

It is by now doubtless that the question of infrastructure will dominate the concerns of architects, landscape architects, urbanists, and planners for the foreseeable future, both as a site of research and analysis and as a field of potential intervention. The participation of design intelligence within this area is urgent: not only is the current stock of traditional infrastructure in a state of physical decay, it is in many cases inadequate to meet the needs of contemporary urbanization and of social and ecological urgencies. The concept of infrastructure is currently undergoing a re-evaluation and shifting from its being understood as an organizational and logistical construct in support of urbanization, to recognizing it as a constructed ecology in complex interdependency with biophysical systems, economies and politics.¹ For significant amounts of the contemporary population, infrastructure has become the prevalent form of urbanism itself, serving as a primary locus of public life and social space.²

Vast territories shaped by distributed infrastructures dedicated to the logistics of transport, storage, distribution and eventual disposal of goods, the accommodation of expanding populations and to the provision of energy and services³ have become the prevailing landscape of urbanized areas. This is a highly controlled and organized terrain, whose dominant spatial types are generated as byproducts of optimization logistics, where, dislodged from traditional discourses of meaning and signification, architecture, and space become one of many techniques of organization and instrumentality. Yet this situation has the potential to empower architecture and design in new ways. Due to the interconnected nature of infrastructure ecologies, small-scaled adjustments in technology, new performative or typological constructs, or a reorganization of constituent elements may have vast repercussions in the mechanics of their operation. Architecture's agency lies first in being able to recognize the system and its agents, and second, in finding effective means of implementation and intervention within this matrix.

The highway system has arguably been the most instrumental factor in structuring settlement patterns and economic development in North America. While the late twentieth century witnessed the establishment of a fine-grained mobility network and the production of a low-density urbanism, the twenty-first century will be defined by the consolidation of supersized, multicentered, networked urbanities, as the interconnection and densification of proximate urban centers create the emerging megaregions of North America. These urban formations⁴ can be defined as agglomerated networks of metropolitan areas with integrated labor

1 Pierre Belanger, "Landscape as Infrastructure," *Landscape Journal* 28:1-09: 79-95.

2 See for example Lars Lerup *After the City*, 2001; Aaron Betsky, "Making ourselves at Home in Sprawl," in *Pst Ex Sub Dis: Urban Fragmentations and Constructions*, 2002; as well as the seminal text by Reyner Banham, *Los Angeles: The Architecture of Four Ecologies*, 1971, and Kazys Varnelis (ed) *The Infrastructural City*, 2009.

3 Charles Waldheim and Alan Berger, "Logistics Landscape," *Landscape Journal*, 27:2-08: 219-256.

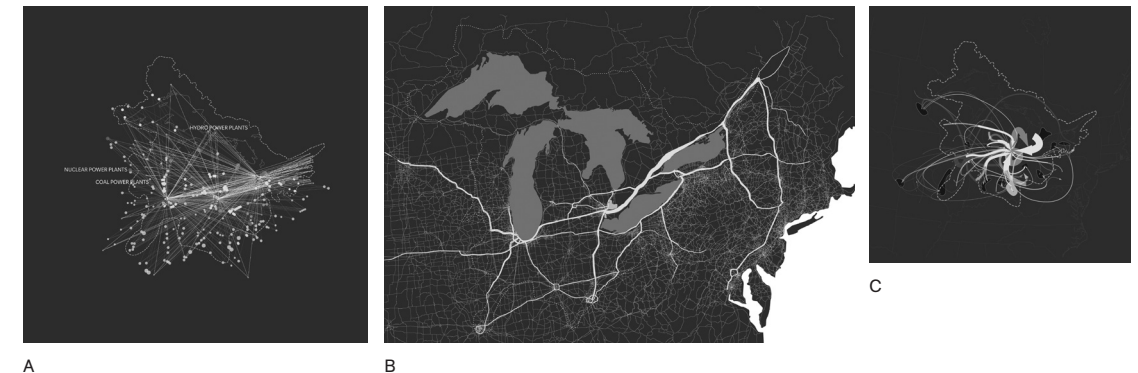
4 The Megaregion, first identified by French geographer Jean Gottman's 1961 *Megalopolis*, is now more commonly referred to as "Megaregion" and has become the focus of several prominent land use and planning agencies. See also Constantinos Apostolos Doxiadis' 1968 *The Emerging Great Lakes Megalopolis*, as well as the regional planning visions of Lewis Mumford, Clarence Stein, and Benton MacKaye. Institutes currently studying and publishing literature on Megaregions include: The Brookings Institute, the Lincoln Institute, the Regional Plan Association, the Metropolitan Institute at Virginia Tech, researchers at the Taubman College Urban and Regional Planning Program at the University of Michigan, as well as the Martin Prosperity Institute at University of Toronto's Joseph L. Rotman School of Management.

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markets, infrastructure, and land use systems that share and organize complex and interdependent transportation networks, economies, ecologies, and cultures.

The largest and most populous of the emerging North American megaregions is the Great Lakes Megaregion, which includes Chicago, Detroit, Toledo, Toronto, Buffalo, Pittsburgh, Cincinnati, Montreal, Milwaukee, Columbus, Indianapolis, and St. Louis.⁵ As a regional territory it controls one-fifth of the world's supply of fresh water and 10,900 miles of shoreline, constitutes the world's largest concentration of research universities, and is home to 30 percent of North America's and 11 percent of the world's Forbes' 2000 international company headquarters.⁶ Daily, over \$900 million worth of goods, or 25 percent of bilateral trade, crosses the Canada-US border.

Visualization of the Great Lakes Megaregion powershed (FIG. A), highway freight volumes (FIG. B), commodityshed (FIG. C), and economic clusters (FIG. E) exposes its interdependent systems of mobility, energy, and economy. Within this area, Southern Ontario's Highway 401 holds the dubious honor of being North America's busiest highway. In Toronto, one section expands to eighteen lanes and typically carries 420,000 commuter and commercial vehicles a day.⁷ As the primary conduit for both commuters and freight between Montreal and Windsor/Detroit, this artery is over-



loaded to the point of near terminal gridlock. This condition will be exacerbated by the provincial growth plan, which projects that Southern Ontario's population will grow by 30 percent, or four million people, by 2030, primarily along the Highway 401 corridor.⁸ On the US side of the border, while rust belt cities and former manufacturing centers are still experiencing depopulation, there remains a population rise projection of 17 percent, or nine million people, by 2050.⁹

This situation is conflated with the demise of cheap and plentiful carbon-based fuels and the projected transformation of energy from single-sourced fuel to a blended

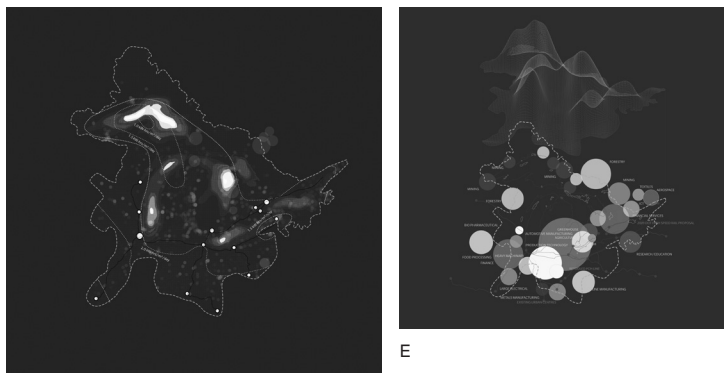
A GLM PowerShed. Chicago-Detroit-Toronto Electrical Interdependencies, 2009
B GLM Freight Based Volumes and Trans-border Flows
C GLM CommodityShed. Chicago-Columbus-Detroit Economic Interdependencies

5 There remains no consensus between research agencies as to the definition of the boundary of the GLM, as identification parameters and methods vary from study to study. See for example Delgado, Epstein et al. 2006 *Methods for Planning the Great Lakes MegaRegion*. The authors, and others, have pointed to the necessity of including the footprint of the Great Lakes Watershed within the megaregion boundary, as a means of acknowledging the profound relationship between ecological and hydrological systems and the broader economic and cultural structures that are typically prioritized in defining the megaregion boundaries. A figure that blends the watershed boundary with that identified by the RPA is utilized in this study.

6 Statistics sources: "Canadian Census Data "(2006) courtesy StatsCan, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics; "Trans-border Freight" (October 2008), The Bureau of Economic Analysis, US Department of Commerce; "Regional Economic Accounts" (Sept 2008), Austin, Affolter Caine, Milway; "The Great Lakes, A World Leading Bi-national Economic Region" (Mar 2007) as published by the Brookings Institute and the CIA World Fact Book <https://www.cia.gov/library/publications/the-worldfactbook/> (retrieved Feb 20, 2009).

matrix of inputs and sources – including solar, wind, nuclear, carbon, geothermal, hydrological, and biomass. Parallel to the current crisis of carbon-based fuel supplies, planners, politicians, engineers, and industrial leaders foresee a future of increasing demand for mobility – especially inter-regional mobility – combined with the unprecedented intensity of projected urbanization and a decaying transport and energy infrastructure.

The Great Lakes Megaregion territorializes significant amounts of renewable energy resources (FIG. D, E), with approximately 7.2 gigawatts of hydroelectric energy, copious potential for biomass energy production, and 1.5 – 2 kilowatt hours per square meter of solar energy potential daily.¹⁰ However, the region's greatest possible powershed contribution lies in 320 gigawatts of potential power that can be generated annually from offshore wind farms, which, if fully exploited, could provide 25 percent of the power needs of the United States.¹¹ However, these power sources require new territorial infrastructures for transmission and conversion. (FIG. F) The development of these new infrastructures, along with



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rapid urbanization occurring proximate to existing highways, the need for increased highway capacity, and the efficiency of electrified high-speed rail, generates significant opportunity at the confluence of the distribution and mobility networks of people, goods, and energy.

The first proposed design intervention within the system is a new typology of highway cross-section, retooled as a conduit of bundled cooperative networks of infrastructures. This would accommodate a variety of transit modes, including high speed and Mag-Lev electrified rail directly tied to high voltage power transmission,¹² dedicated vehicle lanes, high volume data transmission, and freshwater supply (FIG. G). These capacity vectors, stacked and separated to

D GLM PowerShed. Renewable Energy Resource Matrix—Wind, Solar, Hydroelectric and Biomass Source Potentials
E GLM Renewable Energy Matrix with Strategically Differentiated Economic Clusters

7 See Ontario Ministry of Transportation, "Goods Movement in Ontario: Trends and Issues," Technical Report (Dec 2004).

8 Ontario Ministry of Infrastructure Renewal, "Places to Grow: Growth Plan for the Greater Golden Horseshoe" (2006); 7. The American Association of State Highway and Transportation Officials (AASHTO) 2007 report. "A New Vision for the 21st Century," states that from 2007, "Truck volumes are expected to double by 2035, and rail freight to increase by over 60 percent": 57 (www.transportation.org; retrieved March 17 2008)

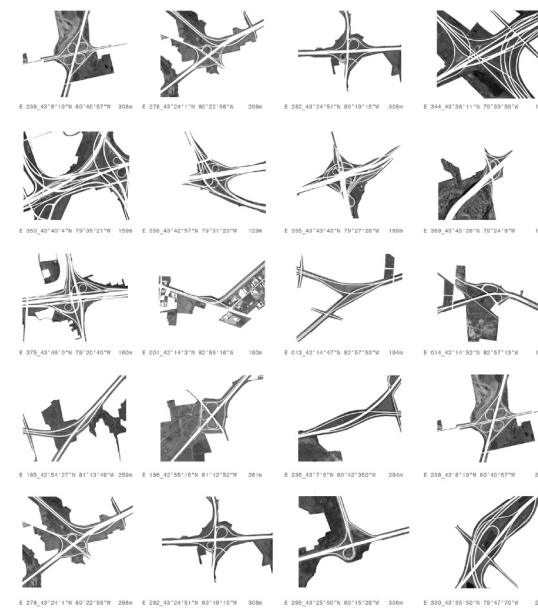
9 America 2050: http://www.america2050.org/great_lakes.html

10 Data sources: "Wind Energy Resource Atlas of the United States" National Renewable Energy Laboratory / US Department of Energy (1986) and OPG Wind Data for Canada (2009). US biomass potential data: National Renewable Energy Laboratory / US Department of Energy site <http://www.nrel.gov/gis/maps.html>. Solar potential data for the US: <http://www.nrel.gov/gis/maps.html>; Solar potential data for Canada: Natural Resources Canada: <https://glfc.cfsnet.nfis.org/maps/server/pv/index.php>.

11 Great Lakes wind potential reports: Land Policy Institute (September 2008 report); "Michigan's Offshore Wind Potential," Helimax Energy Inc. (April 2008 report); "Analysis of Future Offshore Wind Farm Development in Ontario" as well as the U.S. Department of Energy (July 2008 report). "20% Wind Energy by 2030."

12 Transport experts argue that the most effective and efficient technology for a mobility revolution resides in electrified high-speed rail directly tied to renewable energies, productively crossing mobility and energy distribution infrastructures. See Gilbert, Richard and Anthony Pearl (2008). *Transport Revolutions. Moving People and Freight without Oil* (London: Earthscan): 311.

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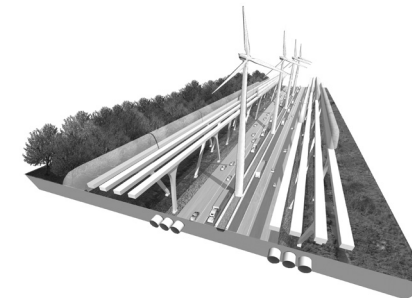


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maximize speed, safety, and accessibility, increase conduit bandwidth, in addition to forming a resource umbilicus that can service increasing demand along the line. Such intervention would effectively shrink the time-space geography of the region, while creating connections between its most robust economic agents. Configured for ease of implementation within the existing right-of-way of major highways, this system eliminates land acquisition and expropriation and recognizes the geography of the highway as the driver for future urban growth.¹³ This infrastructural network would harness and strategically link differentiated economic clusters, reinforcing and supporting the diverse spatial logistics of megaregional agglomeration economies.¹⁴ Through such a lens, the megaregion becomes a primary sociopolitical unit, overshadowing the agency of individual state, provincial, and even national boundaries and structures of governance.

A second design intervention identifies the node of the multimodal transfer interchange node to become a key type and a predominant megaregional construct. These nodes provide transit switch sites, transport redistribution, and refueling (FIG. H, I, J). Beyond logistics and transportation-driven infrastructural provision, this emerging matrix of interconnectivity has the capacity to foster significant transformation to accessing social infrastructures. For example, specialized services such as regional health and research clusters can be connected to major urban centers and rendered accessible to less affluent and diverse communities via the new

F Conduit Urbanism. Nodal Differentiation
G Conduit Urbanism. Strategic Sectional Differentiation



G

13 See visual analysis of urban morphology in Southern Ontario cities relative to the Highway 401 corridor by the authors in "The Post-Carbon Highway," *Fuel*, John Knechtel ed. (2008): 174-17.

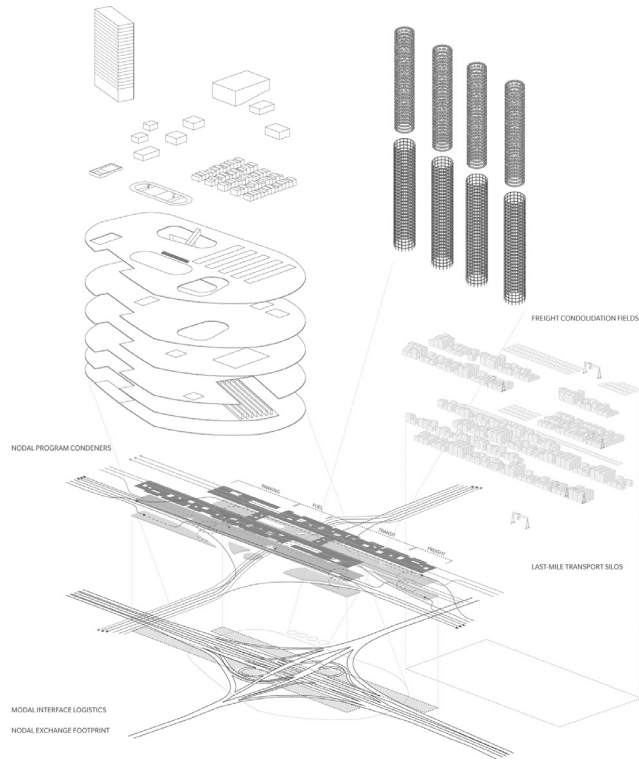
14 Sassen, Saskia. "Megaregions: Benefits beyond Sharing Trains and Parking Lots," in Keith S. Goldfield, ed. 2007. "The Economic Geography of Megaregions," *The Policy Research Institute for the Region*, Trustees of Princeton University: New Jersey: 67.

line of rapid rail-based mobility infrastructure, reaching a wider constituency of participants than the current local Sub-Regional Centers.

Conduit Urbanism offers a strategy for intervention into infrastructure ecologies by catalyzing intensification of existing highway corridors and combining emerging systems of renewable energy distribution, mass transit and



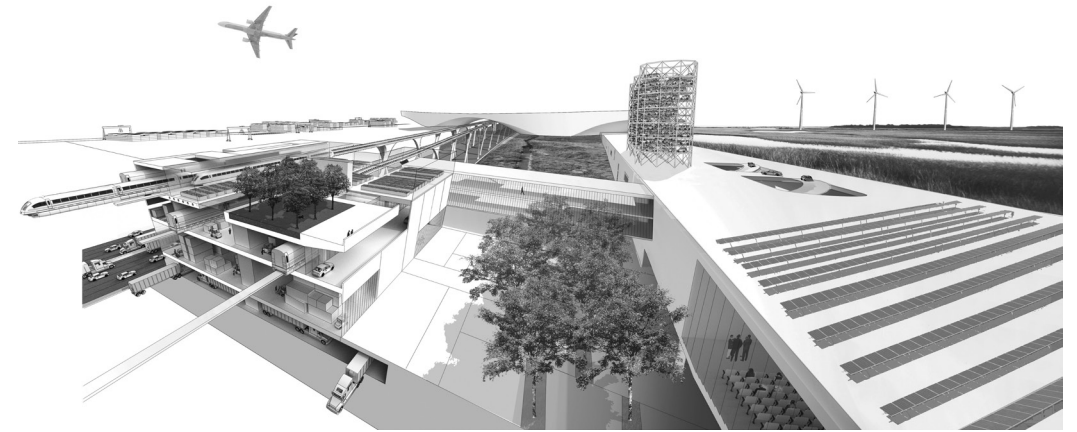
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freight. Mobility and power will activate peri-urban protagonist landscapes and link critical population concentrations within and across the larger megaregion. Territories ranging

H Conduit Urbanism. Strategic Sectional Differentiation
I Conduit Urbanism. Multimodal Transfer Exchange



J

from vast field conditions to precisely defined nodal points of transference are anticipated to emerge as key points of friction and opportunity that will both condition and define the Great Lakes Megaregion, while offering its inhabitants new forms of collective social infrastructure, services, and spatial products within a system of intensified connectivity.

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J Conduit Urbanism. Possible urban worlds along the Multimodal Exchange

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