Infrastructural Cartography: Drawing the Space of Flows¹

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INTRODUCTION

Representing the city other than through its figureground condition poses a challenge, for architects. This is why Louis Kahn's traffic flow-map of Philadelphia, which dematerialized the physical fabric of the city in favor of speed is still such an iconic and popular precedent in explaining how dynamic processes, not static form can determine urban space. Given that much of our contemporary culture is "on the move", it is surprising we cannot draw upon more examples that visualize how mobility systems shape the city. Simply put the discipline of architecture needs new methods to describe the city.

What follows emerges from many attempts to represent the extensive mobility that constitutes our contemporary condition and a means to explain architecture's fallout with the material flows of the post-fordist era. We can contemplate how the flow of people, capital, money, goods and data impacts space (and place) through new drawing techniques that visualize these flows. "Infrastructural Cartography" is the mapping of contemporary global networks to generate a new reading of space and place in the age of globalization delivered here through a series of maps of the FedEx Corporation. Indexing a shipping network is conceived as a productive technique to expose how mobility systems shape space and to shift our perception of space, away from place as solely a territorial construct (topographic space) to one that is determined by a host of interconnected spatio-temporal relationships (topological space).

MAPPING DYNAMIC SYSTEMS: A BRIEF OVERVIEW

In the mid to late 1990s landscape architects armed with a new sense of purpose for their discipline emerged with mapping as a technique to draw complex natural as well as synthetic systems. A pivotal essay that summarized ways in which mapping could be employed instrumentally in landscape design was James Corner's "The Agency of Mapping."² Corner's interest in mapping was a representational one and an attempt to move the discipline away from pictorial simulations of nature into projective representations of space, so that drawings would not just record reality but be an instrument to generate an idea or to use his term, "emancipate potentials" out of a given situation³ Mapping was a technique to recognize and investigate the many states (synthetic and natural) of a site by pulling out each state from the whole as an individual field system, what Corner describes as an "extract". The investigation of a site through its constituent parts or layers de-territorializes the site as a known geographic entity in favor of a set of information vectors that can be studied, manipulated and re-combined (plotted) into new abstract latent assemblies. A map could thereby serve as instrument to explain a complex situation. Corner's essay popularized the role of mapping as a creative practice both within landscape architecture as well as in the discipline of architecture whose interest in mapping emerged with a move away from ideological approaches to urbanism in the belief that the extrapolation of situational information could generate more suitable proposals for the contemporary

city. In particular, Corner's mapping was a suitable technique to represent post-industrial urbanity with an increasing emphasis on the city as a temporal landscape; as a set of effects based on relationships between things; as a performance landscape where the processes of globalization are played out; and as a space where systems and flows are more critical than form in generating space. For this reason, and given its historical role in urban planning, mapping emerges as a suitable mechanism to establish a relationship between global networks and urban space. Information can be represented and synthesized to produce a reading of the city based on the flow systems that produce it.

Recently, the discipline of Global Studies has recuperated mapping as a representational technique to address the problems in communicating the earth as a distributed space of flows. While economic, transportation, information and technological continuity conceive the globe as a singular and unified construct, at the same time globalization has wielded a de-centering and discontinuity of the global spatial field. For example, measuring and perceiving the globe not solely by its geo-spatial configuration but instead through time and space by focusing on flows across the globe emphasizes the earth as a topological as well as a topographic (metric) construct. Apollonian views; static and synoptic views of earth, are insufficient representations because they ignore the dynamic processes that drive global culture⁴ and thereby fail to visualize the topological effects of globalization. Mapping, on the other hand gives shape and meaning to these effects.

Richard G. Smith borrows analogies of the "fold" from both Deleuze and Latour to communicate that metric measurement- near and far- is less important than topological measurement of space⁵. Imagine plotting major world cities on an ironed handkerchief and then crumpling up this handkerchief so that cites previously far away from each other now lie in close proximity or conversely cities originally close together now sit remote from each other. If we imagine that the forces causing the crumpling of the handkerchief are as a result of globalization, then we understand how globalism continually defines new associations between cities that are not metrically but relationally determined. Time is an important characteristic in determining topological relationships and is also one the principal characteristic of the spaces of flow. Mapping therefore emerges as a suitable technique to visualize the temporal complexities of globalization. Other metaphors such as compressing, shrinking and shriveling have also been employed to express the territorial impact of high-speed transportation networks giving rise to time-space cartography in the 1990s. Time-space maps do not display spatial distances but time distances between cities and countries. For example, a well known set of shrinking maps of continental Europe by Spiekermann and Wegner in 1994 which were generated by MDS formulas depict the impact of high speed rail on the territory of Europe.

More recently, David Harvey has used the term "compression" to articulate a new "time regime" in response to the speed of financial flows in how vast sums of money are traded almost in real time across the world⁶, while Manuel Castells employs the term, "timeless time" to describe the transformation of time and space in the information society. He writes: "predictable time is being shattered in the network society", to the point that we are almost free of time as a "linear and measurable" constraint. He cities derivative capital markets, flexible forms of management, real time media communication, changes in reproductive practices and longer life-spans as contributors to the shift in time in contemporary society that he also characterizes as "forever time"⁷.

Deploying maps to represent the world as a set of interconnected ecologies describes the work of the artist Marco Lombardi who made maps to visualize connections between international criminals. Lombardi focused on the flow of money, specifically banking scandals as a metaphor for the corrupt side of global capitalism and the abuse of power that it represented. His large hand drawn pencil diagrams of these situations, called "narrative structures" construct connections between people and world events by overlaying and superimposing previously separate layers of information to serendipitously link characters and wrong doings into composite ecological webs8. Lombardi's images are strikingly beautiful artworks when viewed from afar but really only unfold when you allow yourself into his story.

INFRASTRUCTURAL CARTOGRAPHY

Given their training in critical analysis, ability to coordinate disparate forces during a project and skill in visualizing many aspects of a single object, architects are skilled at the simultaneous superimposition and interpolation of multiple layers of information to discover relationships not immediately evident. Architects make good cartographers. New graphic techniques for the visual communication of data is an important component of design research so that patterns or anomalies can be diagramed and synthesized to "unfold" concepts out of which design scenarios can emerge. Using Lombardi's definition of global flow as a kind of network ecology and faith in Corner's persuasion that mapping is an effective technique to represent complex landscapes. I have developed the term Infrastructural Cartography, a graphic process that plots the space of flows to demonstrate how contemporary mobility networks make space. Not unlike the instrumentality of mapping in Corner's work9, Infrastructural Cartography mines, synthesizes and composes data embedded in complex situations, in this case, global networks, to explain how flow shapes space. Yet it differs from mapping in the Corner sense in that, Infrastructural Cartography is not a means to critically represent nature but instead the production of projective diagrams that visualize the complex processes of urbanization. In an era where the discipline has undertaken largescale urban and infrastructural work, Infrastructural Cartography emerges as a suitable technique to reveal patterns between different information sets; program, economics, geography, time and space that unveil spatial possibilities hitherto unimaginable by conventional architectural documentation. In an attempt to explore and integrate all situational options, Infrastructural Cartography is employed as an instrumental technique to communicate the dynamic behavior of global flow and to uncover new morphologies of space embedded in global network space¹⁰.

Measuring the agency of global flow can give shape and meaning to globalization by re-conceiving the earth internally as a set of network ecologies rather than a proportional geographic specimen viewed from above. This essay argues that the "space of flows¹¹" disrupts the world as a geographic construct and that topographic perceptions of territory do not adequately represent the complexities of contemporary space. For example, precisely because of their privileged view of the world, from the outside, geographic visualization tools (aerial and satellite photography or google earth) miss the hidden systems that are the real qualifiers of contemporary space. Rather than view the world from the exterior, like Lomabardi, this essay instead takes you inside the real processes that define our environment. A cartographic cat-scan of FedEx is employed to make us cognizant of the extent to which flow shapes the built environment.

"The post-industrial global city is a topology of networks, an open, dynamic structure of interconnected nodes, measured in time.¹²"

DRAWING FED EX: VIEW FROM THE INSIDE

We relate to our hyper mobile world through contemporary delivery systems and the convenient services they offer but mostly we have no idea how the contemporary world really works. For example, all we know about FedEx is that a package left in a drop box reaches its destination on time. Curious types will follow the route of the package online for a detailed breakdown of its location at any given moment. All we care is that the package arrives on schedule and we remain clueless of the extensive procedures and coordination necessary to make the delivery deadline. Fed Ex is "black boxed"13, the term given to complex systems that are used ubiguitously, a kind of magic infrastructure, of which a user has no understanding. As a means to expand our research into how globalization implicates architecture, drawing the operations of contemporary delivery networks renders legible the effects of global mobility to perceive space as it really is.

A series of 6 large format mappings of the FedEx Corporation, the world's largest overnight shipping company, indexes the dynamic processes of an overnight delivery system. At a practical level, the maps are c a graphic survey of the company's network and a visual register of how cargo flow makes space across the world. More importantly, the maps reveal patterns between schedules, itineraries, delivery times and distance that are typically beyond our grasp in understanding how the world works. The maps attempt to link and reconcile the different scales of FedEx from the simple drop-of of a package to the complex processes required for a package to arrive at its destination within a prescribed delivery window.

System Space (Figure 1)

FedEx operates a "hub and spoke" system. This means that every package regardless of drop off passes through one centralized location, where it is



Figure 1: FedEx: System Space and Site Space

sorted before being re-distributed to its final destination. The "hub and spoke" model reinforces the importance of a single node as a primary gateway by centralizing control in one or a few strategic sites. It is actually an efficient and somewhat sustainable model to move large quantities of goods, since it requires fewer planes than point to point travel to serve the same amount of destinations. It also eliminates error and optimizes plane volume¹⁴. The spokes of the system are the flight and truck routes that deliver packages to 220 cities around the world each day, while the "hub" actually comprises not one but five attendant spaces (nodes) within the FedEx network. The Superhub¹⁵, a 518 acre facility located at Memphis International Airport is the largest and most critical space within the network. In addition to aircraft facilities and runways, the main supra-structure at the Memphis Superhub is a 39 acre sort centre, a large single story warehouse that sits on the north east corner of the airfield dwarfing the airport's passenger terminal to its south. The sort center houses a conveyor system known as the Matrix that directs the trajectory of 3.5 million packages each night. It typically takes a package 30 minutes to pass through the Matrix, which, if unraveled measures 300 miles, the distance between New York and Philadelphia. Cargo terminals located at most city airports comprise the next node in the system. Packages already having been sorted according to



Figure 2: FedEx: Geo-Temporal Space

zip code in Memphis are directed from the receiving cargo terminal to one of a series of world service centers -regional sorting facilities-where they are loaded onto a truck for final delivery. The FedEx Office is a storefront space that emerged after the company merged with Kinkos in 2004 and the Drop Box, the final node in the system is the ubiquitous metal box seen on street corners and office lobbies.

Geo-Temporal Space (Figure 2)

Analysis of a 24 hour period at the superhub in Memphis employs real-time flight tracking software to plot every arriving and departing flight in and out of the superhub on February 18th 200916. Most flights arrive and depart the superhub between 10:30pm and 3:30am. During this five-hour timeframe, upwards of 3.5 million packages pass through the sort center with the help of 8,000 employees. Package flow is directed by size, type and destination onto outbound planes for delivery across the globe. For the rest of the day, volume at the sort centre is pretty nominal, save for another mini- sort that takes place from noon to 3pm each day when returning planes from overnight priority deliveries arrive with USPS mail- FedEx has delivered mail for the United States Postal System since it began in 1971. Plotting flow in and out of the sort



Figure 3: FedEx: Density

center unveils relationships and patterns between geography, time and space that would otherwise not be immediately evident from a spread sheet of data. Flow patterns are augmented by reproducing a set of frames from a U tube video that vizualize density of airline flow in and out of the airport over a 24 hour period. Mapping flow in and out of the FedEx superhub at Memphis International Airport demonstrates the extreme differences in occupancy found in the spaces that process flow. Peak periods exhibit an intense compression of time and space in order to make delivery deadlines around the world.

Density (Figure 3)

Plotting route density to and from Memphis in one single 24 hour period highlights that the greatest number of inbound flights with a total of 8 planes, is from Newark, New Jersey and at 6 planes the most popular outbound flight is to Los Angeles, although adding figures for Newark and New York (JFK) totals 10 outbound planes to the New York area. Even with only traffic statistics for a single 24 hour period, Newark and LA are the only two cities that appear in the top five for both inbound and outbound flights. One can therefore deduce that most of FedEx's package volume is transnational between these two cities. However some interesting anomalies emerge. Des Moines, Iowa sits within the top 4 cities served by Fed Ex on this particular night. As one of the country's second tier cities, Des Moines is home to a series of large food processing and distribution corporations. Iowa produces 10% of the county's food and hosts nine of the top 10 food companies in the United States including Barilla, Nestlé, Kraft, Heinz, Pepsico, Tyson Foods and Quaker Oats. Plotting the frequency of FedEx planes thus unveils many different ecologies of material flow, some not so predictable. The third most popular inbound destination with 6 flights is St. Louis while a group of the fourth most popular inbound flights with 5 flights each also includes lesser metropolitan areas such as Nashville. Next to L.A. and Newark, the top 5 outbound flights include larger cities such as Dallas, Denver, and Atlanta. Observing these flow patterns yields a supply "v" of cities in the mid and north/east of the country, while receiving cities form a "c" in the east and south. Another interesting flow pattern is the ratio of inbound to outbound flights from a single city. For example, Newark and LA like most cities have almost equal ratios whereas Philadelphia experienced a much lower ratio of inbound to outbound flights on that particular night. Since these patterns are extrapolated from one night's flight data, any findings are speculative rather than conclusive, yet the flow patterns produce information that unveils important and dynamic relationships between cities supporting the hypothesis that "site (place)" be considered not as a fixed location in time but an event that is part of a larger ecological flow. Busiest routes are located within the United States. International destinations to Mexico, England (Stansted) and Germany (Cologne) typically have two inbound and two outbound flights- although we can assume that the three outbound flights to Anchorage are ultimately traveling to Shanghai, Seoul or Tokyo. While FedEx is a global network and visible in many countries across the globe, at the same time the 24 hr route map depicts it as primarily a national network. Like other contemporary networks it has global range with regional specificity.



Figure 4: FedEx: Network

Network (Figure 4)

A map plotting FedEx's entire global network includes its superhubs in; Memphis, Indianapolis and Guangzhou, China and major cargo hubs at airports such as Newark,

Package volume at each site and the acreage of each facility is also documented to summarize the combined global real estate of FedEx. Identifying the anchor cities within the network only reinforces that which has been expressed by other global thinkers such as Sassen and Castells; that intense accumulation of activity in specific locations is fundamental to world when conceived as a space of flows. The map also recognizes global time zones given that time is a primary concern of FedEx, not necessarily the time it takes a package to arrive or the distance it travels but the local clock-time at which a package arrives. Repositioning standard time¹⁷ away from Greenwich, London to align with Memphis disrupts a Eurocentric view of the globe which has dominated western thought since the Roman Empire and serves as a reminder that in place of imperial conquest, territorial supremacy is now a corporate conquest. Globalizations de-centering of hegemonic empires in the economic sphere implies that the globe is no longer conceived from a single centre where knowledge or influence emanates. Yet



Figure 5: FedEx: Trajectories

change of cartographic convention implies a change in the power structures at work at any given time. The demise of one hegemonic regime means the rise of another. The space of flows is dominated by free market corporate interests that serve themselves as much as the global public¹⁸.

Trajectory (Figure 5)

A series of packages tracked courtesy of FedEx's online software yields a detailed timeline of activity between pick up and delivery. From a list of priority packages originating in Chicago, we notice that a package to Guatemala City arrives at its destination faster than a package to Boston or Houston and a package to Zagreb has a longer delivery timeframe than a package to Beijing. The trajectory mappings are evidence that distance is less significant than time in the space of flows. Moreover, the mapping highlights both the efficiencies and inflections within the system. Most delays are caused when packages are in local transit- what Stephen Graham describes as "the last mile". This explains why the delivery of a package in Beijing takes almost 15 hours after having arrived at the airport. Fedx uses bike couriers in many Asian cities to combat traffic



Figure 6: FedEx: Local and Regional Effects

congestion. At the global scale, the space of flows presents an image of seamlessness but in reality there are many nuances to be negotiated within the logics of the system at the local scale. Local spatial effects disrupt the illusion that globalization produces a "one world" system.

Local and Regional Effects (Figure 6):

A close mapping the FedEx network in Chicago and New York identifies the local effects of the system. For example, 8 regional distribution centers serve different areas of the entire Chicago metro area, the largest of which is a120,000 sf facility serving the city's downtown. Most of these centers are located in the city's wealthier areas in the North and West suburbs, which have seen extensive economic development via the relocation of HQs away from the downtown in the last 30 years¹⁹, for example, eighteen Fortune 500 companies boast suburban locations while only 8 are located within Chicago city limits²⁰. Yet mapping FedEx Office locations also reveals much about the geo-spatial effects of the system. By far the largest density are located in the city's downtown business area- the Loop -, which implies that, even with new suburban business locations, most packages to Chicago are dropped off or delivered to downtown. While the drop box is the smallest but the most ubiquitous artifact of the network, plotting the density of drop boxes in Midtown Manhattan via Mapguest and Google, presents FedEx as a field of closely placed points. In fact the map reveals over 150 FedEx locations within a 1.5 mile radius of Grand Central Station. This implies that mobility networks produce clear infrastructural models (hub and spoke) that support a host of specialized exchange nodes from large mega structures (sort center) to fields of dense points (drop boxes). Their territorial effects are thus multi-scalar impacting national and regional planning and local structures.

CONCLUSION

On the one hand the maps might be characterized by James Corner as mere "*tracings*" in that they reproduce or explain a space that already exists²¹. Yet the maps bring together and synthesize the hidden and diverse fields of information that constitute FedEx to unveil "how" an overnight delivery system works and thereby expose the complex processes at play in the space of flows, "the capacity to reformulate what already exists is the important step. And what already exists is more than just the physical attributes of terrain (topography, rivers, roads, buildings) but includes also the various hidden forces that underlie the workings of a given place²²".

But other than describing systemic information, of greater interest are the implications of the maps, specifically how a close reading of the maps affords a new perspective in a discussion of space through the lens of "globalization". I'd therefore like to conclude with a set of lessons that contemplate how a mapping of Fed Ex identifies architecture and urbanism's fall out with contemporary flow networks of post-Fordist space. These lessons are as follows:

1. Since networks rely on infrastructural rather than architectural effects, infrastructure replaces architecture as the primary integer of urbanism. FedEx relies on both hard infrastructure in the form of airports, planes and trucks as well as on soft infrastructural systems in the form of information tracking and monitoring technologies to complete its service. Analysis of the superhub reinforces this shift to infrastructure mediated environments at the architectural scale. The sort center is a dumb shell whose sole function is to enclose the real feature of the space; a 300 mile long conveyor system.

2. The processes of urbanism have become very complex. In the case of Fed Ex the sheer organization and planning involved to make a delivery deadline far outweighs the means of the operation - the simple delivery of a package. The city is organized more by organizational processes rather than formal artifacts.

3. Networks produce multi-scalar effects. While networks perceive the world as an equally serviceable territory, nonetheless there is noticeable accumulation at certain critical points. One the one hand we witness big exchange spaces where the stuff of the network gets done (hubs), while at the other extreme, we witness the network as a distributed field of small points (numerous drop boxes in urban areas with high demand). Networks want to envision a one world system (Wallerstein), yet at the same time, in reality they configure space at very precise moments in very precise ways. In summary, global networks globally actually generate highly specific local effects. 4. Network space is a nocturnal event. FedEx is at its busiest between the hours of 10pm and 3am. This generates a host of new spatial practices, for example, a longer work day. In New Jersey, FedEx picks up as late as 11:30pm while still promising overnight priority delivery. Analysis of the a series of package trajectories (Figure 5) highlights that a package spends most time waiting at its original location or being delivered to its final destination. For this reason, some companies (Ford, Nike, Williams and Sonoma, Medtronic) locate themselves adjacent the airfield in Memphis to exploit late drop off times made possible by their proximity to the superhub. Continued compression of time and space to minimize the gap between production and delivery systems is also an important network effect.

5. The study of mobility systems shifts our perception away from space as solely a territorial construct (topographic space) to one that is determined by a host of interconnected spatio-temporal relationships (topological space). Networks that move goods, data and people seamlessly from one space to another ignore national boundaries and political regimes. This is because networks measure space in time rather than by distance, volume or area. It makes no difference how a FedEx package arrives or how far it travels once it arrives by its designated deadline. Reading contemporary world-space as a multi-layered network ecology rather than a set of specific metric territories separated from each other subverts indigenous or nationalist specializations of space in favor of theories that contemplate space across and between things.²³

Rather than observe the world from the outside as an idealized unified construct as in Apollonian images, the maps bring us inside the processes that shape world space and expose the degree to which mobility systems have emerged as the primary means by which we exist as cultural subjects. More importantly from a disciplinary perspective, this inside view afforded by the maps begins to highlight some of the implications of global network space on architecture and urbanism. In this way, the maps enable the discipline to advance how globalization impacts the built environment beyond current discussions of star-architecture, homogeneous styling and recuperation of the vernacular.

ENDNOTES

1 Manuel Castells and Martin Ince, "Conversation 3: The Space of Flows" in *Conversations with Manuel Castells*, (Cambridge, UK: Polity; Malden MA, 2003), 55.

2 James Corner, "The Agency of Mapping" in Mappings, ed. Denis Cosgrove, (London: Reaktion Books, 1999).

3 For more information on this topic see also Julia Czerniak's essay "Challenging the Pictorial: Recent Landscape Practice," *Assemblage, n. 34*, (Dec., 1997), 110-120.

4 Jerry Brotton, "Terrestrial Globalism" in Mappings. Ed. Denis Cosgrove London: Reaktion Books, Page 71. See also his book titled *Trading Territories:* Mapping the Modern World, London:Reaction Books: 1997

5 Richard G. Smith "World City Topologies," in *The Global Cities Reader*, ed. Neil Brenner and Roger Keil, (London and New York: Routledge, 2006), 400.

6 David Harvey, *The Condition of Postmodernity*, (Cambridge: Blackwell, 1989) Pages 240-259

7 Manuel Castells, "The Information Technology Revolution" and "The Edge of Forever: Timelss Space", in *The Rise of the Network Society* (Cambridge, Mass.: Blackwell, 1996).

8 Robert Hobbs, "Mark Lombardi: Global Networks," in *Global Networks*, 17.

10 In her design practice CLUAA, the author also deploys maps of global flow to generate design proposals within network space. These proposals are not the subject of this paper.

11 Manuel Castells, *The Rise of the Network Society*, (Cambridge, Mass.: Blackwell,1996).

12 Un Studio, "Deep Planning."

13 Stephen Graham, "Constructing Premium Networked Spaces," in Richard Hanley ed., *Moving People, Goods and Information*, (New York and London: Routledge, 2004).

14 For more details on hubs see David Pascoe's "Cultures of the Terminal" in *Airspaces*, (London: Reaktion Books, 2001), 197-236.

15 In 2009, FedEx opened two more superhubs: one at Indianapolis Airport and one in Guangzhau, China. The Memphis location is still considered the main sort node.

16 www.flighttracker.com

17 In 1884 the International Meridian Conference in Washington, D.C. recognized the Greenwich longitude as the zero meridian of the globe. In 1911 the earth was divided into 24 time zones of 15 degrees latitude with an international dateline set 180 degrees away. Although the system was introduced to facilitate a standard for long distance navigation it was no coincidence that the meridian would recognize London as the center of the hegemony of the British Empire.

18 Stephen Graham talks at length about free market development in the telecommunications industry in England and the US. For more details see "The Collapse of the Integrated Ideal," in *Splintering Urbanism: Network Infrastructures, Technological Mobilities and the Urban Condition*, (London: Routledge, 2001).

19 Alan Berger and Lars Lerup, "The Production of

Waste Landscape," in *Drosscape: Wasting Land in Urban America*, (New York: Princeton Architectural Press, 2007), 46-75.

20 http://en.wikipedia.org/wiki/List_of_ companies_in_the_Chicago_metropolitan_area

21 Corner borrows the term" trace" from Deleuze, who also made distinctions between maps that visualize known information as opposed to a map operates more as a rhetorical device anticipating what might become.

22 Corner, "Agency of Mapping."

23 See Francis D.K. Ching, Mark Jarzombek and Vikram Prakash, *A Global History of Architecture* (New York: Wiley Press, 2007) for more information on flow across borders as a method of scholarship as a means to re-present architectural history.