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#3 *Unstable Infrastructures*

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SCAFFOLDING, HARD AND SOFT – INFRASTRUCTURES AS CRITICAL AND GENERATIVE STRUCTURES

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INFRASTRUCTURE, HARD AND SOFT

The term 'infrastructure' typically conjures up images of roads, railways, bridges, military structures, and other public works – heavily material stuff. And this is what 'infrastructure' referred to when the term was first used in the mid-1920s. By the late 1990s, according to a U.S. Presidential Commission, the term came to encompass "man-made systems and processes that function collaboratively and synergistically to produce and distribute a continuous flow of essential goods and services" – systems like transportation, oil and gas distribution and storage, water supply, emergency management, government services, banking and finance, electrical power, and information and communications.[1]

Yet the heavily material stuff persists even in this information age. Our seemingly immaterial, ubiquitous and placeless digital networks rely upon data centers, power plants, fiber-optic cables, satellites, mines yielding coltan and copper, and assembly-line workers and e-waste handlers regularly exposing themselves to toxic materials.[2] These are

1 Cp. The President's Commission on Critical Infrastructure Protection, *Critical Foundations: Protecting America's Infrastructures*, Washington D.C., October 1997. Available at: https://www.fas.org/sgp/library/pccip.pdf [accessed April 30, 2016].

2 Cp. Jennifer Gabrys, *Digital Rubbish: A Natural History of Electronics,* Ann Arbor, University of Michigan Press, 2011; Anissa Ramirez, "Where to Find Rare Earth

among our digital culture's myriad material infrastructures. As sociologists Susan Leigh Star and Geoffrey Bowker remind us, though, intellectual and institutional structures and operations – measurement standards, technical protocols, naming conventions, bureaucratic forms, etc. – are *also* infrastructures. Agreeing on technical protocols, measurement standards and classification systems – all intellectual and administrative infrastructures – is necessary in order for the soft- and hardware to do their jobs.

Star and Bowker suggest too that infrastructure is "inevitably a flexible term, often defined with regard to context and situation". They describe infrastructure as "that which runs 'underneath' actual structures [...] that upon which something else rides, or works, a platform of sorts"; but then acknowledge that "this common-sense definition begins to unravel when we [...] look at multiple, overlapping and perhaps contradictory infrastructural arrangements. For the railroad engineer, the rails are only infrastructure when she or he is a passenger." In other words, infrastructure can easily flip between figure and ground.[3]

Infrastructure as a Critical Structure:

What Critical Tools And Frameworks Does A Focus On Infrastructure Offer Us?

A deeper, networked media history. Even the infrastructural 'ground' has its own substrate, its own platform, too. While the term infrastructure wasn't put into common use until the 1960s, and is thus commonly associated with modern telecommunications, the *idea* of

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Elements", *NOVAnext,* April 2, 2013. Available at: http://www.pbs.org/wgbh/nova/next/physics/rare-earth-elements-in-cell-phones/ [accessed April 30, 2016]; Sy Taffel, "Escaping Attention: Digital Media Hardware, Materiality and Ecological Cost", *Cultural Machine, Vol 13,* 2012. Available at: http://www.culturemachine.net/index.php/cm/article/viewArticle/468 [accessed April 30, 2016].

3 Cp. Shannon Mattern, "Infrastructural Tourism", *Places,* July 1, 2013. Available at: https://placesjournal.org/article/infrastructural-tourism/ [accessed April 30, 2016]. See also Bowker and Star's list of qualities that define an infrastructure: its embeddedness (it's sunk into, inside of, other structures, social arrangements, and technologies); its transparency (it "does not have to reinvented each time or assembled for each task, but invisibly supports those tasks"); its reach or scope (it "has a reach beyond a single event or one-site practice"); it's "learned as part of membership" in a community or practice; it "links with [the] conventions of [that] practice"; it's an "embodiment of standards"; it's "build on an installed base" ("it wrestled with the inertia of the installed base and inherits strengths and limitations from that base"; it is "fixed in modular increments, not all at once or globally"; and "becomes visible upon breakdown" (Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences,* Cambridge, MA: MIT Press, 1999, p. 35.)

infrastructure has existed since the dawn of civilization.[4] People have always needed substrates – physical, intellectual, political, economic – on which to build their settlements, and those ancient structures have had residual effects across history. Digital infrastructures follow many of the same paths – the same, or very similar, conduits; similar network structure – as did early telecommunications infrastructure. "Because of the costs of developing new telecommunications networks", geographers Stephen Graham and Simon Marvin note, "all efforts are made to string optic fibers through water, gas, and sewage ducts; [and] between cities, existing railway, road, and waterway routes are often used."[5] And many early telecommunications hubs are urban centers built up over centuries in part through strength in publishing and a flourishing print culture. Cities thus become magnets for new technological development thanks to capital built up under old media regimes. Digital infrastructures are often predicated on their analog predecessors; old media infrastructures begat new media infrastructures.

I've written elsewhere on the deep history and temporal entanglements of media infrastructures – on the ways in which the rise of trade and the need for record-keeping necessarily made early human settlements into infrastructures for writing, with even the buildings' and cities' clay walls serving as substrates for written texts; and the ways in which, in the early days of democracy, cities were designed, or emerged through trial and error, to be conducive to public address and interpersonal communication.[6] Thinking about media infrastructure through this deep historical perspective helps us to recognize that media histories are entwined with the histories of our cities and civilizations – and that cities have long constituted infrastructural environments that support their essential role as communicative spaces.

The principle of 'path dependency' explains how previous choices and patterns in designing and constructing systems, regardless of the circumstances or conditions under which those choices were originally made, limit our options in future developments: where the cable was lain in the past determines to some degree where we position our new conduits, what file formats have become the industry standard inform our design and production decisions, and how users have come to expect to interact with media – the habitual gestures of flipping pages

4 Cp. Shannon Mattern, "Deep Time of Media Infrastructure", in Lisa Parks and Nicole Staroeislski (eds.), *Signal Traffic: Critical Studies of Media Infrastructures,* University of Illinois Press, 2015.

5 Stephen Graham and Simon Marvin, *Telecommunications and the City: Electronic Spaces, Urban Places,* New York, Routledge, 1996, p. 329.

6 Cp. Mattern, "Deep Time of Media Infrastructure", and Shannon Mattern, "Ear to the Wire: Listening to Historic Urban Infrastructures", *Amodern 2,* 2013. Available at: http://amodern.net/article/ear-to-the-wire/ [accessed April 30, 2016].

and swiping screens, for instance – influences how we build familiarity and novelty into interaction design. Yet those previous 'paths' aren't rigidly deterministic. As Edwards et al. note, "The eventual growth of complex infrastructure and the forms it takes are the result of converging histories, path dependencies, serendipity, innovation, and 'bricolage' (tinkering)."[7] Chance and human agency thus have roles to play in the evolution of our infrastructures and the unfolding of media and technological history.

Media networked across scale. What's more, thinking about media infrastructure as networked and layered helps us to recognize media "as potentially embodied on a macro-scale, as a force whose modes and ideologies and aesthetics of operation can be spatialized, and materialized, in the landscape."[8] Today's media infrastructures encompass hand-held devices and the microchips that make them work, as well as global networks and even extraterrestrial objects, like satellites, which are in turn affected by cosmic forces like sun flares and space dust. When we think about infrastructures, then, we must also think about the granularity of our observations. Graham and Marvin list various scales of infrastructural analysis, including the corporeal, the local, the urban, the regional, the national, the international, and the global.[9] Infrastructures cut across these scales; thinking at the scale of the media object, for instance, or the individual human-media interaction, compels us to 'telescope out' and consider how those objects have been shaped across time, and how they're networked across space. What's more, scale need not be conceived of as merely a geographic quality, Paul Edwards argues; it is also possible to consider scales of force (from the human body to the geophysical), scales of time (from human time to geophysical time), and scales of social organization (from individuals to governments).[10]

Expanding our unit of analysis, 'scaling out' from the page or the screen or the individual media device, helps us appreciate the intermingling of various systems. Media – for their production, distribution, and consumption – rely on the power grid, transportation networks, waste removal systems, and even, in the case of paper

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7 Paul N. Edwards, Steven J. Jackson, Geoffrey C. Bowker, and Cory P. Knobel, *Understanding Infrastructure: Dynamics, Tension, and Design. Report of a Workshop on 'History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures.',* Ann Arbor, University of Michigan, January 2007, pp. 6-7.

8 Mattern, "Deep Time of Media Infrastructure".

9 Cp. Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*, New York, Routledge, 2001, p. 411.

10 Cp. Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems" in Thomas J. Misa, Philip Brey, and Andrew Feenberg (eds.), *Modernity and Technology*, Cambridge, MA, MIT Press, 2003, p. 186.

production and data storage, the availability of water to power the mills and cool the server rooms. Thus, media infrastructures are inevitably part of infrastructural 'constellations' involving myriad other non-media-related networks.

Human infrastructure. Perhaps paradoxically, while we're considering the potent forces of 'deep history' and path dependency, and the heavy engineering that powers our technologies, an infrastructural framework also leads us to acknowledge the role of humble human agency. People have not been mere *beneficiaries* of infrastructure; they've actually served as integral links within those infrastructural networks, providing labor for material extraction or service delivery, for instance; or filling in, with their own hands, when the pumps and pipes and portals fail, or, as is the case in particular disenfranchised pockets of the world, when that scaffolding is simply absent. As AbdouMaliq Simone argues, today in Africa – and, we must acknowledge, in much of the Global South and throughout the history of civilization – people often compensate for "underdeveloped, overused, fragmented, and often makeshift urban infrastructures."[11] Identifying these pockets of informal or shadow infrastructural development – practices of jury-rigging, pirating, and bricolaging – highlights the inherently splintered geography of our seemingly universal infrastructures, the political-economics of access, and the infrastructural roles of biopower and human agency.

Yet in thinking across infrastructures' time and scale, attuned to the entanglement of their hard and soft scaffoldings, we create another role for individual and collective human agency: that of the engaged, critical citizen-consumer. Media scholar Lisa Parks argues that it is our duty as infrastructural "citizen/users" to be aware of the "systems that surround [us] and that [we] subsidize and use."[12] Might we "devise […] ways of visualizing and developing literacy about infrastructures and the relations that take shape through and around them?" she wonders. "Are there ways of representing [infrastructures] that will encourage citizens to participate in sustained discussions and decisions about network ownership, development, and access?"

I've written elsewhere about a number of approaches – mapping, touring, sensing, signaling, even *playing* infrastructure – that various

11 AbdouMaliq Simone, "People as Infrastructure: Intersecting Fragments in Johannesburg", *Public Culture 16*, September 2004, p. 425.

12 Lisa Parks, "Around the Antenna Tress: The Politics of Infrastructural Visibility", *Flow*, March 6, 2009. Available at: http://flowtv.org/2009/03/around-the-antenna-tree-the-politics-of-infrastructural-visibilitylisa-parks-uc-santa-barbara/ [accessed April 30, 2016].

designers and artists have devised to promote infrastructural literacy.[13] Recent years have brought us walking tours of cell-phone antenna networks, interactive maps of transoceanic fiber-optic cables, apps leading us to the nearest public restrooms or farmer's markets, gallery exhibitions featuring photos of data centers and e-waste deposits, crowd-sourced maps of bike routes and sewage systems, and hacking and circuit-bending workshops where kids explore the guts of their iPhones. And a Fall 2014 symposium and screening series at NYU and Anthology Film Archives, examined and exhibited a variety of films, interactive projects, photo projects, and maps that make infrastructure sense-able and intelligible.[14] All of these works are a means of promoting infrastructural literacy, of highlighting the value of using infrastructure as a 'critical scaffolding' through which we can address critical issues, including those pertaining to environmental health, the distribution of public resources, and social justice.

It's worth noting, however, that most of these projects, many of which employ mapping in some form and focus on 'making visible the invisible' highlight the 'hard', material dimensions of infrastructure; very few call attention to 'soft infrastructures' like technical protocols, naming conventions, bureaucratic forms or measurement standards. This paucity of materials to enhance *soft*-infrastructural literacy represents a great opportunity for media-makers, artists, and designers, who might develop new pedagogical infrastructures for thinking *about* intellectual infrastructures. A recent example, however, might provide some inspiration. Hito Steyerl's 2013 video *How Not to Be Seen: A [Expletive] Didactic Educational .MOV File* (which I encourage you to seek out online) offers several strategies for 'disappearing' oneself from surveillance technologies. After addressing the protocols by which surveillance takes place, Steyerl proposes several means of evading it, some of which require a subversion of protocols or an upending of measurement standards. Those evasion techniques include camouflaging yourself, hiding in plain sight, shrinking yourself down smaller than a pixel, living in a gated community, wearing a full-body cloak, or becoming a female over 50. The slightly tongue-in-cheek message arrives by way of a parodic form: a dark Monty Python-esque take on the educational film.

Artists, media-makers designers, critical engineers, digital humanists, and their colleagues might investigate other means of highlighting both

13 Cp. Shannon Mattern, "Infrastructural Tourism", *Places,* July 1, 2013. Available at: https://placesjournal.org/article/infrastructural-tourism/ [accessed April 30, 2016].

14 Cp. Lines and Nodes, *Media, Infrastructure, and Aesthetics.* Available at: http://linesandnodes.com/ [accessed April 30, 2016]. I contributed to the organization of this event.

hard *and* soft infrastructures, and acknowledging their entanglement. But I propose that these critical-creative practitioners' engagement with infrastructure should extend beyond the promotion of infrastructural 'awareness' and intelligence. This is not to diminish the value of such literacy, but, rather, to recognize designers' potential to go beyond the *representation* of infrastructure to the *design* of infrastructures themselves – more efficient, effective, accessible, intelligible, and just infrastructures. Creative practitioners, I suggest, should approach infrastructure as a generative structure – a framework for generating systems and environments and objects, and cultivating individuals and communities, that embody the values we want to define our society.

Infrastructure as Generative Structure

I'll close by looking at a few examples of creative and design challenges posed by infrastructure, which illustrate its relevance to and applications in various media and design fields. First, my New School colleague Christina Moon is studying the global flows of resources and labor involved in 'fast fashion', a relatively new industry, emblematized by retailers like Zara and H&M, that rapidly produces inexpensive, 'disposable' garments inspired by the latest runway trends.[15] As designers increasingly concern themselves with the ethics of labor and the sourcing of material through which their designs are *made material*, Moon's work helps us to recognize the 'material intimacies' of fast fashion: the everyday social and cultural practices of designers and garment workers and wholesalers, the potentially meaningful and constructive dimensions of their work, and the potential for transnational social ties and cultural exchange *in* that work. Rewriting and nuancing the typically pejorative ways we understand 'globalization' and 'neoliberalism', Moon calls designers' attention to the embodied, affective aspects of creative labor – which has the potential to inspire greater cultural and ethical sensitivity throughout the interlocking infrastructures of the global fashion industry.

Second, designers and critical engineers are developing new infrastructures for access to information resources in parts of the world that have thus far been un- or under-served, or in regions subject to government or corporate surveillance or barriers-to-access, or as a response to the noted precariousness of existing networks in the midst of natural disasters or other crisis situations. Mesh networks – distributed systems for providing internet access – allow for greater adaptability, resilience, and sustainability, and stronger privacy

15 Cp. Christina Harriet Moon, *Material Intimacies: The Labor of Creativity in the Global Fashion Industry,* (Diss.), Yale University, 2011.

protections than the centralized systems offered by corporate internet service providers. As Primavera de Filippi writes in *Wired*,

> "What's really revolutionary about mesh networking isn't the novel use of technology. It's the fact that it provides a means for people to self-organize into communities and share resources amongst themselves: Mesh networks are operated *by the community, for the community*."[16]

Indeed, the technology is not novel: the military has been using mesh networking for years to extend and secure battlefield communication in remote and rugged terrain. The infrastructural design offers affordances that appeal to highly disparate populations, and its flexibility – in geography, in scale, in network structure – opens it to a variety of applications embodying widely disparate politics.

Third, we should consider the potential contributions designers can make to the creation of effective, democratic, intelligible infrastructures for our imminent 'sentient cities'. I've written elsewhere about the need for designers to inform the way that people interact with, and experience, their cities' technical infrastructures, or "operating systems".[17] In particular, I've considered how the design of "urban interfaces" – screens and installations and gadgets that help us orient ourselves and navigate the city's various hard and soft infrastructures, track our use of various services and resources, and grant us access to urban data – could "compel us to ask questions about what kinds of cities we want, and what kind of citizens we want to be." Such an introspective design practice requires collaboration among representatives of the myriad networks that constitute a city.

The creation of a *better* interface – an interface that reflects the ethics and politics that we want our cities to embody – is necessarily a collaborative process, one drawing on the skills of designers of all stripes, technicians, engineers, logisticians, cultural critics and theorists, artists, bus drivers and sanitation workers, politicians and political scientists, economists, policymakers and myriad others (including women and people of color, who have been egregiously underrepresented in relevant debates). If our interfaces are to reflect and embody the values of *our* city, the conception and creation of those interfaces should be *ours*, too – not Cisco's, not the administrators',

16 Cp. Primavera de Filippi, "It's Time to Take Mesh Networks Seriously (And Not Just for the Reasons You Think)", *Wired,* January 2, 2014. Available at: http://www.wired.com/2014/01/its-time-to-take-mesh-networks-seriously-and-not-just-for-the-reasons-you-think/ [accessed April 30, 2016].

17 Shannon Mattern, "Interfacing Urban Intelligence" *Places,* April 28, 2014. Available at: https://placesjournal.org/article/interfacing-urban-intelligence/ [accessed April 30, 2016].

certainly not *mine* or *yours*. But ours.

We see a similarly holistic, ecological, cross-infrastructural approach to design reflected in the embrace of "landscape urbanism", which advocates for looking beyond architecture, beyond individual buildings, to acknowledge that cities are composed of intertwined ecological, political-economic, technological, administrative, and social systems and processes.[18]

Finally, I believe it's particularly important for advanced undergraduate students and graduate students to consider the infrastructures undergirding and shaping their own fields of study and practice – or what we might call the "cultural techniques" for making knowledge and generating work within a field.[19] We should consider what enables a theory to take hold, a particular theor*ist* or designer to gain prominence, a 'movement' (like landscape urbanism or the 'sharing economy' or 'object-oriented' philosophies) to gain traction, or a method or process to become naturalized. Underlying our theory and design 'economies' are particular epistemological and disciplinary values, like 'individual genius' and 'sustainability'; academic and commercial markets hungry for branded theories and methods (and even old ideas cloaked in neologisms); PR machines; hordes of grad students, like you, who are eager to discover the 'new big thing', which partly fuels the global networks of conferences and tech festivals and art fairs and TED conferences (not to mention the airplanes and travel budgets [and Carbon expenditures] that make those gatherings possible). These are the entangled soft and hard infrastructures that often propel 'making' in our fields.

What I often find in these novel movements and among the world of celebrity theorists and designers, however, is that the liberal conceptions of 'labor' and 'knowledge' and 'taste' that many of these theoretical and aesthetic movements *actually embody* quite often fail to match up to their professed politics. We're so frequently advocating for more democratic, fluid, inclusive, ethical models of making and

18 Cp. Christopher Gray, "Landscape Urbanism: Definitions & Trajectory", *Landscape Urbanism 1*, 2011. Reprinted in *Scenario Journal*. Available at: http://scenariojournal.com/lu-landscape-urbanism-definitions/ [accessed April, 30, 2016]; Michael Miller, "Landscape Urbanism…Decoded?", *Olin Studio Blog,* January 31, 2013. Available at: http://www.theolinstudio.com/blog/landscape-urbanism-decoded/ [accessed April 30, 2016]; Charles Waldheim (ed.), *The Landscape Urbanism Reader,* New York: Princeton Architectural Press, 2006. See also the *Landscape Urbanism Bullshit Generator*. Available at: http://www.ruderal.com/bullshit/bullshit.htm [accessed April 30, 2016].

19 These final comment are drawn from and inspired by my presentation, "The Cultural Techniques (+ Political Economy) of Theory-Making", which I delivered on a panel discussion on October 16, 2013, at The New School with Lisa Gitelman and Jussi Parikka. Available at: http://www.wordsinspace.net/wordpress/2013/10/16/the-cultural-techniques-political-economy-of-theory-making/ [accessed April 30, 2016].

thinking in the world – yet the theories and practices we're building to make sense of these new modes are still often *built* via 'Great Man' – and I stress *man* – modes of production.

I encourage all of you as students – as the future shapers of your fields of study and practice – to map, deeply and widely, the infrastructures, the cultural techniques that undergird the work in your fields, particularly the work on the 'bleeding edge'. Recognizing the entwined infrastructures that constitute this substrate for practice will ideally cultivate a sensitivity to issues of access, diversity and inclusivity, authorship and attribution, epistemology, and other social values and ethical concerns. Recognizing what's missing in your field's *current* infrastructural ecology might inspire you to contribute to the design of a discursive space or a landscape of practice that embodies a political economy more in line with those liberal values that our theories espouse. You, as critical-creative practitioners, have the opportunity to transform criticality into generativity – to imagine and then *construct* the hard and soft scaffoldings for tomorrow's fields of practice.