-world' manifestation as maintenance labour, but perhaps none so much as in waste and sanitation. If waste is information,[38] then what does it mean that we obscure this information from view? As Mattern remarks on the 'smart' waste chutes installed at the Hudson Yards development: "[they] cultivate an out-of-sight, out-of-mind public consciousness… garbage becomes more of a domestic aesthetic problem than an ecological concern." She asks instead whether the designers might provide a view of the "smart, efficient" waste collection system, making legible the infrastructure of disposal.[39]

The art of Mierle Ukeles has for decades centered waste. Her Manifesto for Maintenance Art (1969) is a critique of the 'Death Instinct' of the Avant-Garde "to follow one's own path to death—do your own thing; dynamic change", in comparison to the unifying and perpetual act of maintenance.[40] In her works, she encourages visitors to observe and participate in waste systems, in durational pieces where she would bring in containers of refuse to the gallery and 'purify' them over the course of an exhibition. In proposing a project for the Fresh Kills landfill site in 2001, she terms it "a true social sculpture composed of 150 million tons from literally billions of individual decisions and acts of rejection."[41]

What is the computational analogue of these sites of disposal? One could, as artist Hito Steyerl remarks, consider the endless cycle of spam as a circulation of discarded 'poor' images, the "trash that washes up on digital economies' shores."[42] Is it the 'mass of dead and broken links' decried by Ted Nelson as the product of one-directional hypertext? Maybe it is the subjects of Bruce Sterling's Dead Media Project, a collection of obsolete information technologies ranging from the Incan qipu to the IBM Letterwriter (itself, ironically, now a dead link maintained by the Internet Archive)[43]. Perhaps it is, as Jennifer Gabrys describes, landfills themselves – built up from the global circulation of e-waste from constant cycles of 'innovation', Ukeles' death instinct alive and well.[44]

In reading these collective 'social sculptures' as the products of complex information systems that we do not care for, how do we

34 *Plant,* ***Zeros + Ones****.*
35 *Suzanne Lacy, "The Crystal Quilt (1985–1987),"* ***SUZANNE LACY****, accessed February 11, 2019, http://www.suzannelacy.com/the-crystal-quilt/.*
36 *Mierle Laderman Ukeles, "Manifesto for Maintenance Art 1969!"* ***Journal of Contemporary Painting****, 1969, http://link.galegroup.com/apps/doc/A533005114/AONE?sid=googlescholar.*
37 *Ezra Teboul, "Maintenance Is Innovation Made Personal / Maintenance Is Innovation Made Social,"* ***Red Thunder Audio // Ezra Teboul****, 2018, https://redthunderaudio.com/post/180493461817/maintenance-is-innovation-made-personal.*
38 *Dietmar Offenhuber and Carlo Ratti,* ***Waste Is Information: Infrastructure Legibility and Governance*** *(MIT Press, 2017).*
39 *Mattern, "Maintenance and Care."*
40 *Ukeles, "Manifesto for Maintenance Art 1969!"*
41 *Jillian Steinhauer, "How Mierle Laderman Ukeles Turned Maintenance Work into Art,"* ***Hyperallergic****, February 10, 2017, https://hyperallergic.com/355255/how-mierle-laderman-ukeles-turned-maintenance-work-into-art/.*
42 *Hito Steyerl, "In Defense of the Poor Image,"* ***E-Flux****, 2009, 9.*
43 *Bruce Sterling, "The Dead Media Project," accessed February 11, 2019, http://www.deadmedia.org/.*
44 *Jennifer Gabrys,* ***Digital Rubbish: A Natural History of Electronics*** *(University of Michigan Press, 2013).*

come to engage these systems? Should we even be obliged to? In acknowledging the individual futility of recycling, waste scholar Max Liborion reminds us that 'even if individual actions don't save the world, they are expressions of an ethic that can lead to other actions that do scale.' This ethic: of care, of attention, is key in engaging these systems past symbolic participation[45].

(co)computing as maintenance work

> *"Discos are more fun than dancing alone"*
> *— Bret Victor*

In Waste is Information, Offenhuber examines the role of interfaces between citizens and governments in 'participatory' waste collection systems, making the argument that the politics of representation of a system require a set of common protocols. He critiques the notion of decentralisation for decentralisation's sake, arguing that the fragmentation of urban services can create the kind of inequality it might purport to dynamically address.[46] Shaw and Graham, too, warn against an uncritical ideal of urban participation, arguing that: "'Openness', 'democracy', 'user-feedback' and 'participation' are all part of the mode of governance for informational capitalism—it is precisely the invitation to behave as an individual that reproduces the power in the hands of an elite."[47]

Nascent 'alternative' narratives of computation are increasingly centred around the co-creation of a common space, and seeing oneself as a part of a system (rather than an observer or user). From the peer-to-peer web to Victor's Dynamicland, utopian visions of future computing infrastructure centre an ideal of participation. In a critique of an overly-simplistic invocation of 'P2P socialism', Ulises Ali Mejias states that "Despite capitalism's attempts to expropriate them, the new models of collaboration opened up by P2P can be fruitful if they are converted into authentic political platforms that revitalize the public sphere. P2P does not have to be a 'publicness without a public sphere.'"[48]

45 *Max Liboiron, "Love in E-Waste, a Workshop," **Discard Studies**, July 1, 2014, https://discardstudies.com/2014/07/01/love-in-e-waste-a-workshop/.*
46 *Offenhuber and Ratti, **Waste Is Information**.*
47 *Shaw and Graham, "An Informational Right to the City?"*
48 *Ulises Ali Mejias, **Off the Network : Disrupting the Digital***

feeling, being the new computer

"More autogestion, less autosuggestion!" — Joe Shaw and Mark Graham[49]

In her essay ***My website is a shifting house next to a river of knowledge. What could yours be?***, artist and designer Laurel Schwulst argues for the artist website as a means of reclaiming the web. This is in direct response to the reducing of the web to a set of sanitised platforms, a reaction to the real difficulty inherent in spontaneously naming a website that isn't Facebook, Google, Twitter or YouTube. She argues that simply by having an 'artist website' — by becoming an active part of the infrastructure — you undertake "an individual act of collective ambition". Schwulst's imaginary of the web is figured heavily in terms of maintenance. The language she uses: tending, cultivating, metaphors of websites as houses and gardens, centre careful, thoughtful development as a form of civic computation.[50]

Shaw and Graham, too, advocate for a techno-future in which "We must actively enjoy the practice of producing and managing our urban information.", and of "actively living with the digital information we produce". This vision – and the visions of P2P projects such as Dat and IPFS – might be utopian, but it acknowledges the role of care in producing change. Within the ideal of homeostasis, Christopher Alexander understood the need for maintenance alongside the creation of the new: "when you build a thing you cannot merely build that thing in isolation, but must repair the world around it, and within it, so that the larger world at that one place becomes more coherent, and more whole; and the thing which you make takes its place in the web of nature, as you make it."[51]

***World.**, 2013, https://lib.mit.edu/record/cat00916a/mit.002181786.*
49 *Shaw and Graham, "An Informational Right to the City?"*
50 *Schwulst, "My Website Is a Shifting House Next to a River of Knowledge. What Could Yours Be?"*
51 *Christopher Alexander, **A Pattern Language: Towns, Buildings, Construction** (Oxford University Press, 1977).*

reappearing act

In a speech to the 2015 World Economic Forum, chairman of Alphabet Inc. (née Google) Eric Schmidt declared that "the Internet will disappear". He seems not to be the only one in on this vanishing act: in recent years, we have been promised a host of disappearances, not least the iPhone, which envisions a product "so immersive the device itself disappears into the experience.". These products will not, of course, go away – instead, as Zach Blas points out "...to disappear the internet is to dissolve its infrastructures into the very materialities that compose contemporary life and the world."[52]

In Situated Knowledges, Haraway underlines the importance of vision, both as a tool of oppression and a tool of resistance. Seeing everything is, of course, impossible: a 'god trick'. But within a "particular and specific embodiment", vision allows us to "become answerable for what we learn how to see."[53] If participation in a system is an act of care, then seeing that system: the garbage truck, the 'dusty' iPhone screen, the HTML is a means by which one can participate. *hnoculture*. Fourth Estate, 1998.

52 *Blas, "Contra-Internet."*
53 *Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,"* ***Feminist Studies*** *14, no. 3 (1988): 575–99, doi:10.2307/3178066.*

AN INCOMPLETE MOTIF INDEX OF THE TECHNOLOGICAL AND THE URBAN

Dylan Halpern

Keywords:
Critical Visualization, Critical Theory, Feminist Theory, Computational Urbanism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STANDARD------------------REAL LIFE---------------REAL TI
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Introduction

This index surveys and describes key themes in critical theory on technology, society, and city. Pointing to ideas as far back as Foucault, this document aims to provide a brief, accessible editorial of motifs from critical geography, planning, visualization, and Science and Technology Studies (STS). Accompanying this paper is a circuit diagram that links and spatializes the ideas included within.

2.0

2.0 is a suffix that denotes a second version of an idea, technology, or method. It is rooted in and references digital technologies and their versions indicated with numeric decimals (e.g. Firefox version 60.3.0, browser at time of writing). 2.0 came to prominence in the 2000s as digital culture became mainstream; Darcy DiNucci's coining of Web 2.0[1] and O'Reilly's[2] subsequent usage was an early indicator of the 2.0 nomenclature to come. For a more complete history of Web 2.0, see Cristina Aced's[3] "Web 2.0: the origin of the word that has changed the way we understand public relations." Now, 2.0 points to a cheap bravado and superficially technicality standing in for evolution; post is currently the preferred scholarly affix to connote evolution.

On the renaissance of "post-" prefixes: Trevor Barnes analyzes "post-" as a reminder to: 1) critically examine disciplinary origins, power, and assumptions; 2) consider non-Western or "other" conceptions within a given discipline, and; 3) reiterate the importance of political practice within a discipline.[4]

1 Darcy DiNucci, "Fragmented Future," **Print**, April 1999, 32, 221–22.
2 Tim O'Reilly, "What Is Web 2.0," September 2005, https://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html.
3 Cristina Aced Toledano, "Web 2.0: The Origin of the Word That Has Changed the Way We Understand Public Relations," n.d., 13.
4 Philip Kelly, "Logics of Dislocation (1996): Trevor J. Barnes," in **Key Texts in Human Geography** (1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications Ltd, 2008), 197–206, doi:10.4135/9781446213742.n23.

Affect, affective rationality

As an element of feminist theory, affect traces an inquiry into emotions. Affect explores, implicates, or interrogates on the role of emotions, simple or complex, in our experiences, ethics, thoughts, and decisions. Increasing in popularity over the past two decades, questions of affect call into question 'residual cultural Cartesianism' that has heretofore excluded substantive considerations of feeling and reason.[5] Deborah Thein traces this turn across disciplines[6]:

> *"Social, cultural and feminist geographers (Bondi 1999 forthcoming; Wood 2002; Airey 2003; Bodi and Fewell 2003; Callard 2003; Thrift 2004), cultural and gender theorists (Chodorow 1999; Ahmed 2002 2004; Harding and Pribram 2002; Sedgwick 2003), philosophers (Nussbaum 2001), sociologists (Jamieson 1998; Hochschild 2000 2003; Williams 2001; Fortier 2003); those in the psychological disciplines (Matthis 2000; Blackman 2004) and neuroscientists (Damasio 2000)..."*
> – Deborah Thein, "After or beyond Feeling? A Consideration of Affect and Emotion in Geography", 2004 (p.450)[7]

Brian Massumi, for example, theorizes "affective rationality" or "affective fact" – a concept of codifying perception into fact, and sometimes reality, based on feelings and intuitions[8].

> *"...the dynamical object exclaimed by the sign of alarm, is nothing other than the dynamic form of the body at this instant of reawakening to its world on alert, imperatively altering....Fire or no fire, transition to and through alert is made."*
> – Brian Massumi, "The Future Birth Of The Affective Fact: The Political Ontology Of Threat" In Digital And Other Virtualities: Renegotiating The Image, 2010 (p.90)[9]

5 N Thrift, "Intensities of Feeling: Towards a Spatial Politics of Affect," **Geografiska Annaler Series B** 86 (n.d.): 57–78; Deborah Thien, "After or Beyond Feeling? A Consideration of Affect and Emotion in Geography," **Area** 37, no. 4 (December 2005): 450–54, doi:10.1111/j.1475-4762.2005.00643a.x.
6 Ibid.
7 Ibid.
8 Antony Bryant and Griselda Pollock, eds., **Digital and Other Virtualities: Renegotiating the Image**, New Encounters. Arts, Cultures, Concepts (London ; New York: I. B. Tauris, 2010).
9 Ibid.

"If you can't be there, feel there." 2018 ad for Facebook "portal" smart hub/tablet device.

Ambividuals

Jennifer Gabrys succinctly describes ambividuals as, "ambient and malleable urban operators that are expressions of computer environments."[10] Applicable to human or machine agents, Gabrys proposes this concept as an alternative to assertions that smart cities point towards a dissolution of individualism[11]. Rather, the ambividual descends from a Foucauldian bloodline, pointing towards environmentality, probabilistic articulations of subjectivity, and the real-time siting of subject through omnipresent sensors.[12]

10 *Jennifer Gabrys, "Programming Environments: Environmentality and Citizen Sensing in the Smart City,"* ***Environment and Planning D: Society and Space*** *32, no. 1 (2014): p.42, doi:10.1068/d16812.*
11 *Ibid.*
12 *Ibid.*

Binary

a) Binary may refer to a two-state definition often represented as 1 or 0: on and off, female and male, good and evil. In electronics, this distinction is recorded by magnetic states in hard drive platters, charge status in Flash memory and other semiconductors, and polarity in electron memory storage. Catherine D'Ignazio reminds us of the centrality of challenging binaries to feminist theory; she traces the "disavowal of binary distinctions" across dichotomies of "nature and culture [37], subject and object [43], reason and emotion [54], and body and world [4], among many others."[13]

> "...don't be evil..."
> – Google (Alphabet) Code of Conduct, Updated July 31, 2018[14]

b) Binary may also be a mode of counting alternative to decimal.

> *1, 10, buckle my shoe*
> *11, 100, shut the door*
> *101, 110, pick up sticks*
> *111, 1000, lay them straight*
> *1001, 1010, begin again*

c) Binary is also a significant concept for the work of Claude Shannon. Shannon theorized a mode of information conveyance through an abstracted numerical form – the binary system.[15] Shannon's work has been foundational in the abstraction of information into code and programming languages, coining the word "bits" as an abbreviation for "binary digits."[16]

Biometric Consciousness

Biometric Consciousness refers to a critical practice and thinking for biometric data on the human body and the individual.[17] Simone

13 *Catherine D'Ignazio and Lauren F Klein, "Feminist Data Visualization," 2016, p.2.*
14 *Alphabet, "Alphabet Investor Relations,"* ***Alphabet Investor Relations****, July 2018, https://abc.xyz/investor/other/google-code-of-conduct.*
15 *C E Shannon, "A Mathematical Theory of Communication,"* ***The Bell System Technical Journal*** *27 (n.d.): 379–423, 623–56.*
16 *Ibid, p.1.*
17 *Simone Browne,* ***Dark Matters: On the Surveillance of Blackness***

Browne conceptualizes critical biometric consciousness as a method "to situate certain biometric information technologies as techniques through which the cultural production of race can be understood."[18] Browne characterizes critical biometric consciousness as a forum for encouraging public discourse on topics including:

- Accountability of data ownership and capture
- The manufacture of technology,
- particularly on mineral extraction and labor
- Fallibility of biometric technology and its probabilistic methods
- Connections of biometric systems to past technologies, histories
- Exclusion based on failure to enroll errors
- Addressing "our linked subjectivity" and responsibilities to and from one another

Black Box

a) Frank Pasquale characterizes a black box as a closed system whose results are so patently true and confident that we needn't question it.[19]

> *"Who refers to Lavoisier's paper when writing the formula H2O for water?"*
> – Bruno Latour

b) A black box may also describe an impenetrable system from which we observe nothing but what comes in and out.

> *During the Cold War, Soviet surveillance of the Pentagon noticed a structure in the 5-acre courtyard. Every day, US officials would go to the structure empty-handed and leave with a mysterious brown bag. KGB operatives spent sleepless nights tossing and turning, wondering why the American 'dogs' darted to and from this cart, searching for 'links' that might serve as clues to what the brown bags contained. Fearing the worst, DOD lore holds that this hot spot "never had any less than two missiles aimed" at it.*[20‡]

c) In aviation, a black box is a flight recorder used to capture critical data in the event of an emergency – typically orange.

Clouds

Where stand the whereabouts of power?

Cloud Computing is a broad category of service delivery. It is generally constructed from a network of remote servers, rather than one locally; it is generally characterized by the vendor maintaining and managing back-end processes (e.g. "the cloud"), a pay-as-you-go pricing model, and options to scale services.[21]

In understanding today's geopolitics, Louise Amoore argues for the importance of institutional/governmental cloud computing, examining its geography, structures, and "practices of data gathering, analysing and knowing."[22] Amoore points to ICITE, a US government 17-agency cloud data repository, as an example of the technology's significance. Such interconnectivity among data points and algorithmic learning forges new perceptions, cognitions, and probabilistic inferences.[23]

> *"Cognitive computing renders perceptible to the analyst 'what matters' geopolitically, using the volume of cloud-based digital data precisely to reduce and flatten the field of vision....The volume is radically condensed down to the target data elements, like beaded drops on ionizing particles through which future trajectories of motion can be inferred."*
> – Louise Amoore, "Cloud geographies: Computing, data, sovereignty"[24]

(Durham: Duke University Press, 2015).
18 *Ibid, p.118.*
19 *Frank Pasquale, **The Black Box Society: The Secret Algorithms That Control Money and Information** (Cambridge: Harvard University Press, 2015).*
20 *Department of Defense, "Defense.Gov News Article: Pentagon Hot Dog Stand, Cold War Legend, to Be Torn Down," June 2015, http://archive.defense.gov/news/newsarticle.aspx?id=1049.*
21 *Techopedia, "What Is Cloud Computing? - Definition from Techopedia," **Techopedia.com**, December 2018, https://www.techopedia.com/definition/2/cloud-computing.*
22 *Louise Amoore, "Cloud Geographies: Computing, Data, Sovereignty," **Progress in Human Geography** 42, no. 1 (February 2018): p.6, doi:10.1177/0309132516662147.*
23 *Ibid.*
24 *Amoore, p.14.*

Amoore references John Allen and his concept of whereabouts of power. He posts that the location of authority is relational[25]. It exists in a network that may or may not be centralized or decentralized. He asserts that power is formulated of media, of "territorially embedded assets and resources – of money, information, people, ideas, symbols, technologies and such…"[26]

In picnics, clouds may appear as simple aerosol masses to some, equestrian visages to a few, and breaks from the heat for others.

code/space

Rob Kitchin and Martin Dodge describe a code/space as bipartite label for the pair-bonded relationship that has flourished between computer programming and spatiality.[27] They are places intrinsically tied to both technology and location. Kitchin and Dodge point to retail services, networked logistics, and increasingly automated vehicles and their motorways as examples of established and emerging code/spaces.

Communicative Objectivity

Orit Halpern describes communicative objectivity as "a radical shift in attitudes to recording and displaying information that produced new forms of observation, rationality, and economy based on the management and analysis of data."[28] Halpern, writing on visual artists like György Kepes, E.A.T., and others, frames communicative objectivity as a data-driven form of knowledge generation. Communicative objectivity makes and remakes facts recursively: pre, post, ad, and propter hoc. Halpern writes that the canvas for communicative objectivity is "the assumed recordability of the world," and so we might offer sensors as its catalysts.

25 *John Allen, "The Whereabouts of Power: Politics, Government and Space,"* ***Geografiska Annaler: Series B, Human Geography*** *86, no. 1 (March 2004): 19–32, doi:10.1111/j.0435-3684.2004.00151.x.*
26 *Allen, p.13.*
27 *Rob Kitchin and Martin Dodge,* ***Code/Space: Software and Everyday Life****, Computer software Studies (Cambridge, Mass: MIT Press, 2011).*
28 *Orit Halpern,* ***Beautiful Data: A History of Vision and Reason Since 1945****, Experimental Futures (Durham: Duke University Press, 2014).*

Critical Visualization

Peter Hall outlines critical visualization as a practice of viz that challenges sensorial, cultural, and scientific assumptions.[29] Contemporary critical visualization – and its cousins, critical mapping and GIS – sidesteps dichotomies of narrative or data-driven motivations, instead creating networked, rhizomatic media that challenge information and knowledge hierarchies. These media are immediately cross and self-referential. They are multiform, interpretable, and varied.

Culture of Simulation

Jennifer Light describes a culture of simulation as a pointer often used to trace smart cities origins in post-war America.[30] Light attributes this term to the work of Jean Baudrillard, but she asserts that it may be deceptive. Instead, Light argues, smart city antecedents may lie "in the context of military war games and RAND and MIT…"[31] Simulations, alongside other military decision-making instruments re-upholstered for municipal governance, present the capacity for legitimate insight concurrent with the seduction of great simplification.

Cyborg

Cyborg may be a portmanteau of cybernetic and organism coined by Manfred Clynes and Nathan Kline.[32]Their concept was originally proposed to enable self-regulation of the human body in deep, cold extraterrestrial travel.

> *"While it is quite difficult to set upper limits to 'natural' human physiological and psychological performance, we can take as minimal the capabilities demonstrated under control conditions such as yoga or hypnosis."*
> – Manfred Clynes and Nathan Kline, Cyborgs and space, 1960[33]

29 *Peter Hall, "Critical Visualization," in* ***Design and the Elastic Mind*** *(New York: Museum of Modern Art, 2008), 122–31.*
30 *Jennifer S. Light,* ***From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America*** *(Baltimore: Johns Hopkins University Press, 2003).*
31 *Light, p.24.*
32 *Manfred Clynes and Nathan Kline, "Cyborgs and Space,"* ***Astronautics****, September 1960, 26–27, 74–76.*
33 *Ibid.*

Donna Haraway's A Cyborg Manifesto establishes cyborg as a conceptual, political, and/or social hybrid[34]. The amalgam is not just of mechanism and organism in a conventional sense; Haraway's cyborg combines real social phenomena and narrative fiction, mapped realities and imagined resources, and physical being and abstract consciousness.[35] Haraway describes the cyborg as a condensed, ontological image of self meant to challenge patriarchal, white ideas of borders and silos; it encourages "pleasure in the confusion of boundaries and for responsibility in their construction,"[36](p.150). Cyborg politics represents a transgression of boundaries in sardonic, irreverent modes; it is fractured into futures of inferno and paradise, depending on your perspective.[37]

> *"People are nowhere near so fluid, being both material and opaque. Cyborgs are ether, quintessence."*
>
> *"[W]e are living through a movement from an organic, industrial society to a polymorphous, information system – from all work to all play, a deadly game."*
> – Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century" 2006,[38](p. 154, 159)

Among the foundations for Haraway's manifesto is Chéla Sandoval's concept of Oppositional Consciousness. Beyond the scope of this index, Sandoval's work is extremely relevant in tracing the genealogy of cyborgian and a few other schools thought included here. For further reading, see Oppositional Consciousness in the Postmodern World: U.S. Third World Feminism, Semiotics, and the Methodology of the Oppressed.

34 *Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late 20th Century," in* ***The International Handbook of Virtual Learning Environments****, ed. Joel Weiss et al. (Dordrecht: Springer Netherlands, 2006), 117–58, doi:10.1007/978-1-4020-3803-7_4.*
35 *Ibid.*
36 *Ibid.*
37 *Ibid.*
38 *Ibid.*

Data Derivative

Louise Amoore describes the data derivative as an amalgam of fragmented data.[39] In making it, fragments are reconstituted and imagined into our "proclivities and potentialities,"[40](p.1). Amoore suggests four fundamental elements of the data derivative: "temporalities; norm/anomaly; the virtual and the visual; and mobilities." Utilized most frequently in security and surveillance through threat assessment and flagging, the data derivative categorizes actions and non-actions of the individual through inferential, probabilistic, normative means.[41] Amoore points to instances of "emptying out" matter or materiality to understand the whole – this forefuns the data derivative,[42](p.129-154).

Data Desires

Data-driven
Data-driven processes or methods rest on seductive forms of decision making in which data points and quantitative thinking may overtake reason, community need, spatiality, or histories. These processes may be contextually useful, contextually neutral, or contextually fatal.

Data Mart
Shannon Mattern notes data mart structures that silo and partition data access[43]. Mattern summarizes this data distribution method in her discussion of The Human Project, a New York based research project that aims to extend and improve human life through a litany of biological samples, exams, and tests from their participants[44]. In The Human Project's data structures, researchers must provide their own biometric identifiers to access the data mart of their subjects' blood, spit, and shit.[45]

39 *Louise Amoore, "Data Derivatives: On the Emergence of a Security Risk Calculus for Our Times,"* ***Theory, Culture & Society*** *28, no. 6 (November 2011): 24–43, doi:10.1177/0263276411417430.*
40 *Ibid.*
41 *Ibid.*
42 *Louise Amoore,* ***The Politics of Possibility: Risk and Security Beyond Probability*** *(Durham: Duke University Press, 2013).*
43 *Shannon Mattern, "Databodies in Codespace,"* ***Places Journal****, April 2018, doi:10.22269/180417.*
44 *Ibid.*
45 *Ibid.*

Data Junkies
Anthony Townsend characterizes John Tolva as a data junkie[46]. Tolva served in 2008 as Chicago Mayor Rahm Emanuel's chief technology officer, animating and optimizing systems from snow plow maps to early warning detection systems.[47] The data junkie is insatiable, always pursue more and deeper data analysis. That analysis may be specular, anthropomorphic, or recursive.

Digital On-Ramps

Digital On-Ramps is a program in Philadelphia spurred by IBM's 2011 Smarter Cities Challenge[48]. It is a "collaborative effort of a network of agencies and employers" that aims to provide inclusive education tools for people at the margins and lacking literacy.[49] As of 2018, DOR has failed to meet its goals to inspire new advanced manufacturing, pharmaceuticals, and petroleum refining jobs.
For Taylor Shelton, Matthew Zook, and Alan Wiig,[50] DOR illustrates the often narrowed scope of smart city initiatives that ignores spatial and historical currents in a city. Shelton, Zook, and Wiig closely tie many purported data-driven smart city solutions with techno-solutionism; frequently, they are shallow promotional initiatives, seductive imaginaries for the city, and, ultimately, insufficient attempts at promoting equity.

Environmentality

Environmentality is a new mode of state governance realized by Jennifer Gabrys[51] after Michel Foucault's[52] concept footnoted in The

46 *Anthony M. Townsend,* ***Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia****, First edition (New York: W.W. Norton & Company, 2013).*
47 *Ibid.*
48 *Taylor Shelton, Matthew Zook, and Alan Wiig, "The 'Actually Existing Smart City'," Cambridge Journal of Regions, Economy and Society 8, no. 1 (March 2015): 13–25, doi:10.1093/cjres/rsu026.*
49 *Ibid.*
50 *Ibid.*
51 *Jennifer Gabrys, "Programming Environments: Environmentality and Citizen Sensing in the Smart City," Environment and Planning D: Society and Space 32, no. 1 (February 2014): 30–48, doi:10.1068/d16812.*
52 *Michel Foucault and Michel Senellart,* ***The Birth of Biopolitics: Lectures at the Collège de France, 1978 - 79****, 1st pbk ed., [Repr.], Lectures at the Collège de France (New York: Picador, 2010).*

Birth of Biopolitics. Gabrys outlines this vision of power as existing through and within "specific spatial-material distribution and relationality of power through environments, technologies, and ways of life"[53],(p.30). The everyday matter and interrelations between spaces, technologies, and life are channels for environmentality to exhibit power; what's more, it exists within those spaces, technologies, and lives – its presence is somewhere between imbued and inherent. Based in Foucault's biopolitics and applied diversely, environmentality indicates a shift in supervision strategy from a focus on subjects (the players) to one of environment (rules of the game),[54](p.34). Gabrys's assessment of environmentality points towards state governance of and through patterns of life; her portrait of power is probabilistic rather than defined.

Applied to the smart city, we might understand environmentality less to do with surveillance technologies per se, but more with the implications of "urban dwellers within specific performances of citizenship."[55](p.37). People in the city are liable to be bound up with "spatial and material" programmatic decisions that bind them to the power of technology in the environment in order to animate and realize civic acts,[56](p.37).

> *"Armed with the first photos of the earth in space, many people began rethinking their foundational images of the planet in the late 1960s. As the Earth was enveloped for the first time in photography, bringing it under control, into focus, and within reach for ordinary human beings, mythologies changed....the worldwatching project begins, turning photographic images into political practices and ideological ideals aimed at environing Nature by disciplining its spaces."*
> – Timothy Luke, On Environmentality: Geo-Power and Eco-Knowledge in the Discourses of Contemporary Environmentalism 1995 [57]

53 *Gabrys, "Programming Environments."*
54 *Ibid.*
55 *ibid.*
56 *Ibid.*
57 *Timothy W. Luke, "On Environmentality: Geo-Power and Eco-Knowledge in the Discourses of Contemporary Environmentalism,"* ***Cultural Critique****, no. 31 (23AD–1995): 57, doi:10.2307/1354445.*

Fourth Utility

The fourth utility is a concept of incorporating broadband internet service to codified utilities – water, heat/gas, electricity. It is motivated by the desire to make information more accessible and to make the internet more like a horizontal plane – at present, it is not.

Gaia

The Gaia Hypothesis from James Lovelock and Lynn Margulis asserts that the Earth as a planet possesses unmanaged, self-regulating dynamic systems.[58] These systems are described physiologically, and normative claims indicate that the Earth ought to be acknowledged and respected in order to maintain our own ecological responsibility and survival.[59]

> *"In truth at first Chaos came to be, but next wide-bosomed Gaia, the ever-sure foundation of all the deathless ones who hold the peaks of snowy Olympus..."*
> - Hesiod, Theogony translated by Hugh G. Evelyn White 1914 [60]

Gaia 2.0

Iterating and adapting the work of Lovelock and Margulis, Bruno Latour expands this idea in response to the Anthropocene, or the "New Climatic Regime." Science published remarks on three of the many features of this hypothesis: autotrophy, or natural systems that efficiently utilize free energy to make and remake; networks, or the activation of trash into treasure through "microbial networks" making up "global biogeochemical cycles;" and heterarchy, or decentralized resilience, resistance, and power.[61]

58 *Bruno Latour and Catherine Porter,* ***Facing Gaia: Eight Lectures on the New Climatic Regime*** *(Cambridge, UK ; Medford, MA: Polity, 2017).*
59 *Ibid.*
60 *Hesiod,* ***The Homeric Hymns and Homerica with an English Translation by Hugh G. Evelyn-White.*** *(Harvard University Press, 1914), http://www.perseus.tufts.edu/hopper/text?doc=urn:cts:greekLit:tlg0020.tlg001.perseus-eng1:104-138.*
61 *Timothy M. Lenton and Bruno Latour, "Gaia 2.0,"* ***Science*** *361, no. 6407 (September 2018): 1066-8, doi:10.1126/science.aau0427.*

Hypothetical Threatprints

Hypothetical threatprints refers to methods in social network analysis that deconstruct subjects to make legible what they can do, risks they represent, and link present and potential future threats.[62] Louise Amoore, expanding on ideas from Tom Black, describe this breaking down and remaking of data points, connecting lines, and network span.[63]

(next page) Valdis Krebs Connecting the Dots: Tracking Two Identified Terrorists, 2007. A social network analysis of two suspects in the 9/11 plane hijackings.[64]

> *"We know nothing about a body until we know what it can do," write Deleuze and Guattari, until we see "what its affects are, how they can or cannot enter into composition with other affects, with the affects of another body."*
> – Louise Amoore, The Politics Of Possibility: Risk And Security Beyond Probability 2013[65]

Lived Multisensoriality

As described by Shannon Mattern, lived multisensoriality is a concept of how other animals might "perceive, inhabit, and construct their habitats."[66] Frequently this alternative sensing experience is illustrated through technologies like 360 panoramic photography, virtual reality, and other interactives. Embracing lived multisensoriality can be a useful oblique strategy for disrupting mapping conventions and embracing feminist, critical, or queer perspectives. Mattern points to Diana Thater's video installations, Studio Tomas Saraceno's hybrid spider webs, Sam Easterson's Animal-Cams, Spurse's cornucopia of psychogeography and tactical urbanism, and the Environmental Performance Agency from Ellie Irons, Catherine Grau, andrea haenggi, and Christopher Lee Kennedy.[67]

62 *Louise Amoore,* ***The Politics of Possibility: Risk and Security Beyond Probability*** *(Duke University Press, 2013), p.133. doi:10.1215/9780822377269.*
63 *Ibid.*
64 *Valdis Krebs, "Connecting the Dots – Social Network Analysis of 9-11 Terror Network," August 2015, http://www.orgnet.com/prevent.html.*
65 *Amoore,* ***The Politics of Possibility.***
66 *Shannon Mattern, "Mapping's Intelligent Agents,"* ***Places Journal,*** *September 2017, doi:10.22269/170926.*
67 *Ibid.*

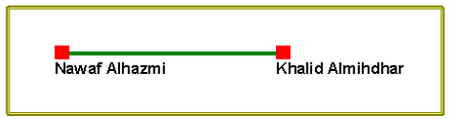

Figure 1 - Two known suspects in January 2000

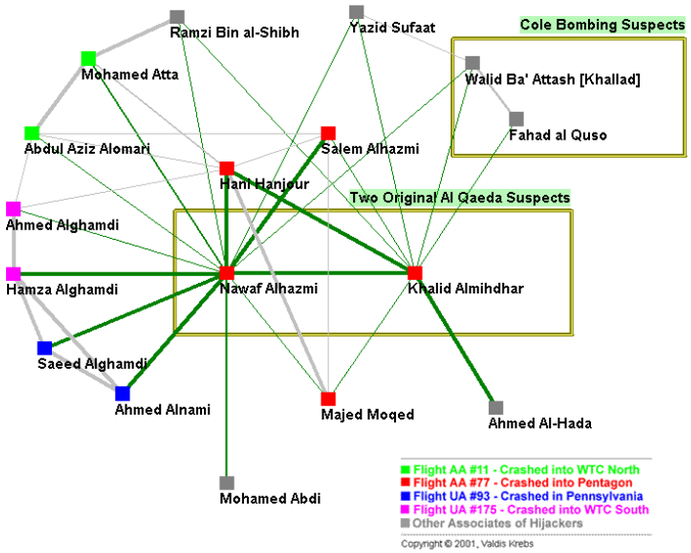

Figure 2 - All nodes within 1 step [direct link] of original suspects

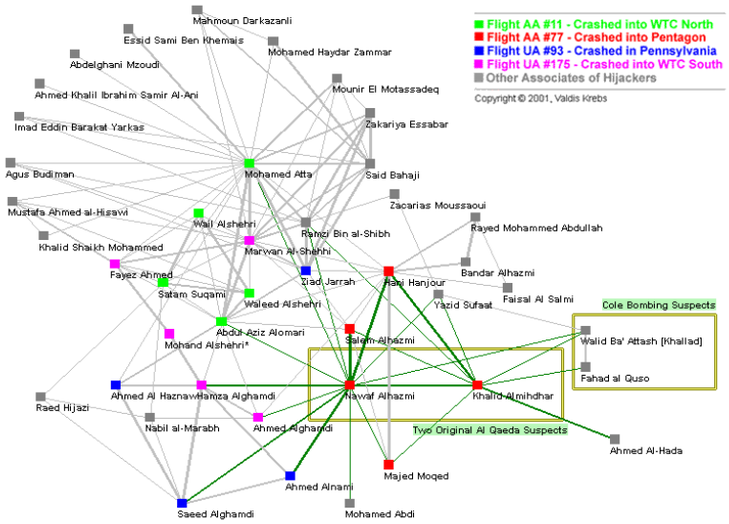

Figure 3 - All Nodes within 2 steps / degrees of original suspects

The Milieu

Milieu, from French for 'middle' or 'medium' or 'environment,' has been utilized by Michel Foucault to serve as a catch-all other. The milieu points to everything except what is known, measured – it refers to the edges, the undersides.

> *"Ignorant of nature's ways led people in ancient times to invent gods to lord it over every aspect of human life. There were gods of love and war; of the sun, earth and sky; of the oceans and rivers; of rains and thunderstorms....Since the connection of cause and effect in nature was invisible to their eyes, these gods appeared inscrutable, and people at their mercy."*
> – Stephen Hawking and Leonard Mlodinow, "The Grand Design", 2010.[68]

Where once gods of things reigned, now gods in the gaps are the prevailing deities, the divine existing in the craquelure and ravines that scar landscapes of reason. Too, the milieu is all that we know around but not about. The other, the it, the unknown unknowns.

Real

Real Time
Real time is a system event-response timing, based on temporal deadlines. The deadlines define whether a system has 'succeeded' or 'failed.' For signal processing and the input and output of information, the process output time must be no greater than the input sensing time, keeping lockstep with reality.

Real time might be contrasted with Unix Time or System Time. Beginning on the Unix epoch at midnight, January 1st, 1970, system time linearly increments upwards, forwards. At time of writing, it is 1543075329 seconds since 01/01/1970 (UTC). On January 19, 2038 this time stamp will no longer function due to 32-bit limitations.[69]

"Real Life"

68 *Stephen Hawking and Leonard Mlodinow, **The Grand Design** (New York: Bantam Books, 2010), p.17.*
69 *Unix Time Stamp, "Unix Time Stamp - Epoch Converter," December 2018, https://www.unixtimestamp.com.*

"Real life" is a pointer to events or actions occurring away from a screen. Distinctions between "real" and "digital" appear to blur as the satirical nature of being is revealing, in such absurdisms at the election of Donald J. Trump, double rainbows, and metabolizing of procaine.

Shitposting

Shitposting is an internet practice of creating and distributing intentionally low quality/effort content, frequently unfunny, in a sarcastic, spammy use of a social media platform or forum. TechCrunch points to a definition of misinformation, and the shitpostbot 5000 points to a consumption of this intentionally meaningless content.[70]

Sociology of Knowledge

T J Barnes looks to Bruno Latour and David Bloor for his history of regression and statistics, situating his analysis as sociology of knowledge. It is a general framework to dissect modes of knowledge generation at the same time as actors doing the generating. Broader than sociology of mathematics, statistics, or science, sociology of knowledge encapsulates cross-cutting interrogation of learning and research approaches; this critique might be carried out by reflective or critical practitioners, theoreticians, or several tribes of historians.

Situated Knowledge

Donna Haraway outlines situated knowledge as "a doctrine of embodied objectivity that accommodates paradoxical and critical feminist science projects."[71] Such objectivity leaves room for the reality of being human, of emotion, and of our intrinsic contradictions. Situated knowledge is a holistic consideration of "subject and object" "as actor and agent" and recognizes communities and networks in place of sole individuals.[72]

70 *John Biggs, "Papa, What's a Shitpost?"* ***TechCrunch****, September 2016, https://techcrunch.com/2016/09/23/papa-whats-a-shitpost.*
71 *Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,"* ***Feminist Studies*** *14, no. 3 (23AD–1988): 575, doi:10.2307/3178066.*
72 *Ibid.*

Sokal Affair

The Sokal Affair is a controversy surrounding the article published in the Spring/Summer 1996 issue of Social Text, "Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity" by Alan Sokal. Sokal conceived and created this article satirically, as a spoof of 1990s critical theory and as a critique of lack of intellectual rigor in the humanities.[73] The submission intended to test the editors of Social Test with an intentionally ill-constructed paper lacking in evidence, argument, and linearity; it was later revealed as a hoax targeting postmodern thinkers, Derrida chief among them.[74]

> "*The world was ersatz and actual, forged and faked, by ourselves and unseen others. Daring to attempt to absolutely sort fake from real was a folly that would call down tigers or hiccups to cure us of our recklessness. The effort was doomed, for it too much pointed past the intimate boundaries of our necessary fictions.*"
> – Jonathan Lethem, Chronic City 2009

Standard

A standard is a rule or practice that has persisted and gained accepted authority. Geoffrey C. Bowker and Susan Leigh Star outline standards' capacity to link disparate and distance systems, enforceability by a governing authority, and staying power that precludes change.[75] Standards are everyday yet invisible instances of the human drive to classify; Bowker and Star assert that many standards exist not because of "natural law" and that "[s]ometimes standards win due to an outright conspiracy."[76] Proliferated and hardened by the information age, Bowker and Star remind us that "[e]ach standard and each category valorizes some point of view and silences another" and that each standard established be deceptively neutral, but laden with morals, values, and inclinations[77].

73 *Alan Sokal, "A Physicist Experiments with Cultural Studies," June 1996, https://physics.nyu.edu/faculty/sokal/lingua_franca_v4/lingua_franca_v4.html.*
74 *Ibid.*
75 *Geoffrey C. Bowker and Susan Leigh Star,* ***Sorting Things Out: Classification and Its Consequences****, Inside Technology (Cambridge, Mass: MIT Press, 1999).*
76 *Ibid.*
77 *Ibid.*

"ISO 639 provides two language codes, one as a two-letter code (ISO 639-1) and another as a three-letter code (ISO 639-2) for the representation of names of languages. ISO 639-1 was devised primarily for use in terminology, lexicography and linguistics. ISO 639-2 represents all languages contained in ISO 639-1 and in addition any other language, as well as language groups, as they may be coded for special purposes when more specificity in coding is needed. The languages listed in ISO 639-1 are a subset of the languages listed in ISO 639-2; every language code element in the two-letter code has a corresponding language code element in the three-letter code, but not necessarily vice versa."
– International Organization for Standardization (ISO) Standard number 639 - "Codes for the representation of names of languages"[78]

Technocratic Feedback Loop

Emily Kaufman establishes the technocratic feedback loop as a snowball effect of bureaucratic systems that self-repeat and reinforce.[79] Kaufman points to policing practices that gather data, indicating the need for more policing; in conducting more policing, our men and women of the force gather data that indicates the need more policing.[80] Ad infinitum: data, policing, data, policing. Kaufman indicates Bernard Harcourt's "ratchet effect" as a precursor to this concept, but emphasizes the significance of technocracy and technological knowledge in the application of biometric data, sensors, and other related tactics.[81]

Technopositionality

Drawing from Matthew Wilson, technopositionality is a situated, critical practice in GIS and geography[82]. Reflective, technopositional

78 *International Organization for Standardization, "ISO 639-1:2002(En)," 2002, https://www.iso.org/obp/ui#iso:std:iso:639:-1:ed-1:v1:en.*
79 *Emily Kaufman, "Policing Mobilities Through Bio-Spatial Profiling in New York City," **Political Geography** 55 (November 2016): 72–81, doi:10.1016/j.polgeo.2016.07.006.*
80 *Ibid.*
81 *Ibid.*
82 *Matthew W. Wilson, **New Lines: Critical GIS and the Trouble of the***

works are "simultaneously about and with the technology."[83] This craft indicts technical and social, and analyzes the act of research and the provenance behind it.[84]

In horology, or the repair and maintenance of clocks, 'witness marks' or 'case marks' are small dings or dents left behind from past workers tools, hands. These marks serve as clues for otherwise inscrutable machines, simultaneously a signifier of tradition and conveyor of information.

Urban Science

a) Urban science is a set of processes that seek to combine algorithmic methods, procedural decision-making, and computational and data-driven efficiencies together with planning practice.
b) Urban Science is a new undergraduate degree and departmental focus between urban planning (course 11) and computer science (course 6). Critical discourse on the program has criticized it as simultaneously historically revisionist – urban planning has had scientific capacities for some time (geography exists) – and techno-solutionist – eschewing context for code.

"We ship 11-6."
– Forthcoming MIT Urban Science Merch

"You think the way the variables relate in New York is the same as the way relate in Boston? And in Paris? And in Mogadishu?"
– Lawrence Susskind on Planning Ideas that Matter[85]

"The fear, of course, is that we lean on the data as some sort of proxy for the 'truth,' and what we know about data in any form is that it's very subjective and is very dependent on the modes in which it was gathered, the context in which it was gathered."
– Gabriella Carollini on Planning Ideas that Matter[86]

***Map** (Minneapolis: University of Minnesota Press, 2017).*
83 *Ibid.*
84 *Ibid.*
85 *MIT DUSP, "Episode 1 - Planning Ideas That Matter: Urban Science: Lawrence Susskind," **SoundCloud**, December 2018, https://soundcloud.com/user-795897165/planning-ideas-that-matter-urban-science-lawrence-susskind?in=user-795897165/sets/urban-science-regression-to.*
86 *MIT DUSP, "Episode 10 - Planning Ideas That Matter: Urban Science : Gabriella Carolini," **SoundCloud**, December 2018, https://soundcloud.*

Endnote:

‡ It was a hot dog stand

com/user-795897165/episode-10-planning-ideas-that-matter-urban-science-gabriella-carolini-episode.

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