Landscape Infrastructure

Pierre Bélanger

Urbanism beyond Engineering

Pierre Bélanger LANDSCAPE INFRASTRUCTURE *Urbanism beyond Engineering* 2013

LANDSCAPE INFRASTRUCTURE

Urbanism beyond Engineering

Pierre Bélanger

Thesis committee

Promotor
Prof. dr. J. Koh
Professor of Landscape Architecture
Wageningen University

Other members
Prof. dr. Arnold J.J. van der Valk
Wageningen University

Prof. dr. Sabine Barles
Institut Français d'Urbanisme, Université Paris 1, France

Prof. dr. Kelly Shannon
The Oslo School of Architecture & Design, Norway

Prof. dr. Dirk F. Sijmons
Delft University of Technology, The Netherlands

LANDSCAPE INFRASTRUCTURE

Urbanism beyond Engineering

Pierre Bélanger

Thesis
submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof.dr. M.J. Kropff
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Monday 13 March 2013
at 11 a.m. in the Aula.

Pierre Bélanger

LANDSCAPE INFRASTRUCTURE *Urbanism Beyond Engineering*.
450 pages.

PhD thesis, Wageningen University, Wageningen, NL (2013)
With references, and summaries in Dutch, English, French

ISBN 978-94-6173-527-0

Propositions

1. Urbanization can be expressed as an ecology of different flows and processes of waste and water, fuel and food, mobility and power.
(this thesis)

2. Landscape infrastructure is both index and interface that spatially incorporates hard technological systems and soft biophysical processes, by design.
(this thesis)

3. The fundamental problem with urbanization is that we consider it a scientific problem.

4. As a socio-dynamic process and geo-spatial strategy, the physical and fluid extents of urbanization lie far beyond the footprints of cities.

5. Decentralization is one of the greatest, structural forces reshaping patterns of urbanization today.

6. Civil engineering nor policy planning alone cannot exclusively address pressing urban challenges of changing climates, resource economies, and population mobility.

7. Ecologies of scale are the new, post-industrial economies of the future.

8. The emergence of ecology and the revival of geography in late 20th century North America is advancing the social and political agency of landscape architecture.

Propositions belonging to the thesis, entitled

'Live, ecological systems can be designed as infrastructures that shape contemporary urban economies'.

Pierre Bélanger
Wageningen, 13 May 2013.

Landscape Infrastructure

Pierre Bélanger

Urbanism beyond Engineering

WUR

ISBN 978-94-6173-527-0
9 789461 735270 >
ISBN 978-94-6173-527-0
Wageningen Universiteit en Researchcentrum (WUR)

Live, ecological systems can be designed as infrastructures that shape contemporary urban economies.

As ecology becomes the new engineering, the project of *Landscape Infrastructure* - a contemporary, synthetic alignment of the disciplines of landscape architecture, civil engineering and urban planning - is proposed here. Predominant challenges facing urban regions today are addressed, including changing climates, resource flows, and population mobilities. Responding to the inertia of land use zoning and overexertion of technological systems at the end of 20th century, the thesis argues for the strategic design of “infrastructural ecologies”, a synthetic landscape of living, biophysical systems that operate as urban infrastructures to shape and direct the future of urban economies into the 21st century.

CONTENTS

Acknowledgements

First and foremost, I would like to thank Prof. Jusuck Koh for his initial invitation to develop this research into doctoral research at the University of Wageningen, the premier institution for studies in Life Sciences and Agricultural Research in the world. His support was catalytic, and was sustained during the past five years while this research was pursued. Like the Michael Hough of the Netherlands (who also was taught by Ian McHarg at the University of Pennsylvania), Professor Koh provided an open, critical forum and a theoretical platform - *the classroom as a lab* - for unlocking several key ideas and concepts presented here. Without his initial invitation to Wageningen in 2006 for a conference on contemporary landscape urbanism, this project would have taken a very different direction.

Unknowingly, the project saw the intellectual influence of Sabine Barles (Université Paris 1), Kelly Shannon (AHO School of Architecture), Dirk Sijmons (Technical University Delft), and Arnold van der Valk (Wageningen University) who shaped the central idea of this book through the influence of their work and writing on the multi-layered landscape of infrastructure, conveyed through histories, ecologies, myths, infrastructures, and urbanisms of water over the past few years. The concluding notion that 'form follows fluidity', as the contemporary inflexion of the historic adage 'form follows function' is an important outcome of their profound influence. Thankfully, they all accepted Professor Koh's invitation and generously agreed to serve as part of the Doctoral Review Committee, sharing their time through focused feedback and critical support.

Several fields have influenced this project, and as a result, several practitioners from different camps - including different industries, organizations, institutions - brought influence and inquiry to this project and its ideas.

Dr. Ted Kesik, Building Scientist & Environmental Engineer, as well Professor Rob Wright, Landscape Architect & Ecological Planner from the University of Toronto, provided the initial impetus for this project early on, in its pre-doctoral stage. Both of them proposed that the measure of influence of this work should find itself on the shelf of the *T Section* (Technology and Engineering) of the University's main library, in the hands of engineers who equally stood to gain from this research. That, in addition to the more common NA and SB sections (Architecture & Landscape) where the book would naturally find a home. Their influence during the incubation period of this project was important.

A very, early supporter of the research of this project was Charles Waldheim, Chair of the Department of Landscape Architecture at the Harvard Graduate School of Design and former Director of the Landscape Architecture Program at the University of Toronto. Charles saw not only the potential for the line of inquiry proposed in the following pages but supported several key studios, seminars and symposia, both at Harvard University and the University of Toronto, at several critical stages of development, providing important steps forward. Together with Mohsen Mostafavi, Dean of the Harvard Graduate School of Design who built the foundation for design's rappel-à-l'ordre at the GSD and the renewal of the landscape project, they have accorded considerable time, latitude and funding to complete this project and cultivate its audience.

Albeit in an unsolicited way, to Neil Brenner, a geographer from New York who joined the Graduate School of Design in 2012 thanks to the initiative of Mohsen Mostafavi and Charles Waldheim. Neil has provided capstone mentorship and intellectual feedback as this project reached maturity. While I hold that theories are for the blind, he conversely argues that, everyone is a theorist, promoting the need to go deep into cultural thinking while resurfacing for air. Neil helped confirm the relevance of the infrastructure subject through the field of landscape and its influence on the discipline of geography in North America. He confirming the influence and extreme differentials in geographic knowledge and discourse between the United States (a country that saw the closure of its geography departments from the 1930s onwards) compared to the geographic culture and geospatial literary of countries of the Commonwealth such as the UK, Australia, Singapore, Nigeria, India, and Canada, where geographic knowledge is more pervasive from an early age, and from where geographic information systems were conceived and innovated.

When arriving in Cambridge, Michael Van Valkenburgh and Antoine Picon from the Harvard GSD and L'École Nationale des Ponts et Chaussées, as well as Alan Berger from MIT, provided unbiased advice at key moments that helped strategize this project. Both their work, and their words, through conversations and courses, have had important influence on the combined polemical, political, technological and popular dimensions that design disciplines often overlook.

Throughout the past few years, several key colleagues have also strongly influenced this project, both directly and indirectly. It is their unsolicited influence, as practitioners and pedagogues from the Harvard Graduate School of Design and University of Toronto that has enabled every minute of every day to be one long, open, extended conversation.

In addition to support from Charles Waldheim, Mohsen Mostafavi, Antoine Picon, and Neil Brenner, colleagues at the Harvard Graduate School of Design whose influence bears importance include Nina-Marie Lister, Hashim Sarkis, Chris Reed, Gary Hilderbrand, Niall Kirkwood, Sonja Duempelmann, Richard T.T. Forman, Anita Berrizbeitia, and Patricia Roberts.

To guest speakers who participated in two separate conferences, the most recent at the Graduate School of Design, in 2012: Kate Ascher (Happold Consulting), Sabine Barles (Université Paris 1), Liz Barry (PLOTS), Erle Ellis (UMBC), Wendi Goldsmith (The Bioengineering Group), Jo Guldi (Harvard Society of Fellows), Kevin S. Holden (USACE), US Army Corps of Engineers, Peter del Tredici (Arnold Arboretum-GSD), Christophe Girot (ETH Zurich), Eduardo Rico & Enriqueta Llabres (ARUP - Relational Urbanism), Todd Shallat (BSU), Kevin Shanley & Ying-Yu Hung (SWA), Dirk Sijmons (TU Delft), Rosalind Williams (MIT), Dawn Wright (ESRI); and the second, in 2009 at the University of Toronto: Stan Allen (Princeton), George Baird (Toronto), Julia Czerniak (Syracuse), Herbert Dreiseitl (Atelier Dreiseitl), Kristina Hill (UCB), Michael Jakob (HEPIA-Genève), Nina-Marie Lister (Ryerson University), Kate Orff (Columbia) and Jane Wolff as well as plenary discussions with Rodolphe El-Khoury, David Fletcher, Ted Kesik, Robert Levit, Liat Margolis, Alissa North, Mason White and Robert Wright. Both events contributed enormously in helping to bring ecology, economy, and engineering closer together, through design, as well as lay out the groundwork for future collaborations and projects together. They serve as a reminder that we have only begun scratching the surface of the infrastructure subject and landscape's tremendous potential.

In addition to Ted Kesik and Robert Wright's influence at the University of Toronto, the guidance of George Baird and Larry Richards provided the ongoing impetus to research and develop thinking at the University of Toronto. In addition. George Baird, Larry Richards, Brigitte Shim, John Danahy, Emily Waugh, Jane Wolff, and Mason White constantly engaged this discussion in reviews, lectures and presentations. Fred Urban provided much encouragement exactly 20 years ago today for the directions proposed here that, albeit experimental some time ago, have become more widely accepted and common today. During those years, Michael Hough was the intellectual entrepreneur that provided important and alternative views at several key moments to the optic on infrastructural practices seen through the development of his office and organization, that has undergone an unprecedented level of growth and influence as a large scale enterprise.

Students from graduate courses at several institutions - the Harvard Graduate School of Design, University of Toronto, BOKU University in Austria, IAAC in Spain, AA in London, TU Delft and Wageningen University in the Netherlands - and several other universities across North America, who performed as unsung institutional stuntmen and pedagogical guinea pigs, put to the test curricular methods, constantly asking critical questions in seminars and studios, exposing holes, gaps and omissions through their inquiries, while seeing potentials, establishing connections and drawing bridges to new dimensions, without judgment. It is those questions that open up new areas of investigation, and those questions should always keep coming.

Those graduate students who became collaborators at OPSYS and the Landscape Infrastructure Lab, helped conceive, incubate, express, and research different ideas, while developing, materializing, and implementing strategizing: Alexandra Gauzza, Alexander S. Arroyo, Sara Jacobs, John Davis, Anne Clark Baker, Elena Tudela, Hana Disch, Stephan Hausheer, Christina Milos, Chen Chen, Pamela Ritchot, Chris de Vries, Curtis Roth, Kimberly Garza, Kees Lokman, Luke Hegeman, Kelly Doran, Fadi Masoud, Behnaz Assadi, Hoda Matar, David Christensen, Brett Hoonaert, Andrew tenBrink, Sarah Thomas, Kimberly Garza, Erik Prince, Aisling O'Carroll, Jacqueline Urbano, Ed Zec, Maya Przybylski, Joshua Cohen, Daniel Seiders, Deborah Kenley, Tawab Hlimi and Daniella Bacchin.

This work would have been impossible either without influence from industry and boards that I had the privilege and opportunity to serve on. From different company representatives and managers who provided unfettered access to sites and records, from floodplains to food terminals, to landfills: Renata van Tscharner (Charles River Conservancy), Brian Ezyk (Republic Services Inc.), Bruce Nicholas, Gianfranco Leo, and Gary DaSilva (Ontario Food Terminal Board), Alexander Reford (Jardins International de Métis), Chris Rickett (Toronto Regional Conservation Authority), and more recently to Kevin Holden, from the U.S. Army Corps of Engineers who opened a huge area of latent collaboration that has been dormant for decades. Together, they have identified the great responsibility upon the practice of landscape architecture to address challenges of large scale projects and the finer grain details of standards and specifications that engineers typically work with.

On several occasions, mostly through short but influential exchanges, in airports and elevators, Jack Dangermond (ESRI), Joe Brown (AECOM), Michael Hough (Envision Group), Rem Koolhaas (OMA/AMO), Winy Maas (MVRDV), Ben van Berkel (UN Studio), George Hargreaves (Hargreaves & Associates), Joe Miotto & Elizabeth Starr (NORR), Bill Hewick (ACME Environmentals), Dirk Brinkman (Brinkman & Associates Reforestation), Martha Schwartz (MSP), Gary Pilger (Pilger Equipment), Wendi Goldsmith (The Bioengineering Group), and Tyler Ginther (Super Soil) provided memorable advice on pursuing dirt research in tandem with practical applications.

Several funding organizations helped support several events and related endeavours including the Harvard Graduate School of Design, University of Toronto Daniels School of Architecture, Landscape & Design, Landscape Architecture Canada Foundation, Netherlands Architecture Fund, Ontario Sand, Stone & Gravel Association, Canada Department of Natural Resources, the Ontario Ministry of Northern Development, Mines and Forestry, Canada Foundation for Innovation, Social Sciences & Humanities Research Council, Natural Sciences & Engineering Research Council and the Canada Golf Foundation. The Norman T. Newton Prize from Harvard University provided me with a copy of Norman T. Newton's *Design on the Land: The Development of Landscape Architecture* (Harvard University/Belknap Press, 1971), an important book whose raison d'être highly influenced my thinking of the field, through how land is constructed and cultivated, neglected or abandoned, designed and engineered.

Informal, raw conversations during experiences and exchanges with friends are the unspoken contributions to this project: Michael Jakob, Peter & Alissa North, Shane & Betsy Williamson, Leslie Lee & Wynne Mun, Maximo & Janine Rohm, Nazrudin Hiyate, Ricardo Pappini, Luc Dandurand, Louis Martin-Villeneuve, and David Lavictoire. In different ways, they all helped test and shape ideas presented here.

Gloria I. Taylor, Jacob & Yoshiko Mazereeuw, defied distance and unconditionally supported this effort through all its developments and discoveries. Finally, an incalculable debt is owed to Miho and Nina, whose unrelenting and unquestioned support provided the greatest level of love, influence and intelligence that seeded and sustained the project, bringing it and many other wonders to fruition.

Propositions

As the result of several processes and projections, the main position proposed here - *landscape infrastructure as contemporary practice* - is contingent on, and represented by a series of inter-related propositions that are respectively preparatory, instrumental, directional.

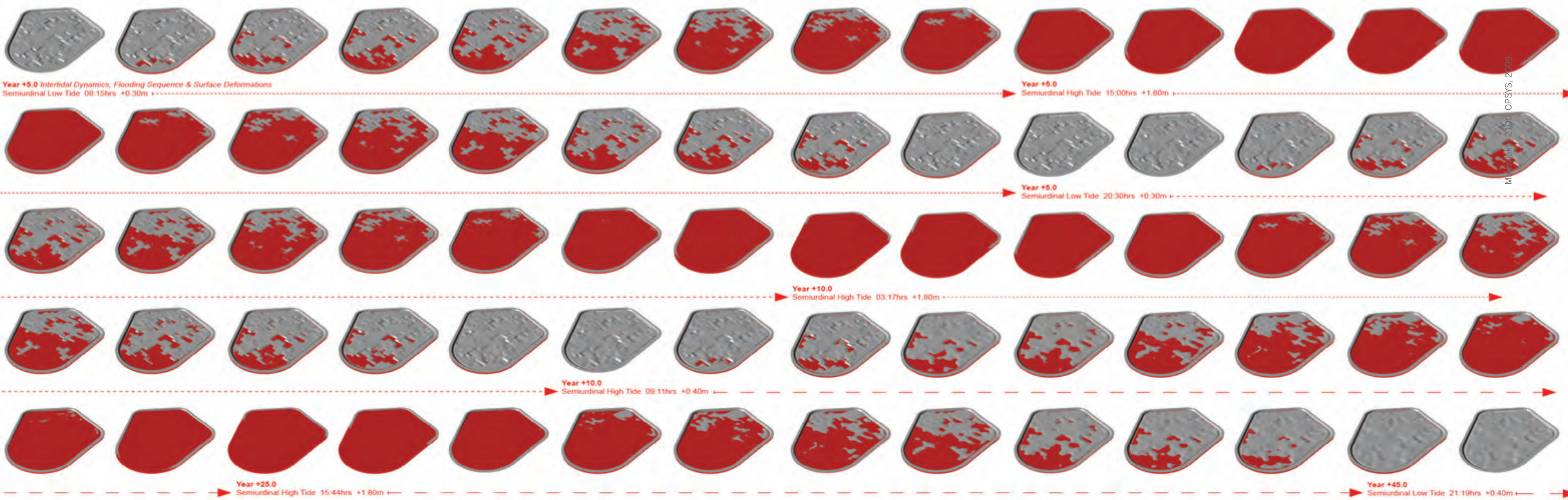
Urbanization can be expressed as an ecology of different flows and processes of waste and water, fuel and food, mobility and power.

As an open system of exogenous and endogenous processes, urbanization can be expressed through different flows, materials and vectors made of of waste (residuals & detritus), water (fluids & hydrologies), energy (fuel & power), food (biota & habitats) and mobility (speed, transportation, communications). Shit, urbanization's excreta, is its most potent example.

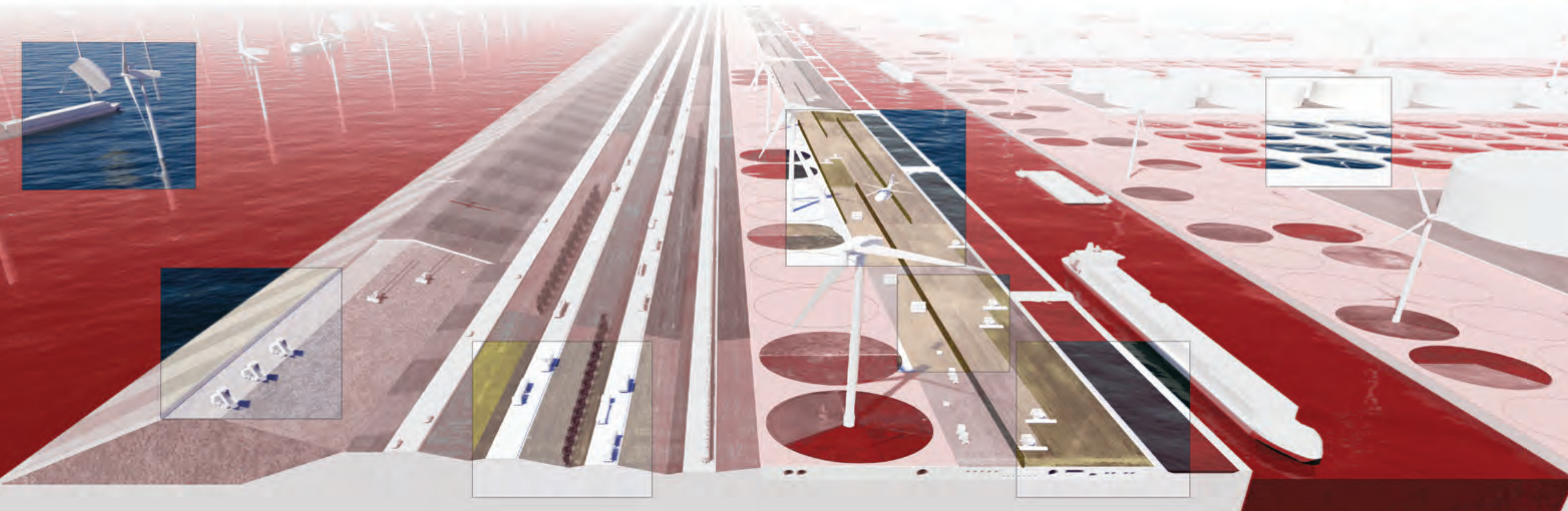
Deepwater Horizon Oil Spill, Gulf of Mexico (May 24, 2010), NASA.

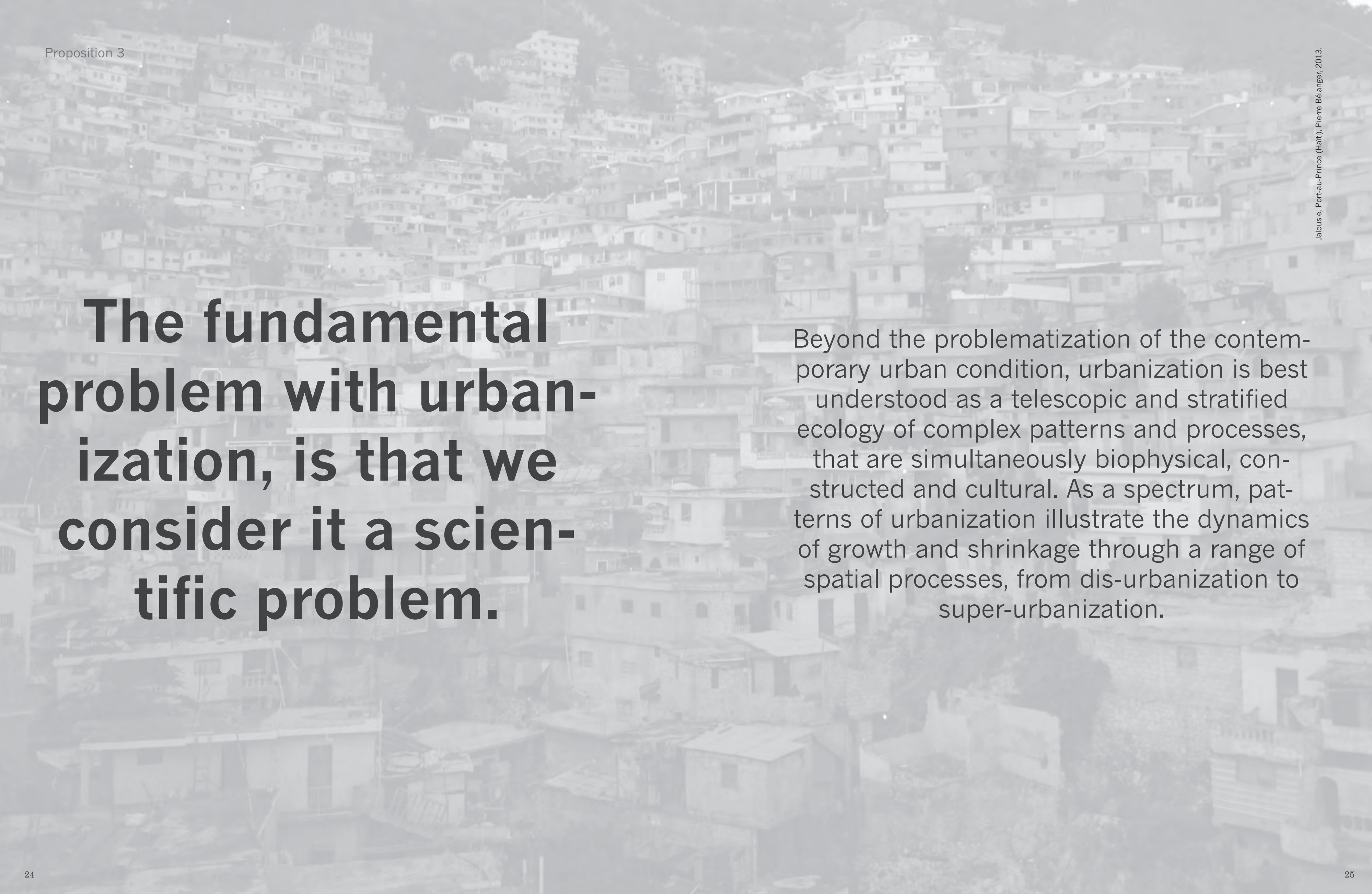
Landscape infrastructure is both index and interface that spatially incorporates hard technological systems and soft biophysical processes, by design.

When viewed as landscape, that is as a field of systems and scales expressed through processes and patterns, either digital or physical, automated or mechanical, infrastructure is both an index and interface that involve constructed technological systems (hardware) and designed biophysical systems (software).



Maasvlakte 2100, OPSYS, 2009.





Jalousie, Port-au-Prince (Haïti), Pierre Bélanger, 2013.

The fundamental problem with urbanization, is that we consider it a scientific problem.

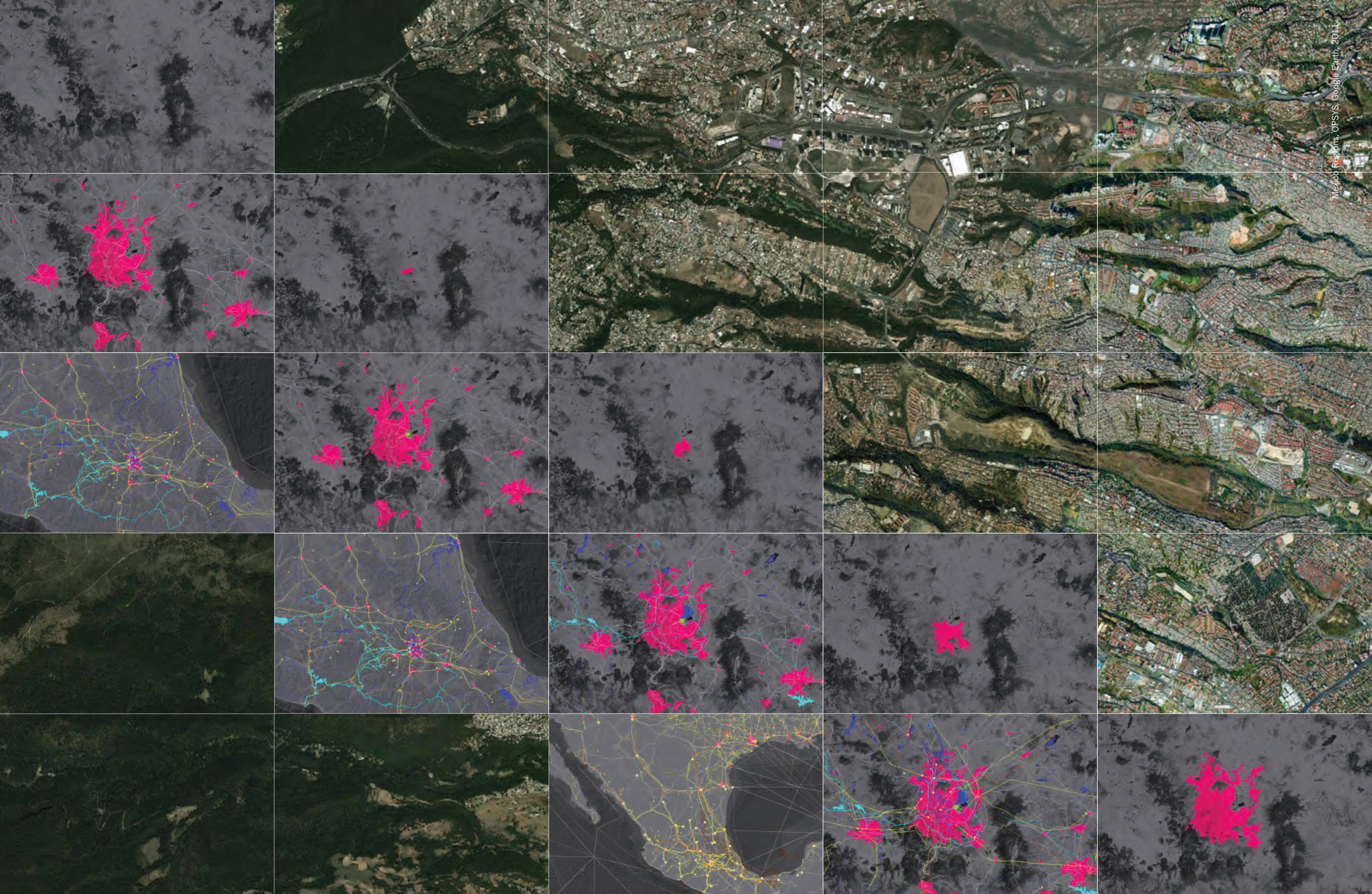
Beyond the problematization of the contemporary urban condition, urbanization is best understood as a telescopic and stratified ecology of complex patterns and processes, that are simultaneously biophysical, constructed and cultural. As a spectrum, patterns of urbanization illustrate the dynamics of growth and shrinkage through a range of spatial processes, from dis-urbanization to super-urbanization.

Flint, Michigan (Leonard Thygesen, 2010)

Lagos Island, Nigeria (Alf Gillman, 2010)

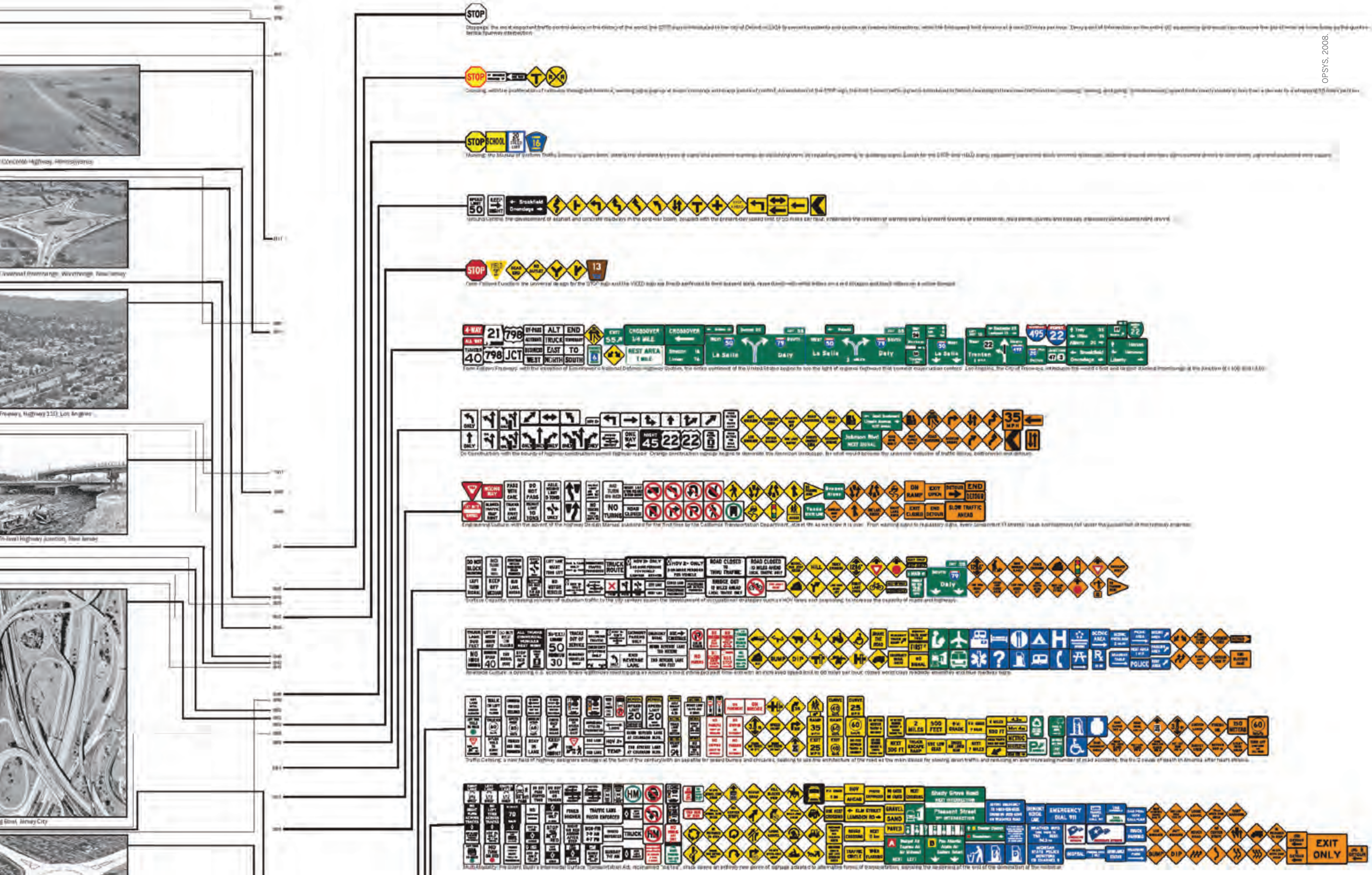
As a socio-dynamic process and geo-spatial strategy, the physical and fluid extents of urbanization lie far beyond the footprints of cities.

When factoring resource regions & biodynamic flows, the regional remapping of urban economies exposes the complexity of urban ecologies, infrastructural systems and social geographies. This landscape opens the extents of urbanization beyond the footprints and grey zones of cities, at different scales, depths, extents, altitudes and atmospheres.

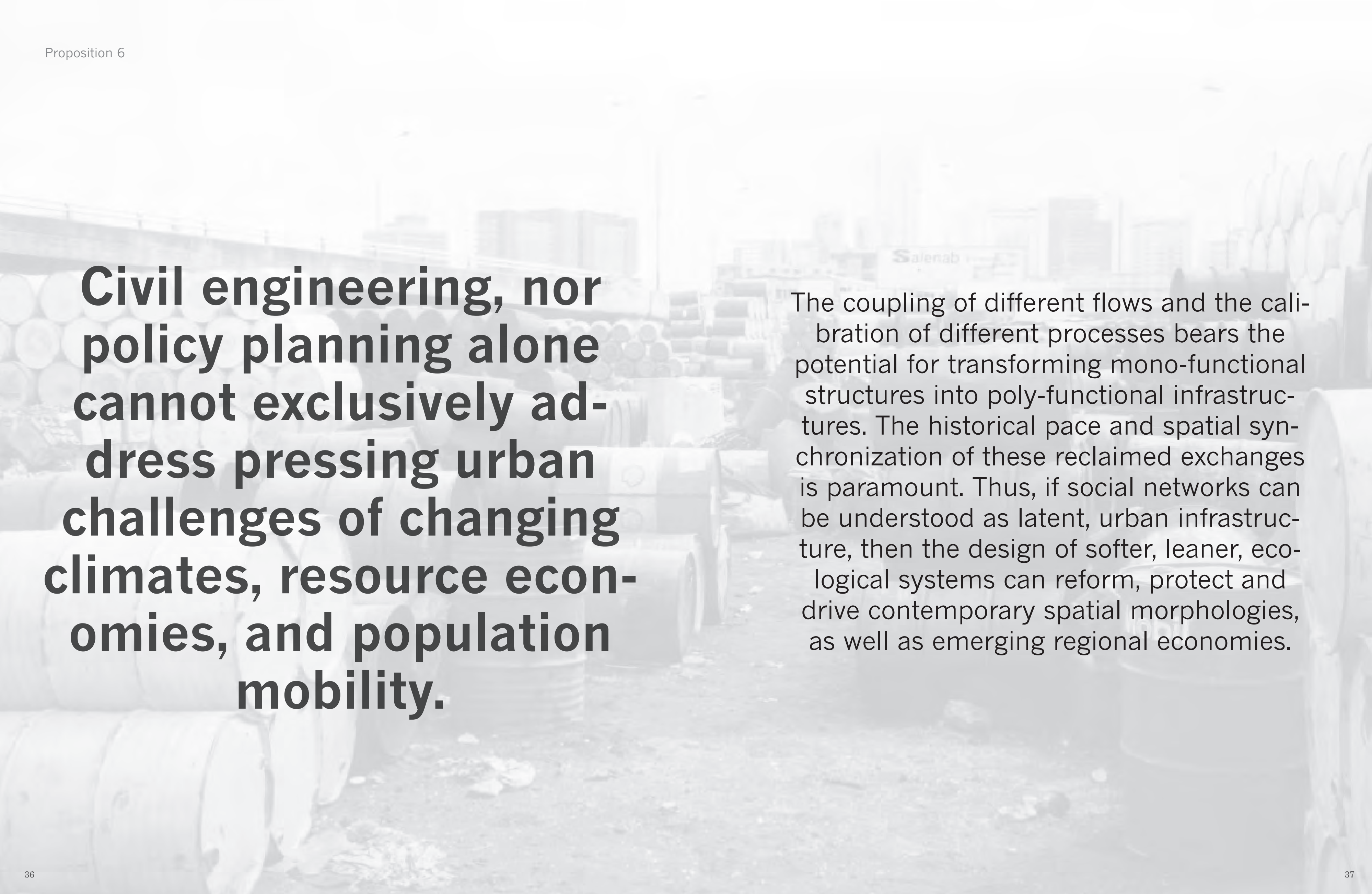

Mexico Regions, OPSYS, Google Earth, 2011.

Decentralization is one of the great-est, structural forces reshaping patterns of urban-ization today.

The exchange of resources, materials and information drive influence patterns and processes of urbanization through various formats of exchange. As decelerant and accelerant, different speeds of urbanization modify and program urban surfaces to accommodate greater auto-mobility and auto-diversity as a result of the decentralization and diffusion of movement. Different speeds, cycles, surface markings and codifications at one end, and infrastructures of mobility at the other, will contribute to these exchanges and movements, while helping to shape urban surfaces and regional patterns.


STOP
SCHOOL
4-WAY
CROSSOVER
REST AREA
La Salle
Daly
ROAD CLOSED
TRUCK ROUTE
NO TURNS
ON RAMP
END DETOUR
EMERGENCY DIAL 911
EXIT ONLY

OPSYS, 2008.



Civil engineering, nor policy planning alone cannot exclusively address pressing urban challenges of changing climates, resource economies, and population mobility.

The coupling of different flows and the calibration of different processes bears the potential for transforming mono-functional structures into poly-functional infrastructures. The historical pace and spatial synchronization of these reclaimed exchanges is paramount. Thus, if social networks can be understood as latent, urban infrastructure, then the design of softer, leaner, ecological systems can reform, protect and drive contemporary spatial morphologies, as well as emerging regional economies.

Edgar Cleijne, 2002.

Ecologies of scale are the new, post-industrial economies of the future.

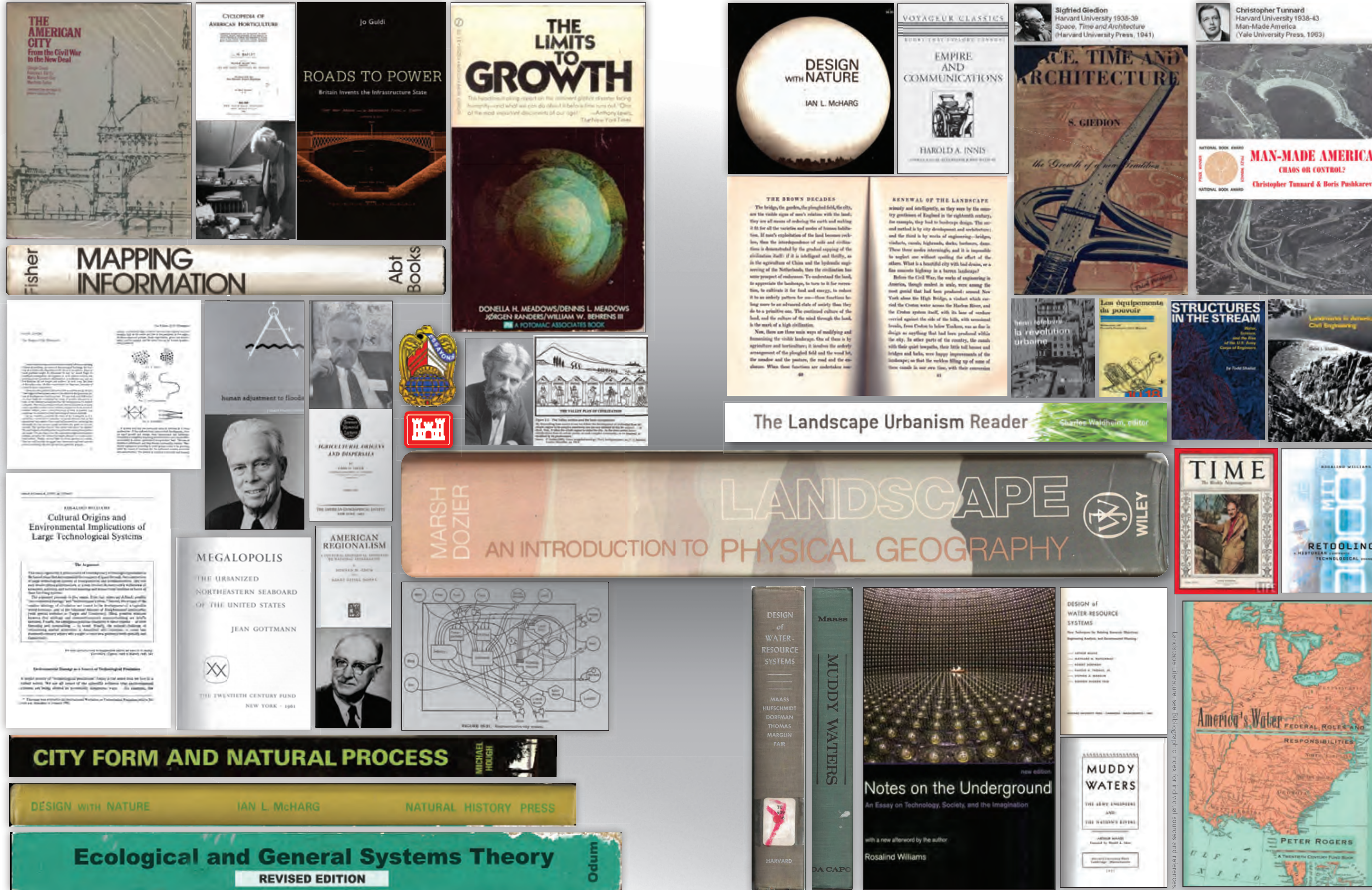
Overturning the industrial economies of scale that have characterized the past two centuries, the design of infrastructural ecologies will radically transform the historic approach to infrastructure engineering, land use planning and spatial zoning. Moving beyond the economic value of production and the utility of land use, the historic categorization of urban land (residential, commercial, industrial, institutional) can be designed for greater flexibilities, overlaps, interconnections, synergies, zones of cultivation and areas of exchanges that privilege ecological systems, as the new economic services of the 21st century.

Subtropical Sydney: OPSYS, 2011.

The emergence of ecology and the revival of geography in late 20th century North America is advancing the social and political agency of landscape architecture.

From a North American vantage, the re-representation of landscape - its histories, techniques, ecologies - is reshaping urban discourse. The overexertion of technological engineering and the inertia of urban planning and zoning, the field of landscape has grown from and contributed to the recent emergence of ecology and revival of geography in the past quarter century.

Marsh & Dozier, 1981.



Landscape Literature, see Bibliographic Index for individual sources and references.

Impulses, Influences, Intentions.

As ecology becomes the new engineering, the project of Landscape Infrastructure - a synthetic alignment of landscape architecture, civil engineering and urban planning - is proposed here. Moving beyond the historic, reformist tendencies of the practice of Landscape Architecture and its surrogate affiliations to the discipline of Architecture, the projective strategy of Landscape Infrastructure harnesses urbanization as predominant process in contemporary spatial transformation and overcomes a century-old reliance on correcting, remediating, fixing the centralized conditions of 19th century urban form, and of the industrial metropolis. Informed by the mother of all design disciplines and agent of urban infrastructure that is civil engineering, this disciplinary alliance borrows intellectual innovations from four foundational schools of landscape thought: the 'school of mapping' at University of Pennsylvania (James Corner & Ian McHarg), the 'school of urbanism' at the University of Toronto (Michael Hough, George Baird, Charles Waldheim), the 'school of engineering' at Delft Technical University (Cornelis Lely, Gerard Philips) and the 'school of ecology' at the University of Wageningen (Adriaan Geuze, Jusuck Koh). Considered together, these schools of thought span important intellectual and disciplinary differentials that still exist in widely divergent, oppositional histories, perpetuated by the hegemony of architecture on the urban subject and of engineering on the technological subject. Through a deeper understanding of the practical and theoretical value of process and flow over ideologies of form and function in the Post-McHargian era, the review and rewriting of urban histories is paramount to the yet, unfinished landscape project of the 21st century.

Conceived in a near reverse chronology, the writings compiled here are the result of several important influences and impulses. Borne from a crisis in disciplinary thinking, these texts present a position that outline a series of scales, strategies and systems for understanding and influencing urbanization through contemporary patterns, processes and precedents. Precipitated by an absence of geospatial knowledge and geographic thought in the design disciplines, the impulse to collect these writings stems from the need to span disciplinary divides through a series of grounded practical thoughts. To accomplish this, the writings operate longitudinally, across large bodies of knowledge, through different subjects and fields, often across long periods of time.

Influences & Intentions

Since they were conceived over a period of five years, the texts were performed under the unknowing influence of several pedagogues and practitioners. Informed by early work on underground urbanization and urban externalities[1] during the past decade, they were initiated under the direct mentorship of an engineer during early stages of incubation and later, towards its end, by proxy, under the indirect guidance of a geographer. Throughout different stages of development, the writings were also influenced by several important, turn-of-the-century ecologists and urbanists from different schools of thought and programs of design.

During this period of incubation, the writings led to the organization of, and were influenced by the outcomes of two international conferences that explored the infrastructure subject as multifaceted interface vis-à-vis the contemporary challenges of shifting climates, population migrations, material resources and biophysical systems. The first, held at the University of Toronto Daniels School of Architecture, Landscape & Design in 2008, explored the strategic influence of a growing body of ecological knowledge to unearth a series of contemporary practices, paradigms and technologies tht are reshaping the contemporary urban landscape. The second, held at the Harvard Graduate School of Design in 2012, reexamined the infrastructure subject as multi-disciplinary design practice through the invitation of ecologists, engineers, historians, geographers and architects. Through the polyvalent subject of infrastructure, these conferences brought together a wide range knowledge from the natural sciences (biologists, ecologists, hydrologists, geologists), applied sciences (civil and

1. See "Underground Landscape: Stratigraphy of Downtown Toronto's Pedestrian Network" by Pierre Bélanger, in *Tunnelling and Underground Space Technology* (Elsevier Science Publications, 2007): 272-292; "Foodshed: the Global Infrastructure of the Ontario Food Terminal" in *Food*, edited by John Knechtel (Cambridge: MIT Press, 2007): 208-239; Airspace: The Economies & Ecologies of Landfilling in Michigan" in *Trash*, edited by John Knechtel (Cambridge: MIT Press, 2006): 132-135.

environmental engineers), the arts (economists, geographers, historians) and designers (landscape architects, planners, urban designers). Demonstrating the subliminal nature of infrastructure as media, these conferences elucidated the relevance of innumerable practitioners as part of the urban project, that is, as urbanists.

Through the influence of these collaborations and conferences, the widening of the infrastructure subject exposes three critical imperatives:

1. Urbanize the histories of the landscape field.
2. Expose the biophysical complexities of urban processes.
3. Project contemporary urban ecologies as performative infrastructures.

As propositions, these imperatives also underscore the role of Landscape Architects as the directors of these multilateral efforts. As a project, this role lies beyond the authorship or the authority of any single discipline yet relies on the initiative and urgency of the prevailing attitude cultivated in the current practice of Landscape Architecture. As agents of multiple complexities and interlocutors of manifold constituencies, Landscape Architects propose how design is contextual and contingent, preemptive and responsive, as well as strategic and projective.

Media & Methods

Like a geo-photographic essay, the writings presented here are coupled with original drawings and diagrams from design competitions and field research, as well as with historic images from archival sources. Coupling image and text, these visual representations are more than background or backdrop to the writings, they operate as spatial evidence, surpassing the subsidiary or auxiliary function of illustrations in scientific journals. The graphic content becomes geographic, and the context of the field becomes figural. As both operators and interpreters, images establish a spatial discourse that dissolves differences between the textual and the visual, the analytical and the descriptive, as well as the historic and the territorial. This dual intention in representation thus proposes how the writings articulate a position between design and research, between the inductive and the deductive, sliding across the synchronic and the diachronic, between the practical and pedagogical.

Since theories are naturally imperfect as modes of representation, often carrying the burden of blind spots and knowledge holes, the language of this position is purposely kept practical and pragmatic, while maintaining a commitment to graphic, diagrammatic, and spatial tones throughout for easier understanding and application. Organized nearly chronologically, the contents of the compilation can be read in two ways, mapping a road through from its earlier descriptive beginnings (the appraisal) to its most recent projective formulations (the proposal). From the bottom up, it threads multiple lineages, provide multiple interpretations and creates several affiliations for distinct, design disciplines. The compilation also speaks to the influence of large scale organizations and seeks to communicate their effects on the ground. Through current and historic examples, as well as visual timelines and diagrams, the built-in dumbness of the graphic dimension focuses on interconnections between previously disconnected ideas, disciplines, and practices. Distributed between the main body of writings, imaging of the contents takes on a dual role. To bridge textual gaps, the images spatialize the information, situating them geographically, ecologically and historically. Here, maps work as graphic footnotes, images as illustrative evidence, and diagrams as spatial charts. As a result, the strategies are presented less as a definitive solution to a specific problématique but rather as a concentration of ideas that dissolves the divisions raised by the professionalization of practice and its unintended feeder mechanism, the disciplinary industrialization of academia.

Structure & Sequence

As a turn-of-the-century appraisal of current urban conditions, this position is also a projective proposal. The context of the position locates itself at the turn of the new millennium where disintegrating industrial structures of the 19th and 20th centuries are collapsing under the weight of emerging urban economies of the 21st. Mapped out, this momentous shift is sponsoring unprecedented spatial diffusions and social concentrations, thanks to the revival of geography and the emergence of ecology. Challenging the overexertion of engineering and elucidating the inertia of urban planning, the pace of decentralization is loosening the grip of centralized infrastructure and redrawing the contours and complexities of contemporary urban life.

Reaching across disciplinary divides, the writings are also structured to operate as multilayered spans across multiple horizons, between disconnected bodies of knowledge and different professional practices, each vetted by its own constituencies. To this end, the first spanning effort begins with “Redefining Infrastructure”, a text that indexes patterns and processes of urban change that occurred in North America, from crisis and conflict, in relation to the birth of urban infrastructure and unprecedented urban agglomerations. By first outlining the precepts and principles of infrastructure at the onslaught of the 20th century, the spatial and technocratic transition that occurred in the industrial metropolis of North America is described from a series of conflicts and crises. The 20th century was not designed, nor planned, it was engineered. It was a period of heightened urban need where fresh water sources required separation from waste effluents, where energy resources were required and inventoried to achieve economies of scale as well as to light up the extended work day, where highways had to be constructed to short circuit the distance between farm and market, with the rise of logistical cold chains, amidst patterns of increasing daily mobility. As preeminent planners, civil engineers were the chief architects in recognizing the basic utilities and practical services required by urban concentrations. Usurping ideologies of form, this preliminary groundwork establishes an understanding of urbanization through a series of basic, irreducible flows - waste and water, fuel and food, mobility and energy - that would underlie modern urban life in the 20th century and beyond.

As this structural change took place, from the regulation of form to that of flow, so did land use patterns. Through Euclidean method of planning, premised on the legal separation of incompatible land uses, the techniques of urban transformation literally bulldozed the ground, partitioned hydrologic systems, making mud of pre-existing conditions. From this tabula rasa emerges the “Landscape of Speed”, a lens on how the revolution in transportation systems – through the auspices of speed and safety, as well as materialities of asphalt and concrete, formed the surfaces, if not the backbone of urban spatial patterns. Roads and rails, airports and seaports generated distinctive vectors of movement but also contributed to unprecedented intermodal ecologies and networks of movement. Yet, for its onward march towards progress and seamlessness, the modern separation of land uses and the axial focus of roadways created new surface conditions. They cut across large swaths of preexisting grounds and indivisible systems. These infrastructures of mobility also required logistical landscapes and processes: resource mines and resource extraction, product manufacturing and processing facilities, fuel supplies and distribution networks, storage zones and warehousing capabilities, intermodal ports & dredging operations. All these changes were serviced by inflows (energy resources, markets, materials, personnel, operators, workflows and schedules), but they also produced unintended outflows (discharges, emissions, effluents, inequities) and other occupational hazards by the nature of the industrial economies that made them possible. As externalities, these pollutants are, today, urbanism’s waste, its excreta.

Intentions

From this shit of urbanization spills out a set of new exchanges based on the recuperation and reclamation of those pollutants, premised on backflows and reflows of waste. In lieu of linear, fixed and closed systems of industrial systems, new circular economies and systemic interconnections generate and yield contemporary waste ecologies exemplified through residual solid wastes, liquid effluents, gaseous emissions. Through the recalibration of urban flows across this “Metabolic Landscape”, the reclamation of waste materials, waste fluids and waste lands as urban resources can radically reorganize spatial patterns by short-circuiting the distance between ecological networks and economic systems through material flows. This contraction of the urban field yields a set of unprecedented ecological formations - *protoecologies* - that are best described and formulated with the infrastructural design of historic externalities of waste, water and energy as part of the urban project. Thus, in this recursive environment, the assembly line that once made possible the economies of scale of industrial production extends and curves back onto itself to form new connections and circuitries. At an urban scale, this vast “Landscape of Disassembly” rises from a neo-modern horizon where the current dismantling of the industrial metropolis and out of the exhaustion of economies of scale, demonstrate that the economic positivism of production alone no longer holds as the exclusive driver of growth. Speed and scale are now being supplanted by the double notions of synchronicity and synergy made possible through the sequencing of material flows, brownfields, services and geographies, by design.

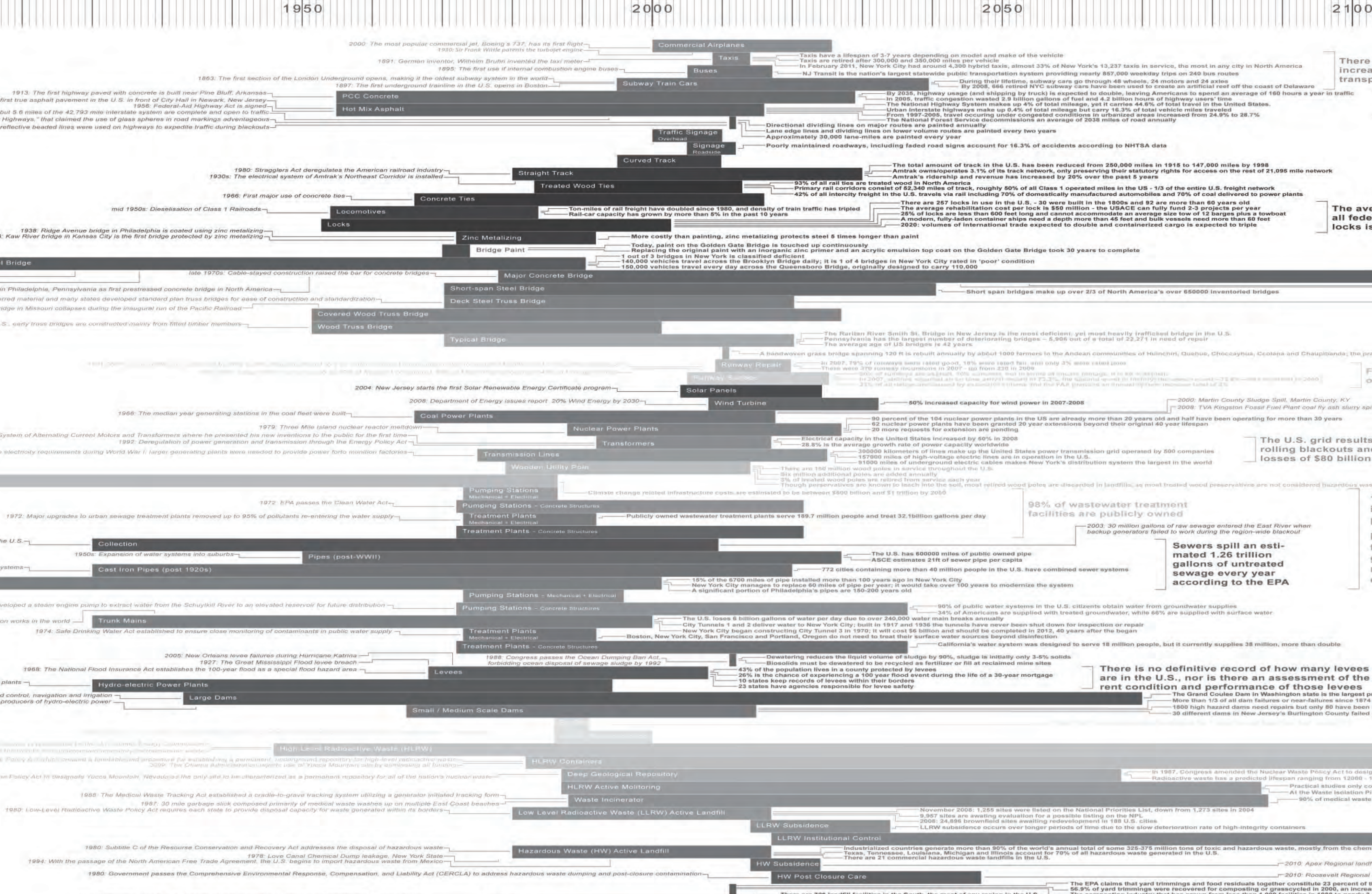
This contemporary ecology of flows aims to substantiate an underlying claim that “Landscape” operates “as Infrastructure”, in reference to the indivisible systems of biotic resources, agents and services that support economies. By tracking the patterns of industrialization across the cities, ports and waters of the Great Lakes during the past two centuries, hydrologic changes during three past centuries provide a registration of regional contexts of urbanization. In the vein of the McHarg-ian and Forman-esque project on the urban region, this hydrologic optic help us move beyond the footprint of cities, enlisting watershed regions as as new units of development while avoiding classic forms of environmental determinism. This

“Regionalization” of urban conditions provides an operative optic, a methodological instrument for reviewing patterns of urbanization through the formation of multiple regions beyond the footprint of cities themselves, even as they jump across watershed divides as they most often do. They open a horizon to better perceive these ecological and economic confluences, as well as the forces and flows of urban externalities.

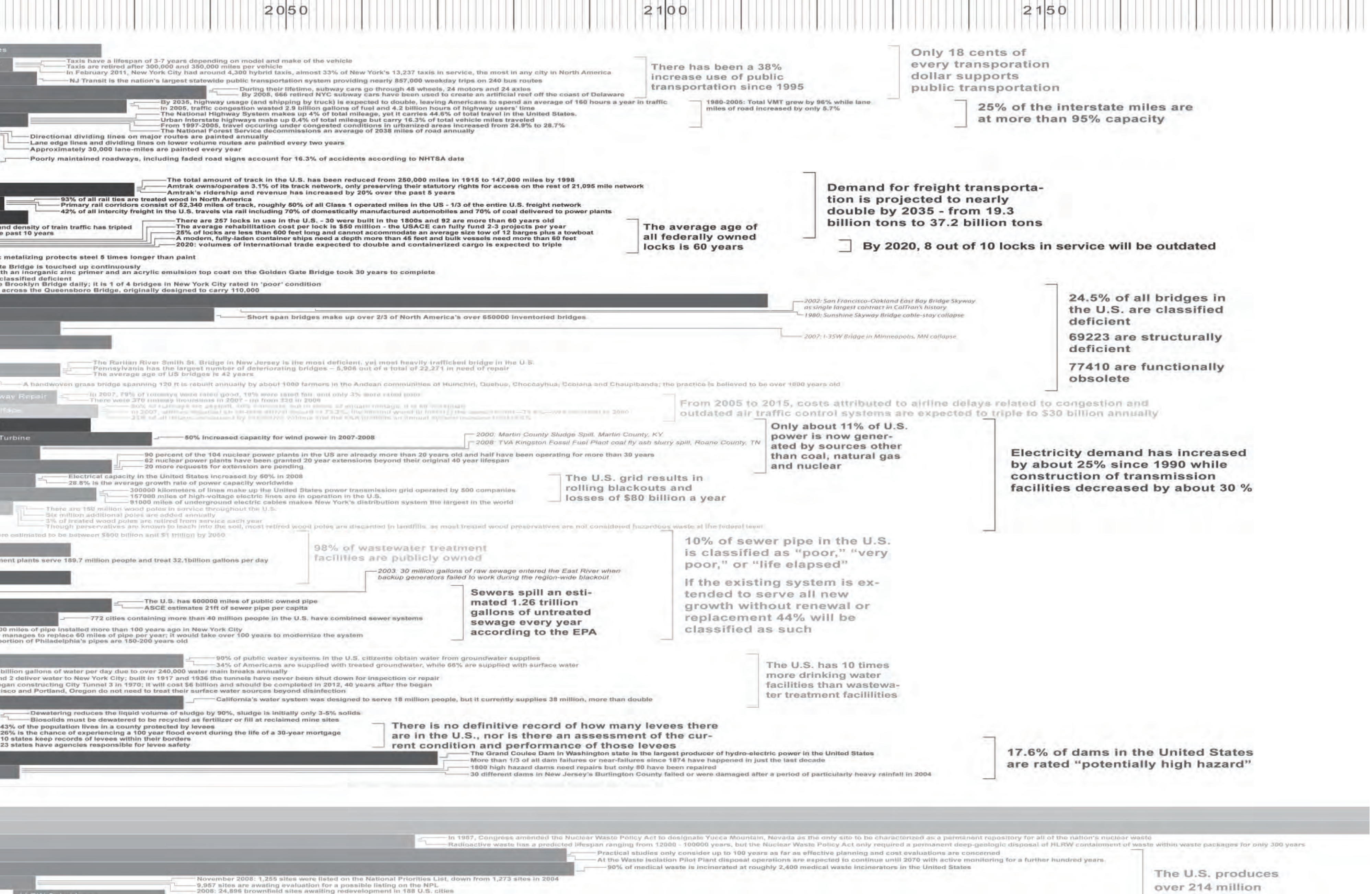
Stemming from this contemporary telescopic outlook, a final proposition is made with the conflation of “Landscape Infrastructure” as both critique of technocratic, monocular thinking, and as strategy for moving “Urbanism beyond Engineering”. It is a push beyond civil engineering and land use planning as drivers of urban form, via the design of “Infrastructural Ecologies” as denominators of new urban flows through contemporary crossovers of infrastructure with complex, dynamic ecological systems. By circumventing use-value attributions to land perpetuated by transportation planning and civil engineering, this push away from the form of cities to the flows of urban economies focuses attention on overlapping, competing ecological complexities and social cultures. The interconnectivity and expansiveness of a landscape of living, biotic systems is no longer negligible, nor avoidable. Requiring us to move beyond Fordist forms of engineering and Taylorist modes of planning, the engagement of inherent ecological forces and flows through the design of spatial patterns and processes - the landscape infrastructures of urban economies - has now become a pressing imperative.

>
Infrastructure Lifespans & Expiry Dates
Chart visualizing the serviceable lifespans of equipment associated with waste, water, energy and transportation systems across North America, mainly built at the beginning of the 20th century, and after World War II.

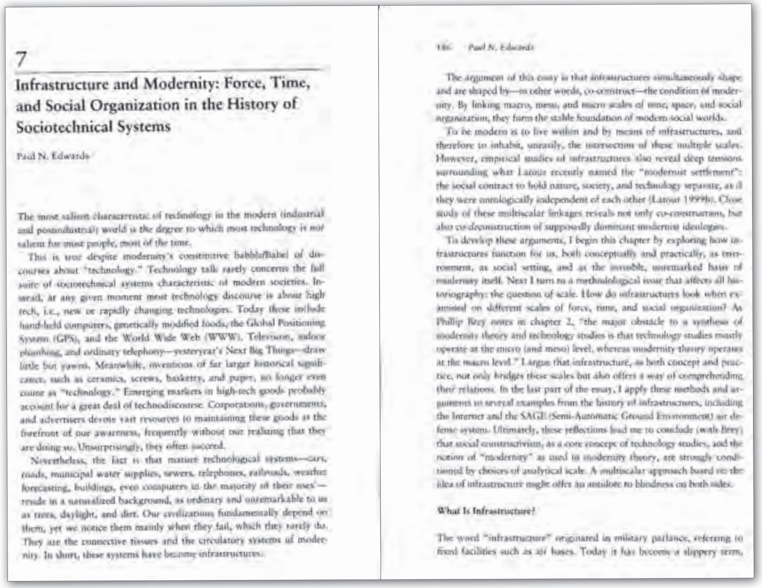
raphic created by OPSYS/Alexandra Gauzza. A full color version will appear in *Landscape Infrastructure: Urbanism beyond Engineering* (MIT Press, 2013).



1950
2000
2050
2100
2000: The most popular commercial jet, Boeing's 737, has its first flight
1930: Sir Frank Wittle patents the turbojet engine
Commercial Airplanes
1891: German inventor, Wilhelm Bruhn invented the taxi meter
Taxis
Taxis have a lifespan of 3-7 years depending on model and make of the vehicle
Taxis are retired after 300,000 and 350,000 miles per vehicle
In February 2011, New York City had around 4,300 hybrid taxis, almost 33% of New York's 13,237 taxis in service, the most in any city in North America
1895: The first use if internal combustion engine buses
Buses
NJ Transit is the nation's largest statewide public transportation system providing nearly 857,000 weekday trips on 240 bus routes
1863: The first section of the London Underground opens, making it the oldest subway system in the world
1897: The first underground trainline in the U.S. opens in Boston
Subway Train Cars
During their lifetime, subway cars go through 48 wheels, 24 motors and 24 axles
By 2008, 666 retired NYC subway cars have been used to create an artificial reef off the coast of Delaware
1913: The first highway paved with concrete is built near Pine Bluff, Arkansas
first true asphalt pavement in the U.S. in front of City Hall in Newark, New Jersey
1956: Federal-Aid Highway Act is signed
PCC Concrete
Hot Mix Asphalt
By 2035, highway usage (and shipping by truck) is expected to double, leaving Americans to spend an average of 160 hours a year in traffic
In 2005, traffic congestion wasted 2.9 billion gallons of fuel and 4.2 billion hours of highway users' time
The National Highway System makes up 4% of total mileage, yet it carries 44.6% of total travel in the United States.
Urban interstate highways make up 0.4% of total mileage but carry 16.3% of total vehicle miles traveled
From 1997-2005, travel occuring under congested conditions in urbanized areas increased from 24.9% to 28.7%
The National Forest Service decommissions an average of 2038 miles of road annually
Directional dividing lines on major routes are painted annually
Lane edge lines and dividing lines on lower volume routes are painted every two years
Approximately 30,000 lane-miles are painted every year
Traffic Signage Overhead
Signage Roadside
Poorly maintained roadways, including faded road signs account for 16.3% of accidents according to NHTSA data
Curved Track
1980: Stragglers Act deregulates the American railroad industry
1930s: The electrical system of Amtrak's Northeast Corridor is installed
Straight Track
The total amount of track in the U.S. has been reduced from 250,000 miles in 1916 to 147,000 miles by 1998
Amtrak owns/operates 3.1% of its track network, only preserving their statutory rights for access on the rest of 21,095 mile network
Amtrak's ridership and revenue has increased by 20% over the past 5 years
Treated Wood Ties
93% of all rail ties are treated wood in North America
Primary rail corridors consist of 52,340 miles of track, roughly 50% of all Class 1 operated miles in the US - 1/3 of the entire U.S. freight network
42% of all intercity freight in the U.S. travels via rail including 70% of domestically manufactured automobiles and 70% of coal delivered to power plants
1966: First major use of concrete ties
Concrete Ties
mid 1950s: Dieselisation of Class 1 Railroads
Locomotives
Ton-miles of rail freight have doubled since 1980, and density of train traffic has tripled
Rail-car capacity has grown by more than 5% in the past 10 years
Locks
There are 257 locks in use in the U.S. - 30 were built in the 1800s and 92 are more than 60 years old
The average rehabilitation cost per lock is $50 million - the USACE can fully fund 2-3 projects per year
25% of locks are less than 600 feet long and cannot accommodate an average size tow of 12 barges plus a towboat
A modern, fully-laden container ships need a depth more than 45 feet and bulk vessels need more than 60 feet
2020: volumes of international trade expected to double and containerized cargo is expected to triple
1938: Ridge Avenue bridge in Philadelphia is coated using zinc metalizing
Kaw River bridge in Kansas City is the first bridge protected by zinc metalizing
Zinc Metalizing
More costly than painting, zinc metalizing protects steel 5 times longer than paint
Bridge Paint
Today, paint on the Golden Gate Bridge is touched up continuously
Replacing the original paint with an inorganic zinc primer and an acrylic emulsion top coat on the Golden Gate Bridge took 30 years to complete
Bridge
1 out of 3 bridges in New York is classified deficient
140,000 vehicles travel across the Brooklyn Bridge daily; it is 1 of 4 bridges in New York City rated in 'poor' condition
150,000 vehicles travel every day across the Queensboro Bridge, originally designed to carry 110,000
late 1970s: Cable-stayed construction raised the bar for concrete bridges
Major Concrete Bridge
in Philadelphia, Pennsylvania as first prestressed concrete bridge in North America
Short-span Steel Bridge
Short span bridges make up over 2/3 of North America's over 650000 inventoried bridges
Deck Steel Truss Bridge
Covered Wood Truss Bridge
Wood Truss Bridge
Typical Bridge
The Raritan River Smith St. Bridge in New Jersey is the most deficient, yet most heavily trafficked bridge in the U.S.
Pennsylvania has the largest number of deteriorating bridges – 5,906 out of a total of 22,271 in need of repair
The average age of US bridges is 42 years
A handwoven grass bridge spanning 120 ft is rebuilt annually by about 1000 farmers in the Andean communities of Huinchiri, Quehue, Choccayhua, Ccolana and Chaupibanda
Runway Repair
Runway Surface
2004: New Jersey starts the first Solar Renewable Energy Certificate program
Solar Panels
2008: Department of Energy issues report 20% Wind Energy by 2030
Wind Turbine
50% increased capacity for wind power in 2007-2008
2000: Martin County Sludge Spill, Martin County, KY
2008: TVA Kingston Fossil Fuel Plant coal fly ash slurry spill
1966: The median year generating stations in the coal fleet were built
Coal Power Plants
1979: Three Mile Island nuclear reactor meltdown
Nuclear Power Plants
90 percent of the 104 nuclear power plants in the US are already more than 20 years old and half have been operating for more than 30 years
62 nuclear power plants have been granted 20 year extensions beyond their original 40 year lifespan
20 more requests for extension are pending
System of Alternating Current Motors and Transformers where he presented his new inventions to the public for the first time
1992: Deregulation of power generation and transmission through the Energy Policy Act
Transformers
Electrical capacity in the United States increased by 50% in 2008
28.8% is the average growth rate of power capacity worldwide
electricity requirements during World War I: larger generating plants were needed to provide power forto munition factories
Transmission Lines
300000 kilometers of lines make up the United States power transmission grid operated by 500 companies
157000 miles of high-voltage electric lines are in operation in the U.S.
91000 miles of underground electric cables makes New York's distribution system the largest in the world
The U.S. grid results in rolling blackouts and losses of $80 billion
Wooden Utility Pole
There are 150 million wood poles in service throughout the U.S.
Six million additional poles are added annually
3% of treated wood poles are retired from service each year
Though perservatives are known to leach into the soil, most retired wood poles are discarded in landfills, as most treated wood preservatives are not considered hazardous waste
Pumping Stations Mechanical + Electrical
Climate change related infrastructure costs are estimated to be between $800 billion and $1 trillion by 2050
1972: EPA passes the Clean Water Act
Pumping Stations - Concrete Structures
98% of wastewater treatment facilities are publicly owned
1972: Major upgrades to urban sewage treatment plants removed up to 95% of pollutants re-entering the water supply
Treatment Plants Mechanical + Electrical
Publicly owned wastewater treatment plants serve 189.7 million people and treat 32.1billion gallons per day
Treatment Plants - Concrete Structures
2003: 30 million gallons of raw sewage entered the East River when backup generators failed to work during the region-wide blackout
Collection
Sewers spill an estimated 1.26 trillion gallons of untreated sewage every year according to the EPA
1950s: Expansion of water systems into suburbs
Pipes (post-WWII)
The U.S. has 600000 miles of public owned pipe
ASCE estimates 21ft of sewer pipe per capita
Cast Iron Pipes (post 1920s)
772 cities containing more than 40 million people in the U.S. have combined sewer systems
15% of the 6700 miles of pipe installed more than 100 years ago in New York City
New York City manages to replace 60 miles of pipe per year; it would take over 100 years to modernize the system
A significant portion of Philadelphia's pipes are 150-200 years old
Pumping Stations - Mechanical + Electrical
developed a steam engine pump to extract water from the Schuylkill River to an elevated reservoir for future distribution
Pumping Stations - Concrete Structures
90% of public water systems in the U.S. citizents obtain water from groundwater supplies
34% of Americans are supplied with treated groundwater, while 66% are supplied with surface water
Trunk Mains
The U.S. loses 6 billion gallons of water per day due to over 240,000 water main breaks annually
City Tunnels 1 and 2 deliver water to New York City; built in 1917 and 1936 the tunnels have never been shut down for inspection or repair
1974: Safe Drinking Water Act established to ensure close monitoring of contaminants in public water supply
Treatment Plants Mechanical + Electrical
New York City began constructing City Tunnel 3 in 1970; it will cost $6 billion and should be completed in 2012, 40 years after the began
Boston, New York City, San Francisco and Portland, Oregon do not need to treat their surface water sources beyond disinfection
Treatment Plants - Concrete Structures
California's water system was designed to serve 18 million people, but it currently supplies 38 million, more than double
2005: New Orleans levee failures during Hurricane Katrina
1927: The Great Mississippi Flood levee breach
1968: The National Flood Insurance Act establishes the 100-year flood as a special flood hazard area
1988: Congress passes the Ocean Dumping Ban Act, forbidding ocean disposal of sewage sludge by 1992
Dewatering reduces the liquid volume of sludge by 90%, sludge is initially only 3-5% solids
Biosolids must be dewatered to be recycled as fertilizer or fill at reclaimed mine sites
Levees
43% of the population lives in a county protected by levees
26% is the chance of experiencing a 100 year flood event during the life of a 30-year mortgage
10 states keep records of levees within their borders
23 states have agencies responsible for levee safety
There is no definitive record of how many levees are in the U.S., nor is there an assessment of the current condition and performance of those levees
Hydro-electric Power Plants
Large Dams
Small / Medium Scale Dams
The Grand Coulee Dam in Washington state is the largest
More than 1/3 of all dam failures or near-failures since 1874
1800 high hazard dams need repairs but only 80 have been
30 different dams in New Jersey's Burlington County failed
High Level Radioactive Waste (HLRW)
HLRW Containers
Deep Geological Repository
In 1987, Congress amended the Nuclear Waste Policy Act to designate
Radioactive waste has a predicted lifespan ranging from 12000
HLRW Active Moitoring
1988: The Medical Waste Tracking Act established a cradle-to-grave tracking system utilizing a generator initiated tracking form
1987: 30 mile garbage slick composed primarily of medical waste washes up on multiple East Coast beaches
Waste Incinerator
Practical studies only
At the Waste Isolation Pilot
90% of medical waste
1980: Low-Level Radioactive Waste Policy Act requires each state to provide disposal capacity for waste generated within its borders
Low Level Radioactive Waste (LLRW) Active Landfill
November 2008: 1,255 sites were listed on the National Priorities List, down from 1,273 sites in 2004
9,957 sites are awaiting evaluation for a possible listing on the NPL
2008: 24,896 brownfield sites awaiting redevelopment in 188 U.S. cities
LLRW subsidence occurs over longer periods of time due to the slow deterioration rate of high-integrity containers
LLRW Subsidence
LLRW Institutional Control
1980: Subtitle C of the Resourse Conservation and Recovery Act addresses the disposal of hazardous waste
1978: Love Canal Chemical Dump leakage, New York State
1994: With the passage of the North American Free Trade Agreement, the U.S. begins to import hazardous waste from Mexico
Hazardous Waste (HW) Active Landfill
Industrialized countries generate more than 90% of the world's annual total of some 325-375 million tons of toxic and hazardous waste, mostly from the chem
Texas, Tennessee, Louisiana, Michigan and Illinois account for 70% of all hazardous waste generated in the U.S.
There are 21 commercial hazardous waste landfills in the U.S.
HW Subsidence
2010: Apex Regional landf
1980: Government passes the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to address hazardous waste dumping and post-closure contamination
HW Post Closure Care
2010: Roosevelt Regional
The EPA claims that yard trimmings and food residuals together constitute 23 percent of
56.9% of yard trimmings were recovered for composting or grasscycled in 2000, an increa


2050
2100
2150
Taxis have a lifespan of 3-7 years depending on model and make of the vehicle
Taxis are retired after 300,000 and 350,000 miles per vehicle
In February 2011, New York City had around 4,300 hybrid taxis, almost 33% of New York's 13,237 taxis in service, the most in any city in North America
NJ Transit is the nation's largest statewide public transportation system providing nearly 857,000 weekday trips on 240 bus routes
During their lifetime, subway cars go through 48 wheels, 24 motors and 24 axles
By 2008, 666 retired NYC subway cars have been used to create an artificial reef off the coast of Delaware
There has been a 38% increase use of public transportation since 1995
Only 18 cents of every transporation dollar supports public transportation
By 2035, highway usage (and shipping by truck) is expected to double, leaving Americans to spend an average of 160 hours a year in traffic
In 2005, traffic congestion wasted 2.9 billion gallons of fuel and 4.2 billion hours of highway users' time
The National Highway System makes up 4% of total mileage, yet it carries 44.6% of total travel in the United States.
Urban interstate highways make up 0.4% of total mileage but carry 16.3% of total vehicle miles traveled
From 1997-2005, travel occuring under congested conditions in urbanized areas increased from 24.9% to 28.7%
The National Forest Service decommissions an average of 2038 miles of road annually
1980-2005: Total VMT grew by 96% while lane miles of road increased by only 5.7%
25% of the interstate miles are at more than 95% capacity
Directional dividing lines on major routes are painted annually
Lane edge lines and dividing lines on lower volume routes are painted every two years
Approximately 30,000 lane-miles are painted every year
Poorly maintained roadways, including faded road signs account for 16.3% of accidents according to NHTSA data
The total amount of track in the U.S. has been reduced from 250,000 miles in 1915 to 147,000 miles by 1998
Amtrak owns/operates 3.1% of its track network, only preserving their statutory rights for access on the rest of 21,095 mile network
Amtrak's ridership and revenue has increased by 20% over the past 5 years
93% of all rail ties are treated wood in North America
Primary rail corridors consist of 52,340 miles of track, roughly 50% of all Class 1 operated miles in the US - 1/3 of the entire U.S. freight network
42% of all intercity freight in the U.S. travels via rail including 70% of domestically manufactured automobiles and 70% of coal delivered to power plants
Demand for freight transportation is projected to nearly double by 2035 - from 19.3 billion tons to 37.2 billion tons
and density of train traffic has tripled
e past 10 years
There are 257 locks in use in the U.S. - 30 were built in the 1800s and 92 are more than 60 years old
The average rehabilitation cost per lock is $50 million - the USACE can fully fund 2-3 projects per year
25% of locks are less than 600 feet long and cannot accommodate an average size tow of 12 barges plus a towboat
A modern, fully-laden container ships need a depth more than 45 feet and bulk vessels need more than 60 feet
2020: volumes of international trade expected to double and containerized cargo is expected to triple
The average age of all federally owned locks is 60 years
By 2020, 8 out of 10 locks in service will be outdated
: metalizing protects steel 5 times longer than paint
te Bridge is touched up continuously
th an inorganic zinc primer and an acrylic emulsion top coat on the Golden Gate Bridge took 30 years to complete
classified deficient
e Brooklyn Bridge daily; it is 1 of 4 bridges in New York City rated in 'poor' condition
across the Queensboro Bridge, originally designed to carry 110,000
2002: San Francisco-Oakland East Bay Bridge Skyway as single largest contract in CalTran's history
Short span bridges make up over 2/3 of North America's over 650000 inventoried bridges
1980: Sunshine Skyway Bridge cable-stay collapse
2007: I-35W Bridge in Minneapolis, MN collapse
24.5% of all bridges in the U.S. are classified deficient
69223 are structurally deficient
77410 are functionally obsolete
The Raritan River Smith St. Bridge in New Jersey is the most deficient, yet most heavily trafficked bridge in the U.S.
Pennsylvania has the largest number of deteriorating bridges – 5,906 out of a total of 22,271 in need of repair
The average age of US bridges is 42 years
A handwoven grass bridge spanning 120 ft is rebuilt annually by about 1000 farmers in the Andean communities of Huinchiri, Quehue, Choccayhua, Ccolana and Chaupibanda; the practice is believed to be over 1800 years old
way Repair
In 2007, 79% of runways were rated good, 18% were rated fair, and only 3% were rated poor
There were 370 runway incursions in 2007 - up from 330 in 2006
rface
From 2005 to 2015, costs attributed to airline delays related to congestion and outdated air traffic control systems are expected to triple to $30 billion annually
Turbine
50% increased capacity for wind power in 2007-2008
2000: Martin County Sludge Spill, Martin County, KY
2008: TVA Kingston Fossil Fuel Plant coal fly ash slurry spill, Roane County, TN
Only about 11% of U.S. power is now generated by sources other than coal, natural gas and nuclear
90 percent of the 104 nuclear power plants in the US are already more than 20 years old and half have been operating for more than 30 years
62 nuclear power plants have been granted 20 year extensions beyond their original 40 year lifespan
20 more requests for extension are pending
Electricity demand has increased by about 25% since 1990 while construction of transmission facilities decreased by about 30 %
Electrical capacity in the United States increased by 50% in 2008
28.8% is the average growth rate of power capacity worldwide
300000 kilometers of lines make up the United States power transmission grid operated by 500 companies
157000 miles of high-voltage electric lines are in operation in the U.S.
91000 miles of underground electric cables makes New York's distribution system the largest in the world
The U.S. grid results in rolling blackouts and losses of $80 billion a year
There are 150 million wood poles in service throughout the U.S.
Six million additional poles are added annually
3% of treated wood poles are retired from service each year
Though perservatives are known to leach into the soil, most retired wood poles are discarded in landfills, as most treated wood preservatives are not considered hazardous waste at the federal level
re estimated to be between $800 billion and $1 trillion by 2050
98% of wastewater treatment facilities are publicly owned
ment plants serve 189.7 million people and treat 32.1billion gallons per day
10% of sewer pipe in the U.S. is classified as "poor," "very poor," or "life elapsed"
If the existing system is extended to serve all new growth without renewal or replacement 44% will be classified as such
2003: 30 million gallons of raw sewage entered the East River when backup generators failed to work during the region-wide blackout
The U.S. has 600000 miles of public owned pipe
ASCE estimates 21ft of sewer pipe per capita
772 cities containing more than 40 million people in the U.S. have combined sewer systems
Sewers spill an estimated 1.26 trillion gallons of untreated sewage every year according to the EPA
00 miles of pipe installed more than 100 years ago in New York City
manages to replace 60 miles of pipe per year; it would take over 100 years to modernize the system
portion of Philadelphia's pipes are 150-200 years old
90% of public water systems in the U.S. citizents obtain water from groundwater supplies
34% of Americans are supplied with treated groundwater, while 66% are supplied with surface water
billion gallons of water per day due to over 240,000 water main breaks annually
nd 2 deliver water to New York City; built in 1917 and 1936 the tunnels have never been shut down for inspection or repair
gan constructing City Tunnel 3 in 1970; it will cost $6 billion and should be completed in 2012, 40 years after the began
isco and Portland, Oregon do not need to treat their surface water sources beyond disinfection
California's water system was designed to serve 18 million people, but it currently supplies 38 million, more than double
The U.S. has 10 times more drinking water facilities than wastewater treatment facililities
Dewatering reduces the liquid volume of sludge by 90%, sludge is initially only 3-5% solids
Biosolids must be dewatered to be recycled as fertilizer or fill at reclaimed mine sites
43% of the population lives in a county protected by levees
26% is the chance of experiencing a 100 year flood event during the life of a 30-year mortgage
10 states keep records of levees within their borders
23 states have agencies responsible for levee safety
There is no definitive record of how many levees there are in the U.S., nor is there an assessment of the current condition and performance of those levees
The Grand Coulee Dam in Washington state is the largest producer of hydro-electric power in the United States
More than 1/3 of all dam failures or near-failures since 1874 have happened in just the last decade
1800 high hazard dams need repairs but only 80 have been repaired
30 different dams in New Jersey's Burlington County failed or were damaged after a period of particularly heavy rainfall in 2004
17.6% of dams in the United States are rated "potentially high hazard"
In 1987, Congress amended the Nuclear Waste Policy Act to designate Yucca Mountain, Nevada as the only site to be characterized as a permanent repository for all of the nation's nuclear waste
Radioactive waste has a predicted lifespan ranging from 12000 - 100000 years, but the Nuclear Waste Policy Act only required a permanent deep-geologic disposal of HLRW containment of waste within waste packages for only 300 years
Practical studies only consider up to 100 years as far as effective planning and cost evaluations are concerned
At the Waste Isolation Pilot Plant disposal operations are expected to continue until 2070 with active monitoring for a further hundred years
90% of medical waste is incinerated at roughly 2,400 medical waste incinerators in the United States
November 2008: 1,255 sites were listed on the National Priorities List, down from 1,273 sites in 2004
9,957 sites are awaiting evaluation for a possible listing on the NPL
2008: 24,896 brownfield sites awaiting redevelopment in 188 U.S. cities
The U.S. produces over 214 million

Redefining Infrastructure.



7

Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems

Paul N. Edwards

The most salient characteristic of technology in the modern (industrial and postindustrial) world is the degree to which most technology is *not* salient for most people, most of the time.

This is true despite modernity's constitutive babble/Babel of discourses about "technology." Technology talk rarely concerns the full suite of sociotechnical systems characteristic of modern societies. Instead, at any given moment most technology discourse is about high tech, i.e., new or rapidly changing technologies. Today these include hand-held computers, genetically modified foods, the Global Positioning System (GPS), and the World Wide Web (WWW). Television, indoor plumbing, and ordinary telephony—yesteryear's Next Big Things—draw little but yawns. Meanwhile, inventions of far larger historical significance, such as ceramics, screws, basketry, and paper, no longer even count as "technology." Emerging markets in high-tech goods probably account for a great deal of technodiscourse. Corporations, governments, and advertisers devote vast resources to maintaining these goods at the forefront of our awareness, frequently without our realizing that they are doing so. Unsurprisingly, they often succeed.

Nevertheless, the fact is that mature technological systems—cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers in the majority of their uses—reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt. Our civilizations fundamentally depend on them, yet we notice them mainly when they fail, which they rarely do. They are the connective tissues and the circulatory systems of modernity. In short, these systems have become infrastructures.

186 *Paul N. Edwards*

The argument of this essay is that infrastructures simultaneously shape and are shaped by—in other words, co-construct—the condition of modernity. By linking macro, meso, and micro scales of time, space, and social organization, they form the stable foundation of modern social worlds.

To be modern is to live within and by means of infrastructures, and therefore to inhabit, uneasily, the intersection of these multiple scales. However, empirical studies of infrastructures also reveal deep tensions surrounding what Latour recently named the "modernist settlement": the social contract to hold nature, society, and technology separate, as if they were ontologically independent of each other (Latour 1999b). Close study of these multiscalar linkages reveals not only co-construction, but also co-deconstruction of supposedly dominant modernist ideologies.

To develop these arguments, I begin this chapter by exploring how infrastructures function for us, both conceptually and practically, as environment, as social setting, and as the invisible, unremarked basis of modernity itself. Next I turn to a methodological issue that affects all historiography: the question of scale. How do infrastructures look when examined on different scales of force, time, and social organization? As Phillip Brey notes in chapter 2, "the major obstacle to a synthesis of modernity theory and technology studies is that technology studies mostly operate at the micro (and meso) level, whereas modernity theory operates at the macro level." I argue that infrastructure, as both concept and practice, not only bridges these scales but also offers a way of comprehending their relations. In the last part of the essay, I apply these methods and arguments to several examples from the history of infrastructures, including the Internet and the SAGE (Semi-Automatic Ground Environment) air defense system. Ultimately, these reflections lead me to conclude (with Brey) that social constructivism, as a core concept of technology studies, and the notion of "modernity" as used in modernity theory, are strongly conditioned by choices of analytical scale. A multiscalar approach based on the idea of infrastructure might offer an antidote to blindness on both sides.

What Is Infrastructure?

The word "infrastructure" originated in military parlance, referring to fixed facilities such as air bases. Today it has become a slippery term,

Paul N. Edwards, "Infrastructure & Modernity" (Modernity and Technology, 2003): 185-186.

Mature technological systems - cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers in the majority of their uses - reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt. Our civilizations fundamentally depend on them, yet we notice them mainly when they fail, which they rarely do. They are the connective tissues and the circulatory systems of modernity. In short, these systems have become infrastructures.

Paul N. Edwards, *Infrastructure & Modernity*, 2003

As long-predicted energy shortages appear, as questions about the interaction of energy and environment are raised in legislatures and parliaments, and as energy-related inflation dominates public concern, many are beginning to see that there is a unity of the single system of energy, ecology, and economics. The world's leadership, however, is mainly advised by specialists who study only a part of the system at a time.

Howard T. Odum, *Energy, Ecology, Economics*, 1974

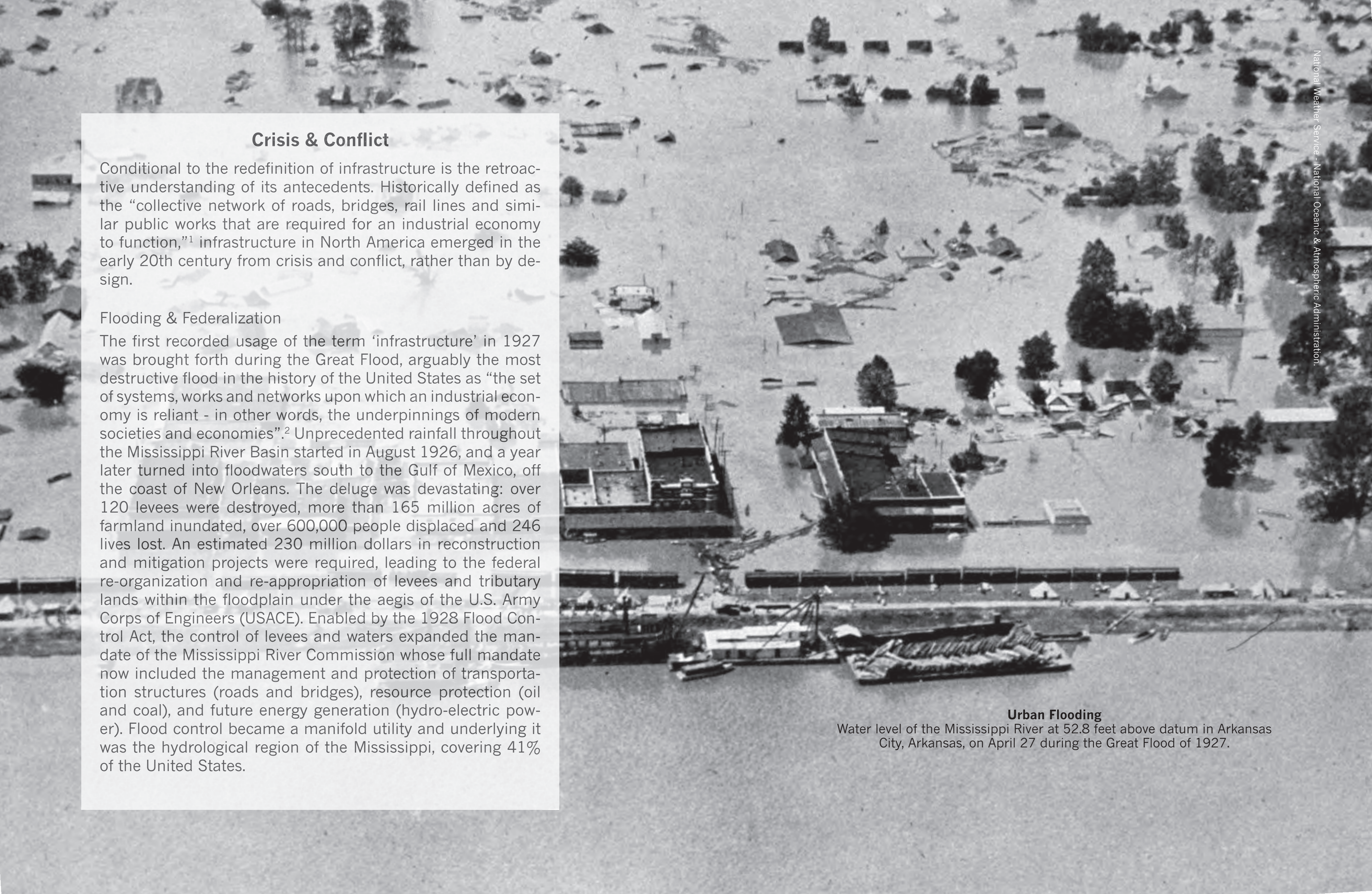
Much of the problem of the environment arises from under-investment in elementary services and plants for keeping things clean or cleaning things up. It is the kind of expenditure against which the modern economy systematically discriminates.

John Kenneth Galbraith, *Economics & Public Purpose*,1973

Engineering Catastrophe or, Natural Urban Hazard?

I-35 Mississippi River Bridge (Minnesota), collapsed on Aug. 1, 2007, replaced within a year, opening on Thursday, September 18, 2008. Photo: Minnesota DOT, 2007.

Cities are sustained by infrastructure. Highways, airports, power plants and landfills largely figure as the dominant effigies of contemporary urbanism. The sheer size of these elements renders their understanding as a single system practically impossible, yet their smooth functioning depend precisely on their continuity to support urban and industrial economies. Often found underground, or on the periphery of cities, the presence of infrastructure remains largely invisible until the precise moment at which it breaks down or fails. Floods, blackouts and shortages serve as a few reminders of the fragility of this invisible background that less than a century ago, barely even existed. Rarely, do we stop to interrogate the functioning of this superstructure, but recent events - such as the rise and fall of water levels or the spike in energy and food prices - are instigating a critical review of the basic foundation on which North American cities depends. Emerging from current economic exigencies and ecological imperatives, the following essay addresses this current techno-cultural shift. By re-examining the precepts of infrastructure — *the basic system of essential services that support a city, a region or a nation*, and by reviewing current patterns of urbanization from which they emerged, new regional pressures are requiring a thorough rethinking and reinvestment into this vast field of practice.



Crisis & Conflict

Conditional to the redefinition of infrastructure is the retroactive understanding of its antecedents. Historically defined as the “collective network of roads, bridges, rail lines and similar public works that are required for an industrial economy to function,”[1] infrastructure in North America emerged in the early 20th century from crisis and conflict, rather than by design.

Flooding & Federalization

The first recorded usage of the term ‘infrastructure’ in 1927 was brought forth during the Great Flood, arguably the most destructive flood in the history of the United States as “the set of systems, works and networks upon which an industrial economy is reliant - in other words, the underpinnings of modern societies and economies”.[2] Unprecedented rainfall throughout the Mississippi River Basin started in August 1926, and a year later turned into floodwaters south to the Gulf of Mexico, off the coast of New Orleans. The deluge was devastating: over 120 levees were destroyed, more than 165 million acres of farmland inundated, over 600,000 people displaced and 246 lives lost. An estimated 230 million dollars in reconstruction and mitigation projects were required, leading to the federal re-organization and re-appropriation of levees and tributary lands within the floodplain under the aegis of the U.S. Army Corps of Engineers (USACE). Enabled by the 1928 Flood Control Act, the control of levees and waters expanded the mandate of the Mississippi River Commission whose full mandate now included the management and protection of transportation structures (roads and bridges), resource protection (oil and coal), and future energy generation (hydro-electric power). Flood control became a manifold utility and underlying it was the hydrological region of the Mississippi, covering 41% of the United States.

Urban Flooding
Water level of the Mississippi River at 52.8 feet above datum in Arkansas City, Arkansas, on April 27 during the Great Flood of 1927.

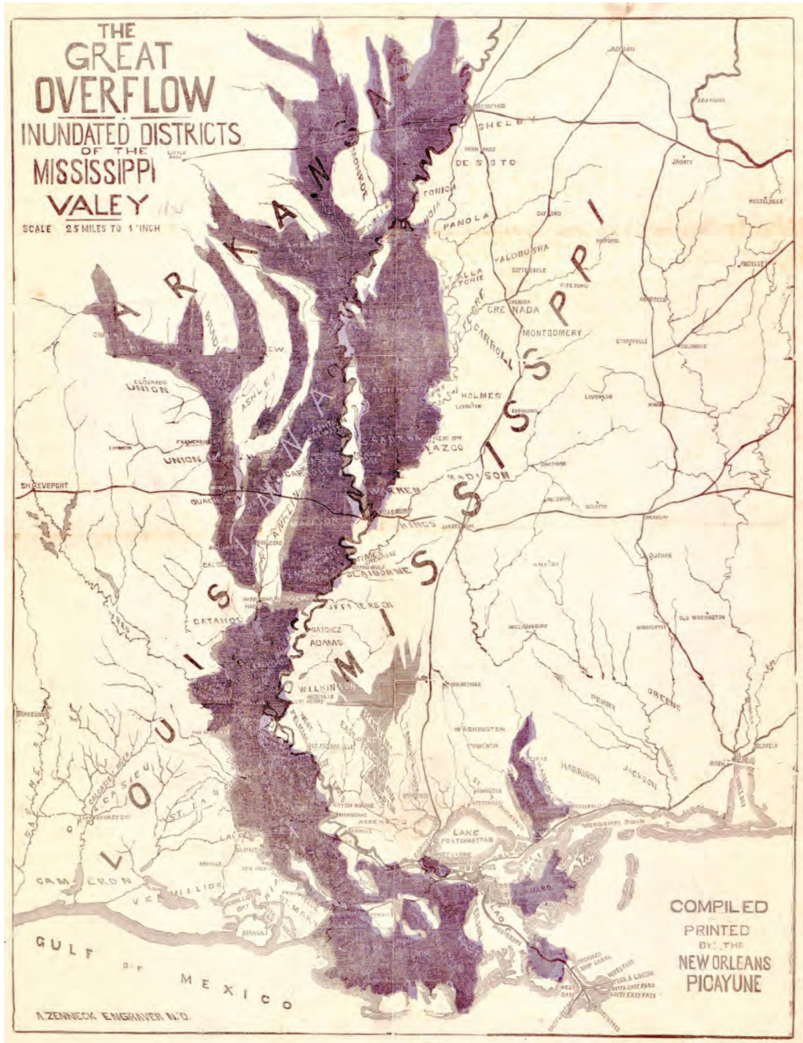
National Weather Service - National Oceanic & Atmospheric Administration.

Diagram: Pierre Bélanger, Laura Gosmino, Anna Kramer, 2008-2009.

Euclidean Geography
Spatial effect of exclusionary zoning practices in Euclid, Ohio, the birthplace of modern land planning with Interstate 90 neatly separating historic residential land to the north from commercial and industrial land to the south, leading towards newer residential development.

Euclidean Zoning & Planning

The inception of zoning is central to the birth of infrastructure in North America. In a landmark case dating back to 1926, Village of Euclid, Ohio vs. Ambler Realty Co. (272 U.S. 365), a U.S. Supreme Court judge approved an injunction by a municipality to prevent the development of an industrial cluster next to a residential neighborhood and town centre. Symptom of not-in-my-backyard retorts, the case led to the first legislated instance of urban land segregation[3] from which precipitated modern planning by way of single-use, exclusionary zoning. Euclidean planning led to the widespread practice of land use separation and classification. Its pervasiveness became so widespread that, in the absence of regional or national planning authority, Euclidean zoning predisposed peripheral agricultural lands for future urban expansion. With the simultaneous rise of motorization and wider transportation corridors, land use subdivision inadvertently enabled the insertion of transportation and utility corridors as buffers between incompatible land uses. Marking the birth of modern land jurisprudence across North America, zoning remains to this day one of the most instrumental mechanisms in the social, spatial and economic structure of the North American landscape since the Jeffersonian grid.[4]



Records of the Coast and Geodetic Survey, RG 23

Public Operations
Map of federal flood relief measures and reparation strategies along the Mississippi River in 1927 under the Hoover administration, after successive series of flooding.

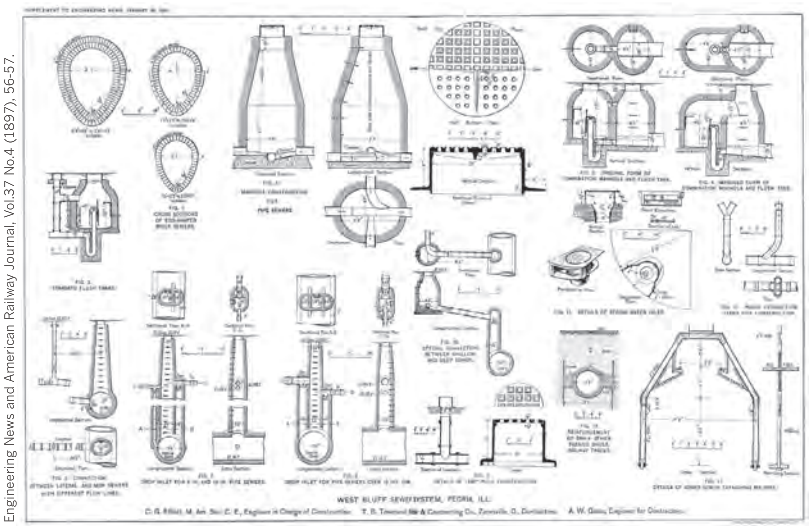
URBANIZATION & THE PUBLIC IMPERATIVE FOR INFRASTRUCTURE

In the background of flood events and zoning laws, two other major transformations marked the North American landscape: the urbanization of market economies and the regionalization of local resources. With the end to the Great Westward March and the closing of the Western frontier, urbanization established a definitive shift from a rural-agrarian pattern towards an urban-industrial one. The National Census revealed that in 1920, half of the country's population lived in cities and suburbs instead of rural areas.[5] The farming exodus of the 19th century marked a turning point: city populations exploded, especially in the Northeast and Midwest regions. America became urban. From the increasing size of dense agglomerations came a dramatic set of new challenges in the supply of basic, essential services.

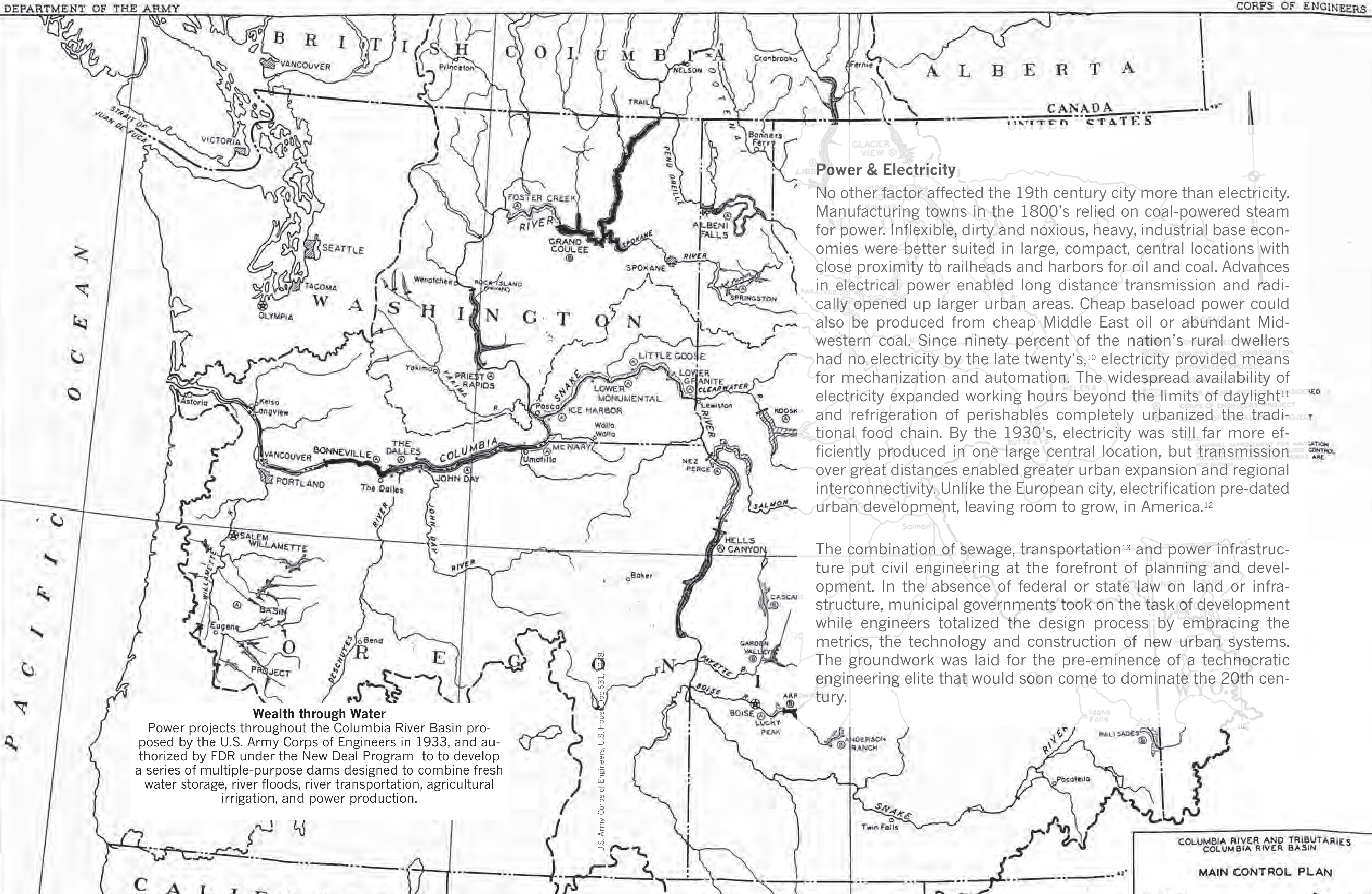
Effluents & Engineering

While flooding and land reclamation preoccupied the U.S. Army Corps of Engineers, the effective drainage of cities and towns saw the birth of an entirely new professional specialization: the sanitary engineer. With the Yellow Fever epidemic during the plague decade in the 1790's and the cholera outbreaks in the late 1800's, cities on the East Coast, the flushing of untreated sewage and dumping of garbage in water courses that served as drinking water supply saw considerable cases of waterborne disease.[6] Three types of effluents conditioned the new urban discipline of sanitation engineering: groundwater, surface runoff and sewage. The illustrious sanitary engineer of the 19th century, Colonel George E. Waring Jr. advocated the separation of effluent conveyance, while acknowledging the inseparability of the planning of these components as a system.[7] From cesspools to illicit dumping, the uncoordinated methods of sewage posed a clear and present danger to public health and a reconception of two essential sectors of the urban landscape: sanitation and transportation.[8] With limitations placed on surface capacity, urban density privileged roads and streets for underground pipes (covered canals, buried streams) and subterranean facilities as the principal means of conveyance, doubling for surface transportation.[9] Simultaneously, the use of comprehensive city plans was fading, largely from the failure of urban planning to control the fragmentary expansion of large industrial metropolises.

Engineering News and American Railway Journal, Vol.37 No.4 (1897), 56-57.



Modern Systems of Separation
Engineered profiles of sewers, drains, and closets for urban sewage conveyance, typical of systems advocated by preeminent sanitary engineer Col. George E. Waring Jr.'s 1889 treatise *Sewerage & Land Drainage.*



Wealth through Water

Power projects throughout the Columbia River Basin proposed by the U.S. Army Corps of Engineers in 1933, and authorized by FDR under the New Deal Program to to develop a series of multiple-purpose dams designed to combine fresh water storage, river floods, river transportation, agricultural irrigation, and power production.

U.S. Army Corps of Engineers, U.S. House Doc 531, 1948.

Power & Electricity

No other factor affected the 19th century city more than electricity. Manufacturing towns in the 1800's relied on coal-powered steam for power. Inflexible, dirty and noxious, heavy, industrial base economies were better suited in large, compact, central locations with close proximity to railheads and harbors for oil and coal. Advances in electrical power enabled long distance transmission and radically opened up larger urban areas. Cheap baseload power could also be produced from cheap Middle East oil or abundant Midwestern coal. Since ninety percent of the nation's rural dwellers had no electricity by the late twenty's,[10] electricity provided means for mechanization and automation. The widespread availability of electricity expanded working hours beyond the limits of daylight[11] and refrigeration of perishables completely urbanized the traditional food chain. By the 1930's, electricity was still far more efficiently produced in one large central location, but transmission over great distances enabled greater urban expansion and regional interconnectivity. Unlike the European city, electrification pre-dated urban development, leaving room to grow, in America.[12]

The combination of sewage, transportation[13] and power infrastructure put civil engineering at the forefront of planning and development. In the absence of federal or state law on land or infrastructure, municipal governments took on the task of development while engineers totalized the design process by embracing the metrics, the technology and construction of new urban systems. The groundwork was laid for the pre-eminence of a technocratic engineering elite that would soon come to dominate the 20th century.

ROOSEVELT, REFORM & REGIONALIZATION

Retrospectively, the early 20th century marked a turning point in urban America. The sudden crash of the stock market in the late 20's, prolonged droughts in the Midwest throughout the 1930's and the military buildup to the Second World War, swiftly put into question the predominant history of laissez-faire economics and the passive role of government. Responding to the Great Depression,[14] U.S. President Franklin Roosevelt swiftly rolled out the public works era of the New Deal between 1933-1935 by creating an alphabet of agencies empowered to kickstart the economy and reclaim land.[15] From the AAA (Agricultural Adjustment Act) to the WPA (Work Progress Administration), the new federal structure addressed the two most pressing issues facing the nation: economic stagnation and imminent decentralization. Influenced by regionalist Howard W. Odum,[16] FDR foresaw the requirement for cooperative planning through the visible hand of government in energy production and soil conservation, housing development and highway construction.[17]

The President as Planner
Franklin D. Roosevelt and Wally Richards overlooking a comprehensive plan while touring Greenbelt, Maryland, one of three suburbs planned by the Resettlement Administration of the New Deal in the late 1930s.

Library of Congress - National Archives, 1937.

U.S. DOT - Federal Highway Administration - Office of Infrastructure.

Private Roads to Public Highways

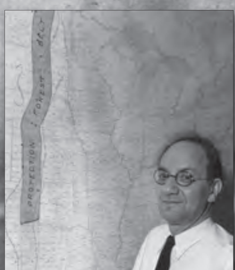
The late 1920's was a turning point for urbanization. The inflexible, centralized structure of industrial cities and heavy manufacturing industrial towns was unlocked by three simultaneous technological shifts: increasing speeds in truck transport, expanding reach of electricity and the explosion of automobility. Commonly attributed to his second successor, the continental highway system was the legacy of FDR's New Deal. By the late 1930s, pressure for constructing a network of highways was building. The agony of farm-to-market dirt paths and privately-owned toll roads posed significant obstacles to regional mobility and communication. Free roads were synonymous with freedom and democracy.[18,19] Opposing the private control of roads yet cautious of eminent domain,[20] FDR saw the 41,000-mile interregional urban network that he conceived as the spine of a new urban network[21] for the decentralization of cities and the development of new greenbelt housing settlements. Set back by World War II, FDR's plan for the largest, greatest public works project in the world was resumed by Eisenhower in 1956 as the U.S. Interstate & Defense Highway System.[22]

Private to Public
The first issue of "Public Roads" magazine in 1918, after the inception of the 1916 Federal Road Act and the Bureau of Public Roads authorizing for the first time funds for transportation originally administered by the Department of Agriculture. Source: Bureau of Public Roads, Historical Division.

Super-Planning
Public exhibition opening of the systemic configuration of the National Highways planned under the Federal-Aid Highway Act of 1956 under Dwight D. Eisenhower, the successor to FDR's Interregional System of Toll-Free Highways consisting of seven east-axis and three north-south linkages.

Crops & Conservation

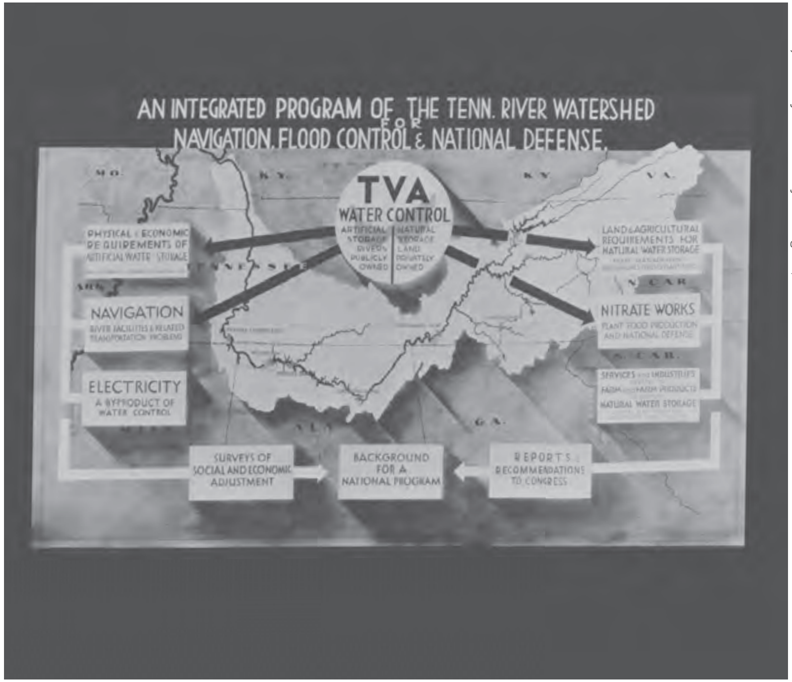
What motorization did for cities, mechanization did for agriculture. Mowers, reapers, and plows were replaced with the gas-powered tractor, accelerating food production and rural economies. Using less manpower, yields skyrocketed but low crop prices and high machinery costs forced farmers to work more land, of lesser quality, to pay off new equipment debts. Meager economic conditions during the Great Depression pushed cost-cutting further. Cash crops of corn, wheat and oats took precedence while well-known soil conservation practices were abandoned. From the Canadian Prairies to the Panhandles in the Southern U.S., grasslands became vulnerable to the dangers of drought and wind storms; a looming prelude to decade of the Dust Bowl. Affecting over 75% of the country across 27 states, the farming crisis resulted in a New Deal program to regulate farming practices, diversify crops and manage yields. Operationalized by the Civilian Conservation Corps, the Soil Conservation Law in 1935 further tackled soil and moisture loss with the Great Shelter Belt Project, involving over 200 million trees to establish a 100-mile wide, 1200-mile long windbreak from Alberta to Texas. Preemptive measures included crop rotation, strip farming, contour plowing and terracing towards diversifying the crop cover for feedstock[23] and regional grain cooperatives were formed to help farmers pool their purchasing power. Uncoordinated, ruthless practices of self-guided farmers came to an end by a federally regulated system of soil conservation known today as the Natural Resources Conservation Service.[24]



Forester as Forecaster
Pioneer of the relation of forests, streamflow and flood control, Dr. Raphael Zon with his 1933 proposal for a 2000-mile forest shelter belt in the Great Plains to provide thousands of jobs for enlisted crews of Civilian Conservation Corps , the soil soldiers of America's silviculture, and the tree army of FDR's Works Progress Administration.

Soil Tsunami
Biblical in proportion, the wall of dust and darkness approaching Stratford, Texas, on April 18, 1935, when droughts and tornadoes hit the Dust Bowl after decades of ruthless, unregulated land-farming practices across the U.S. Midwest and Canada during the 1930s.

Source: National Weather Service - NOAA, George E. Marsh Collection.



United States Farm Security Administration - Office of War Information (Overseas Picture Division, Washington Division) courtesy of the Library of Congress, 1933-1945.

Watershed as infrastructure
Display panel of the TVA showing the watershed boundary crossing through 7 different states as a complex, urban infrastructure involving flood control, electricity generation, fertilizer manufacturing, economic development of public resources, and private lands throughout the Tennessee Valley.

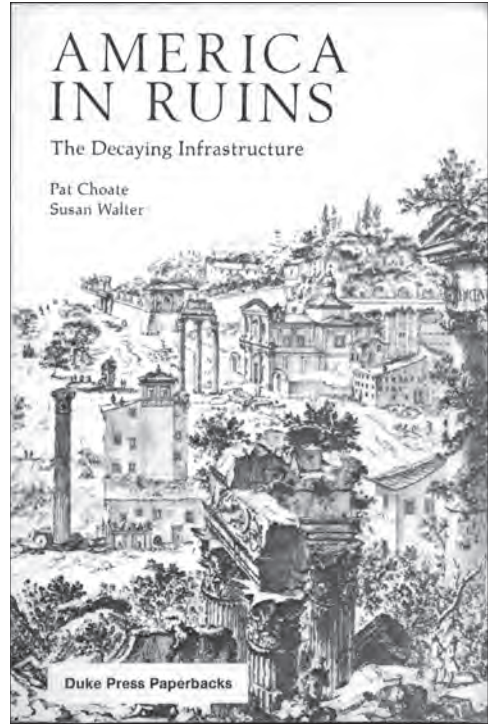
Private Utilities to Public Power

The late 1920's was a terminus for power speculators. The trust-busting Public Utility Holding Company Act of 1935 burst the bubble on under-regulated, over-inflated, privately-held holding companies. Utility giants Wilbur Foshay, Samuel Insull and George Ohrstrom either went bankrupt or fled the country.[25] From this shift, FDR saw a major opportunity to combine his agenda of recovery-relief-reform with the production and supply of power in the Tennessee Valley Authority (TVA). Informed by the Connecticut Valley Power Exchange (CONVEX) formed earlier in 1922, the TVA's mandate combined public and private objectives as a model of regional planning never seen before in the U.S..[26] Under the guidance of Arthur Morgan and Benton Mackaye, the TVA managed the nation's fifth-largest river system to reduce flood damage, produce power, maintain navigation, provide recreational opportunities, and protect water quality in the 41,000-square-mile watershed.

Making planning an imperative, FDR realigned the role of public governance and instituted a decisive shift in the prevailing dynasty of private, localized control of land resources.[27] With the Defense Act in place by 1916, FDR's public plans and programmatic innovations in the 1930's became the blueprint for an interregional infrastructure where farm fields, drainage systems, transportation networks, power plants and energy grids became matters of national social security.

DEREGULATION, DIVESTMENT, DECLINE & DECAY

In the foreground of an overheated postwar economy, the U.S. population doubled from 125 million to 250 million between 1950 and 1990. Placing excessive pressure on the demand for public services, a major shift occurred in federal governance and public infrastructure in the early 1980's under the Reagan administration. Mirroring Margaret Thatcher's methods in Great Britain, Ronald Reagan laid the ground work for deregulation and divestment to kick start a stagnating economy. To reduce the national deficit, Reagan's strategy relied on corporate tax cutting and privatization of public services.[28] From military manufacturing to energy generation, no public sector was spared. In the footsteps of his predecessor Jimmy Carter who deregulated the transportation sector, Reagan started with the oil and gas industry in the 1980's.[29] Reversing FDR's legacy, privatization effectively snowballed after Reagan paving the way for the outsourcing of public services by successive administrations for the next three decades.[30,31,32,33]



Infrastructure as Matter of National Security
Neo-reformist proposal by economist Pat Choate and political scientist Susan Walter, typical of the1980s advocacy for infrastructure renewal and capital investment. where economic and administrative efficiency presided over national infrastructure planning.

Brothers-in-Arms or, Les Frères du Laissez-Faire
B-Actor-turned-President Ronald Reagan shaking hands with Milton Friedman, Nobel-winning monetarist economist and intellectual architect of the free-market policies for Republican U.S. Presidents, and adviser to former British Prime Minister Margaret Thatcher.

Courtesy of PBS Pressroom, 1984.

Underlying this deregulatory legacy inherited from Reagan's supply-based economics is the decay of urban infrastructure.[34] Privatization of public services extended well into the ownership of public assets and management of public works crystallizing the nation's silent crisis today.[35] A major network of post-war infrastructures - airports, harbors, roads, sewers, bridges, dikes, dams, power corridors, terminals, treatment plants—are now suffering from lack of repair and maintenance.[36] Recent bridge collapses in Minnesota and Montreal or the prolonged effects of Hurricane Katrina are symptoms of the hidden costs associated with privatization of public infrastructures. Plagued by delayed maintenance and chronic underfunding, crumbling infrastructure will require an investment of $2.2 trillion over the next five years.[37] Representing double the amount currently invested, several questions are being urgently raised in the long term effectiveness of deregulation policies that exist today.

How then, can we rethink the conventional logic of infrastructure - the background process of essential services that underlies cities and regions - to effectively sustain sprawling populations and diversifying urban economies for the future?[38]

Tennessee Valley Authority, 2008.A

Tipping point
Aerial view of the TVA Kingston Fossil Plant at the confluence of the Emory River and Clinch River in Tennessee, where 4 million cubic meters (1 billion gallons) of coal fly ash slurry were spilled after a dike rupture on Monday, December 22, 2008

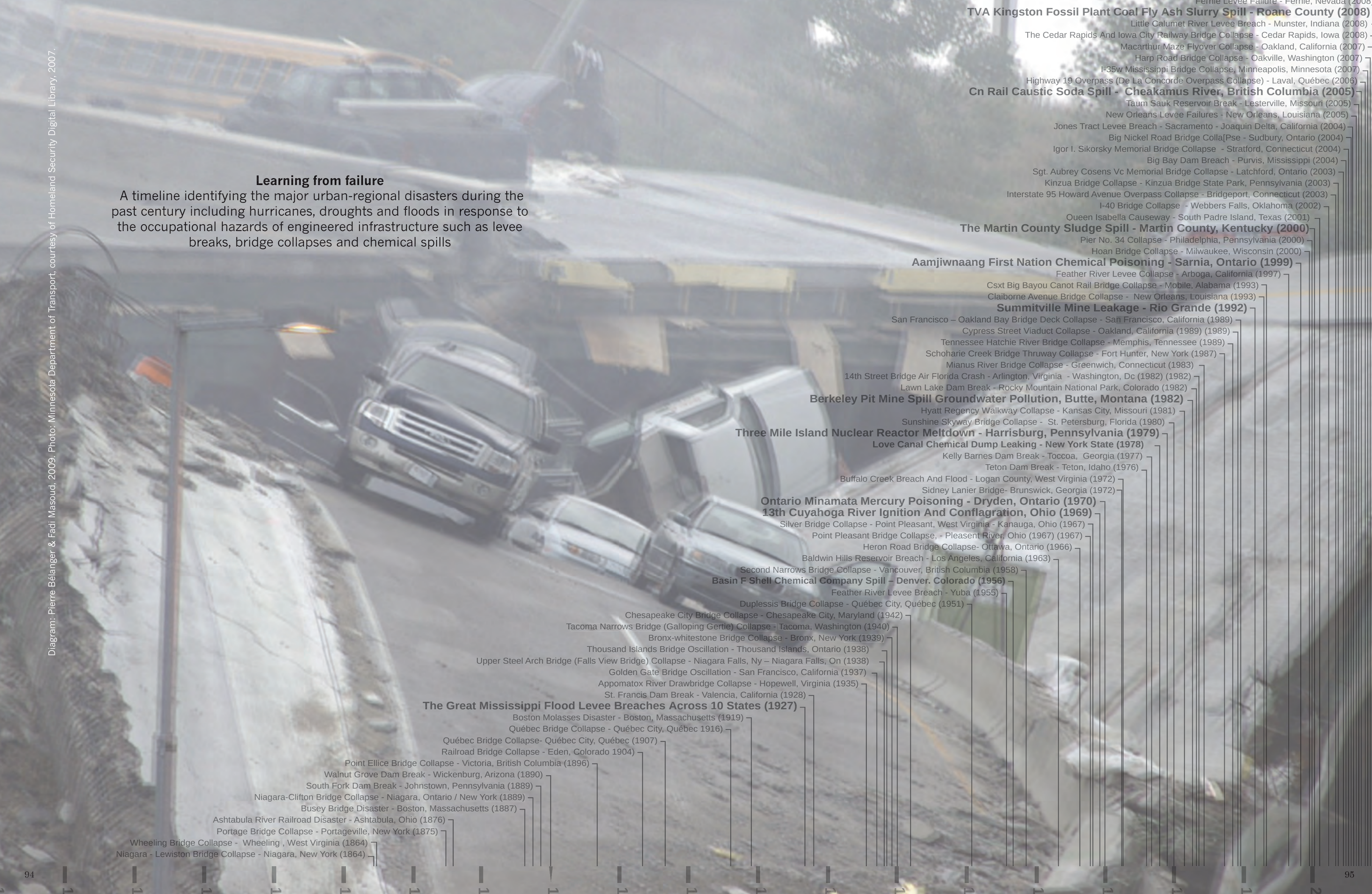


Diagram: Pierre Bélanger & Fadi Masoud, 2009. Photo: Minnesota Department of Transport, courtesy of Homeland Security Digital Library, 2007.

Learning from failure

A timeline identifying the major urban-regional disasters during the past century including hurricanes, droughts and floods in response to the occupational hazards of engineered infrastructure such as levee breaks, bridge collapses and chemical spills

Fernie Levee Failure - Fernie, Nevada (2008)
TVA Kingston Fossil Plant Coal Fly Ash Slurry Spill - Roane County (2008)
Little Calumet River Levee Breach - Munster, Indiana (2008)
The Cedar Rapids And Iowa City Railway Bridge Collapse - Cedar Rapids, Iowa (2008)
Macarthur Maze Flyover Collapse - Oakland, California (2007)
Harp Road Bridge Collapse - Oakville, Washington (2007)
I-35w Mississippi Bridge Collapse, Minneapolis, Minnesota (2007)
Highway 19 Overpass (De La Concorde Overpass Collapse) - Laval, Québec (2006)
Cn Rail Caustic Soda Spill - Cheakamus River, British Columbia (2005)
Taum Sauk Reservoir Break - Lesterville, Missouri (2005)
New Orleans Levee Failures - New Orleans, Louisiana (2005)
Jones Tract Levee Breach - Sacramento - Joaquin Delta, California (2004)
Big Nickel Road Bridge Colla[Pse - Sudbury, Ontario (2004)
Igor I. Sikorsky Memorial Bridge Collapse - Stratford, Connecticut (2004)
Big Bay Dam Breach - Purvis, Mississippi (2004)
Sgt. Aubrey Cosens Vc Memorial Bridge Collapse - Latchford, Ontario (2003)
Kinzua Bridge Collapse - Kinzua Bridge State Park, Pennsylvania (2003)
Interstate 95 Howard Avenue Overpass Collapse - Bridgeport, Connecticut (2003)
I-40 Bridge Collapse - Webbers Falls, Oklahoma (2002)
Queen Isabella Causeway - South Padre Island, Texas (2001)
The Martin County Sludge Spill - Martin County, Kentucky (2000)
Pier No. 34 Collapse - Philadelphia, Pennsylvania (2000)
Hoan Bridge Collapse - Milwaukee, Wisconsin (2000)
Aamjiwnaang First Nation Chemical Poisoning - Sarnia, Ontario (1999)
Feather River Levee Collapse - Arboga, California (1997)
Csxt Big Bayou Canot Rail Bridge Collapse - Mobile, Alabama (1993)
Claiborne Avenue Bridge Collapse - New Orleans, Louisiana (1993)
Summitville Mine Leakage - Rio Grande (1992)
San Francisco – Oakland Bay Bridge Deck Collapse - San Francisco, California (1989)
Cypress Street Viaduct Collapse - Oakland, California (1989) (1989)
Tennessee Hatchie River Bridge Collapse - Memphis, Tennessee (1989)
Schoharie Creek Bridge Thruway Collapse - Fort Hunter, New York (1987)
Mianus River Bridge Collapse - Greenwich, Connecticut (1983)
14th Street Bridge Air Florida Crash - Arlington, Virginia - Washington, Dc (1982) (1982)
Lawn Lake Dam Break - Rocky Mountain National Park, Colorado (1982)
Berkeley Pit Mine Spill Groundwater Pollution, Butte, Montana (1982)
Hyatt Regency Walkway Collapse - Kansas City, Missouri (1981)
Sunshine Skyway Bridge Collapse - St. Petersburg, Florida (1980)
Three Mile Island Nuclear Reactor Meltdown - Harrisburg, Pennsylvania (1979)
Love Canal Chemical Dump Leaking - New York State (1978)
Kelly Barnes Dam Break - Toccoa, Georgia (1977)
Teton Dam Break - Teton, Idaho (1976)
Buffalo Creek Breach And Flood - Logan County, West Virginia (1972)
Sidney Lanier Bridge- Brunswick, Georgia (1972)
Ontario Minamata Mercury Poisoning - Dryden, Ontario (1970)
13th Cuyahoga River Ignition And Conflagration, Ohio (1969)
Silver Bridge Collapse - Point Pleasant, West Virginia - Kanauga, Ohio (1967)
Point Pleasant Bridge Collapse, - Pleasent River, Ohio (1967) (1967)
Heron Road Bridge Collapse- Ottawa, Ontario (1966)
Baldwin Hills Reservoir Breach - Los Angeles, California (1963)
Second Narrows Bridge Collapse - Vancouver, British Columbia (1958)
Basin F Shell Chemical Company Spill – Denver. Colorado (1956)
Feather River Levee Breach - Yuba (1955)
Duplessis Bridge Collapse - Québec City, Québec (1951)
Chesapeake City Bridge Collapse - Chesapeake City, Maryland (1942)
Tacoma Narrows Bridge (Galloping Gertie) Collapse - Tacoma, Washington (1940)
Bronx-whitestone Bridge Collapse - Bronx, New York (1939)
Thousand Islands Bridge Oscillation - Thousand Islands, Ontario (1938)
Upper Steel Arch Bridge (Falls View Bridge) Collapse - Niagara Falls, Ny – Niagara Falls, On (1938)
Golden Gate Bridge Oscillation - San Francisco, California (1937)
Appomatox River Drawbridge Collapse - Hopewell, Virginia (1935)
St. Francis Dam Break - Valencia, California (1928)
The Great Mississippi Flood Levee Breaches Across 10 States (1927)
Boston Molasses Disaster - Boston, Massachusetts (1919)
Québec Bridge Collapse - Québec City, Québec 1916)
Québec Bridge Collapse- Québec City, Québec (1907)
Railroad Bridge Collapse - Eden, Colorado 1904)
Point Ellice Bridge Collapse - Victoria, British Columbia (1896)
Walnut Grove Dam Break - Wickenburg, Arizona (1890)
South Fork Dam Break - Johnstown, Pennsylvania (1889)
Niagara-Clifton Bridge Collapse - Niagara, Ontario / New York (1889)
Busey Bridge Disaster - Boston, Massachusetts (1887)
Ashtabula River Railroad Disaster - Ashtabula, Ohio (1876)
Portage Bridge Collapse - Portageville, New York (1875)
Wheeling Bridge Collapse - Wheeling , West Virginia (1864)
Niagara - Lewiston Bridge Collapse - Niagara, New York (1864)

ECOLOGY AS ECONOMY

Retrospectively, the generic, technological apparatus of modern infrastructure has largely overshadowed the pre-eminence of biophysical systems that underlie it. Whereas in the past, industrial economies were forced to contaminate or destroy the environment in service of the economy, today that equation is being reversed. Mutually dependent, the economy is now inseparable from the environment.

Responding to the current state of decaying infrastructures and ecological pressures, new models and practices[39] are now beginning to challenge the dogma of neo-liberal deregulation and the absence of federal planning:

A. Ecological Engineering:

Linear, static, mono-functional methods of engineering give way to design flexibilities, circular operabilities, interconnections, interdependencies, and multi-dimensional capabilities towards optimization and performance.

B. Dezoning:

Redevelopment and rezoning of land through the layering of land uses and biophysical systems, generates financial mechanisms necessary to the reclamation of decaying infrastructure and contaminated land.

C. Planning for Failure:

Reliant on a culture of contingency and preparedness, risk forecasting are force generators in the planning of urban regions over successive generations.[40]

D. Regionalization:

The watershed region is a hydrophysical infrastructure that provides a strategic, intermediary scale for planning across jurisdictions.[41]

Questioning the unchallenged prominence of civil engineering as the most influential disciplines in the 20th century as well as the unnoticed inertia of urban planning, the field of infrastructure is taking on extreme relevance for public practices and public organizations. The merger of biophysical systems with contemporary infrastructure is now rapidly becoming the dominant order for urban regions. Road networks and freshwater supply can no longer be planned without their watersheds. Sewage treatment and power plants can no longer be engineered without their wasteheds. Buildings and facilities can no longer de designed without their energy systems. From this vantage, ecology is in and of itself, an economy.

Infrastructure as Landscape[42]

Demands for more renewable forms of development and flexible forms of infrastructure are sponsoring interdisciplinary crossover. Sliding between planning and engineering, contemporary landscape practice can propose a sophisticated operating system for urban regions where the complex agency of living systems and dynamic processes can be deployed through long range, large scale strategies. From the rise of environmental concerns in the 1970s to the crisis of public works in the 1980s to the erosion of engineered structures in the 1990s, the ecological restructuring of urban infrastructure must include the management of water resources, waste cycling, energy generation, food production and mass mobility. Paramount to practice and pedagogy,[43] infrastructure needs to be reintegrated and redefined as a sophisticated, instrumental landscape of essential resources, processes and services that collectively underpins and upholds the ongoing, unfinished urbanization of the 21st century.

Endnotes

Epigraph: Paul N. Edwards, "Infrastructure & Modernity" in Modernity and Technology edited by Thomas J. Misa, Philip Brey, Andrew Feenberg (Cambridge: MIT Press, 2003): 185-226.

1. According to the *American Heritage Dictionary of the English Language - 4th edition* (Boston, MA: Houghton Mifflin, 2000).

2. Prior to the Civil War, the work of the U.S. Army Corps of Engineers (USACE) was preceded by the Corps of Topographical Engineers. See Beers, Henry P. "A History of the U.S. Topographical Engineers, 1813-1863" Military Engineering (Jun 1942): 287-91 & (Jul 1942): 348-52.

3. As an instrument for assigning land use types, Euclidean zoning should be differentiated from 'zoning density' used in inner cities. See M. Christine Boyer, Dreaming the Rational City: The Myth of American City Planning (Cambridge, MA: MIT Press, 1983): 139-170. The first case of the use of zoning density was in New York explains Raphael Fischler in "The metropolitan dimension of early zoning: Revisiting the 1916 New York City Ordinance" American Planning Association. Journal of the American Planning Association Vol.64 No.2 (Spring 1998): 170-188.

4. Sidney Willhelm's Urban Zoning and Land-Use Theory (1962) Michael J. Pogodzinski and Tim R. Sass' The Economic Theory of Zoning: A Critical Review (1990) are two of the most important texts from the planning discipline that have identified, assessed and argued for a deeper understanding of the significance of zoning practice.

5. Between 1880 and 1890, almost 40 percent of the townships in the United States lost population to urban migration.

6. See Martin V. Melosi, The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present (Baltimore: Johns Hopkins University Press, 2000).

7. See Col. George E. Waring Jr.. "The Separate Sewer System," The Manufacturer and Builder, Vol.21 No.9 (September 1889). In an 1889 article entitled "SANITARY ENGINEERING", the NY Times reported that lack of attention to this new science was considerable and that architects ignored its developments at their own peril (Bottom of FormSeptember 8, 1889).

8. Starting in 1855, Chicago was the first comprehensive city to install a sewer plan in the U.S. and by 1905, all U.S. towns with population over 4,000 had city sewers.

9. As the City Beautiful gave way to the Sanitary City, the modern age of sewage systems and civil engineering was born. The planning of the Park & Parkway system in Buffalo (NY) by Frederick Law Olmsted and George E. Waring Jr. in the 19th century is one of the best examples of open space planning in conjunction with sanitary engineering and transportation networks.

10. According to the 1930 United States Census.

11. Radical time-savings could be achieved for domestic chores with household electrical appliances.

12. With voltages increasing rapidly between 1900 and 1920, more power could be transmitted across longer distances. In addition to better roads and faster vehicles, a whole array of technologies made decentralization possible and convenient, including electrical energy distribution, telecommunications including broadcasting (radio, television) and narrowcasting (telephone). See Alan S. Berger, The city: urban communities and their problems (Dubuque, IA: Wm. C. Brown Company, 1978).

13. By the 1930s, 60 percent of households owned an automobile. The clamour and smell of horses and buggies were being replaced with the fumes and fuels of cars and trucks, and their attendant services (fuel stations, mechanical garages and parking lots), naturally leading to the next challenge: traffic and congestion. Self-appointed traffic engineer William Phelps Eno came to the rescue of the rule-less road with inventions like the one-way street and the roundabout in addition to countless rule books and behavior changes. Espousing the theory of continuous, uniform traffic flow through control was central to Eno's view, a central tenet of transportation today. Road engineering became synonymous with urban planning, while speed and mobility became unquestioned drivers of urban form across North America. See William Phelps Eno, The story of highway traffic control, 1899-1939 (Saugatuck, CT: The Eno Foundation for Highway Traffic Control, 1939) and The Science of Highway Traffic Regulation, 1899 and 1920 (Washington D.C.: Brentano's, 1920).

14. In the aftermath of World War I, the 1929 Crash was a period of economic crisis characterized by John Kenneth Galbraith as the failure to restore a functioning world economy after the First World War, described in his The Great Crash (New York, NY: Mariner Books, 1954).

15. The most comprehensive account of landscape planning in America is Francesco Dal Co's "From Parks to the Region: Progressive Ideology and the Reform of the American City" in The American City: From the Civil War and the New Deal, edited by Giorgio Cucci, Francesco Dal Co, Mario Manieri-Elia and Manfredo Tafuri (Cambridge, MA: MIT Press, 1979): 143-292.

16. Howard W. Odum's opus Southern Regions the United States (1936) considerably influenced presidential policy in in the ealry 20th century. See William Edward Leuchtenburg, The White House Looks South: Franklin D. Roosevelt, Harry S. Truman, Lyndon B. Johnson (Baton Rouge, LA: Louisiana State Press, 2005).

17. Key advisor to FDR who helped shape the Civilian Conservation Corps, France Perkin shepherded other important New Deal initiatives including The Public Works Administration by the Federal Emergency Relief Administration, the National Labor Relations Act, the Social Security Act, and the Fair Labor Standards, Act.

18. According to FDR's right hand man at the Federal Highway Administration Thomas H. Macdonald who wrote the government-sponsored manifesto entitled Toll Roads and Free Roads, "free roads are ideal for free people".

19. See New Deal City by Sue Halpern, Mother Jones (May/June 2002).

20. Arguably, roads are the last and most important public space in North America.

21. Furthering the objectives of decentralization and democracy, FDR's progressive vision of the highway system moved ahead with the planning of greenbelt towns by the New Deal Resettlement Administration (RA), lead by agricultural economist, Rexford Tugwell. Planned along major intercity corridors, three new towns were built out of more than 3000 models. Erroneously depicted as garden cities or Radburn carbon copies, FDR's urbanism (read super-urbanism) was informed by Tugwell's documented admiration of the planned Soviet economy and its collectivist ideals. Fomenting socialism during a predominantly anti-Soviet era, the greenbelt projects were rare exemplars of planned decentralization anticipating future urban sprawl. The urban cooperatives, the superblocks, and the cul-de-sacs that make up these experiments have long matured, but remain a forward looking demonstration of America's foray into the public practice of urban planning. See Gwendolyn Wright, Building the Dream: A Social History of Housing in America (Cambridge, MA: MIT Press, 1983) and Sue Halpern, "New Deal City", Mother Jones (May/June 2002).

22. See American Public Works Association, Top Ten Public Works Projects of the Century Program 1900-2000 (Washington D.C.: APWA, 2000).

23. Seed stock included oats, alfalfa, barley, and milo (sorghum) to feed cattle, hogs, sheep, horses, and chickens.

24. In total, 3.5 million people were employed in conservation projects, 2.5 billion trees planted, 40 million acres of farm land protected, 1 million acres of grassland reclaimed, 800 state parks created along with 52,000 campgrounds between 1933 and 1941. see Douglas Helms, "Hugh Hammond Bennett and the Creation of the Soil Erosion Service" Historical Insights Number 8 (Washington, D.C.: Natural Resources Conservation Service, USDA, September 2008).

25. FDR was committed to the benefits of electricity as an instrument of democracy: "But these cold figures do not measure the human importance of the electric power in our present social order. Electricity is no longer a luxury. It is a definite necessity. It lights our homes, our places of work and our streets. It turns the wheels of most of our transportation and our factories. In our homes it serves not only for light, but it can become the willing servant of the family in countless ways. It can relieve the drudgery of the housewife and lift the great burden off the shoulders of the hardworking farmer." See The Public Papers and Addresses of Franklin D. Roosevelt, Vol. 1, 1928-32, (New York, NY: Random House, 1938), p. 727, reprinted from the Works of Franklin D. Roosevelt, The "Portland Speech" A Campaign Address on Public Utilities and Development of Hydro-Electric Power, Portland, OR (September 21, 1932).

26. The TVA was arguably the most sophisticated and most comprehensive programs of the New Deal. It supplied reliable, competitively priced power, support a thriving river system, and stimulate sustainable economic development in the public interest.

27. The Great Depression was the catalyst: assuaging deep-rooted, hard line attitudes by rugged individualists, smoothening the path for a U.S. president focused on the economy of the commons. From the Soil Conservation Program to the Interregional Highway System to the Tennessee Valley Authority, FDR's epic vision of social progress was "a piece of social and physical engineering of a scale [...] and profundity" that, according to German-born British historian Reyner Banham, was "difficult to match even in the Russian five-year plans." See "Valley of the Dams" in A Critic Writes: Selected Essays by Reyner Banham edited by Mary Banham, Sutherland Lyall, Cedric Price, and Paul Barker (Berkeley, CA: University of California Press, 1996): 204. See also Reyner Banham, "Tennesse Valley Authority: The Engineering of Utopia" in Casabella 542-543 (January-February 1988):74.

28. Under Reagan, federal spending shifted from transportation and energy to the military sector. See John D. Donahue, The Privatization Decision: Public Ends, Private Means (New York, NY: Basic Books, 1989).

29. Ronald Reagan was formerly registered as a Democrat and strong admirer of FDR and the New Deal Era before switching to the Republican party in the early 1950's.

30. Modeled on Thatcher's Energy Policy of 1983, Reagan loosened the grip of government on the free market economy. His loyal vice-president George H.W. Bush loosened the energy market in the early 1990' with Management Circular A-76. Clinton oversaw the deregulation the financial market in the late 1990's with the removal of New Deal-era anti-speculation laws (1933 Glass-Steagall Act) that kept banking, insurance and brokerage separate. George W. Bush eased up environmental standards for air and water pollution sponsoring the growth of coal and petrochemicals. The compound effect of these deregulatory measures are considered the principal causes of the housing mortgage foreclosure crisis and credit crash in 2008-2009.

31. Against the backdrop of deindustrialization, the Reagan administration instituted the adage that government was synonymous with bureaucracy. "Government is the problem, not the solution", "just leave it to the market place" became conventional wisdom reinstating the primacy of free enterprise in America.

32. By the turn of the 21st century, the federal government had become the largest industry for the private sector. There was and still is a flood of money expected to be made in the privatization of infrastructure. For an emerging account of the hidden benefits of the valuation of infrastructure as an asset, see Roads To Riches: Why investors are clamoring to take over America's highways, bridges, and airports—and why the public should be nervous by Emily Thornton in Business Week (May 7, 2007) and Amanda Witherell "Who Owns Our Cities? Privatizing Public Services Imperils Cities" in RP&E Vol. 15, No. 1 (Spring 2008).

33. See Deborah Solomon, "The Builder: Interview with Felix Rohatyn", The New York Times (February 18, 2009).

34. The underlying conflict in the privatization of public services is that it does not account for the spin-off benefits and synergies associated with public delivery of services that effectively equalize the extremes between different classes. See Jenny Anderson, "Cities Debate Privatizing Public Infrastructure", The New York Times (August 26, 2008).

35. Another important factor is the historic failure of Superfund to clean more than 1300 severely contaminated sites around the U.S. is a case in point of the effects of deregulation. Its administrative body, CERCLA, had used over 90% private contractors for the execution of over a thousand cleanup projects yet most of them got locked up in endless litigation with very little work done on the ground. Now, more than 400,000 sites with real

and perceived environmental hazards dot the American landscape, totaling more than $2 trillion in devalued property. according to a national report on brownfields redevelopment titled Recycling America's Land.

36. John Kenneth Galbraith foreshadowed this crisis three decades ago: "much of the problem of the environment arises from under-investment in elementary services and plants for keeping things clean or cleaning things up. It is the kind of expenditure against which the modern economy systematically discriminates" in Economics & Public Purpose (New York: Pelican Books,1973): 305.

37. See ACSE, Report Card for America's Infrastructure (2008) and Pat Choate & Susan Walter, America in Ruins: The Decaying Infrastructure (Durham: Duke Press Paperbacks, 1983).

38. Calling for a response to the crevasses between the two cultures of the sciences and the humanities, Paul Sears - in a provocative essay entitled "Ecology - A Subversive Subject" pointed out that: "the view of nature derived from the ecological studies called into question some of the cultural and economic premises widely accepted by Western Societies. Chief among these premises was that human civilizations, particularly of advanced technological cultures, were above or outside of the limitations, or "laws" of nature." See Robert P. McIntosh, The Background Of Ecology: Concept And Theory (Cambridge, UK: University of Cambridge, 1985): 1. Paul Sears was the first to speculate that if ecology were" taken seriously as an instrument for the long run welfare of mankind, [then it would] endanger the assumptions and practices accepted by modern societies, whatever their doctrinal commitments. Paul B. Sears "Ecology-A Subversive Subject" BioScience 14 No.7 (1964): 11.

39. Although the push for the a federal-regional Land Use Policy was defeated in the 1970s, consolation prizes came in the form of protective measures across broad concern for environmental matters resulting in notable legislation (National Environmental Policy Act of 1969, the Clean Air Act Amendment of 1970, the Federal Water Pollution Act of 1970, the Federal Water Pollution Control Act Amendments of 1972, the Coastal Management Act 1972) but that are only mere remedies to the larger challenge of long range public planning. As a point of comparison between planning policy and the pattern of land development in the US and Canada. Wetland reclamation in the U.S. is allowed through substitution of same size acreage within another watershed system, whereas in Canada, the practice of wetland reclamation or substitution is prohibited.

40. See János Bogárdi, Zbigniew Kundzewicz, Risk, Reliability Uncertainty And Robustness Of Water Resource Systems (Cambridge UK: Cambridge University Press, 2002).

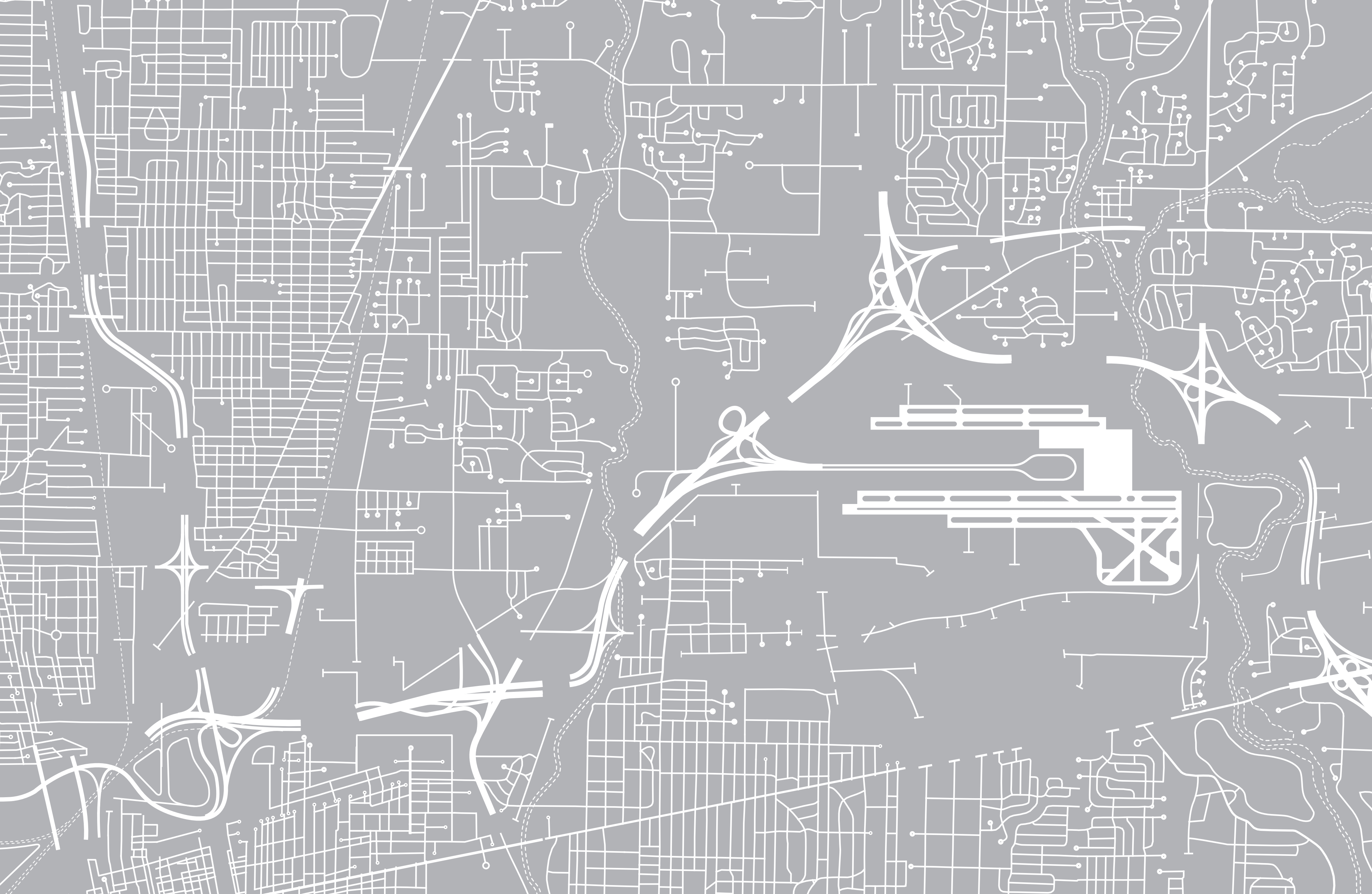
41. See Michael Hough, "The Urban Landscape: The Hidden Frontier", Bulletin of the Association for Preservation Technology - Landscape Preservation Vol.15 No.4 (1983): 9-14.

42. The understanding of infrastructure as a landscape enables us to engage dimensions of urbanism that have previously been either ignored by their banality or considered untouchable by virtue of the magnitude at which they operate. As an integrative and horizontal field that transcends disciplinary boundaries, contemporary landscape practice is gaining considerable momentum as it includes the operative, logistical and ecological aspects of infrastructure. Sponsoring interdisciplinary crossover, this dual field of design implies a dual identity in both research and practice, where synthesis of ecology preconditions the detail of implementation, where long term resource management is as important as short term mobilization of capital, where the commonwealth of public systems presides over the uncoordinated guise of self-interests, requiring the sustained engagement from public agendas and private motives. From this platform, landscape infrastructure strategies can be telescopic, sliding across a spectrum of scales: short, immediate interventions sequenced over long periods of time with durable effects. As public brain trusts, universities become complicit in this urban agenda, capable of transcending competing ideologies: between the technical and the political, the liberal and the conservative, the private and the public, the historic and the futuristic. The gradual deprofessionalization of conventional disciplines towards common ecological and economic objectives will allow flexible public-private practices to cut across sluggish specializations that all too often stunt land redevelopment and economic renewal. These co-operations can usurp stylistic variations or disciplinary differences in project execution. In stark contrast to the 20th century paradigm of speed and permanence, the effects of future transformation will be slow and subtle, requiring the active and sustained engagement of long-term, opportunistic partnerships that bridge the private and public sectors.

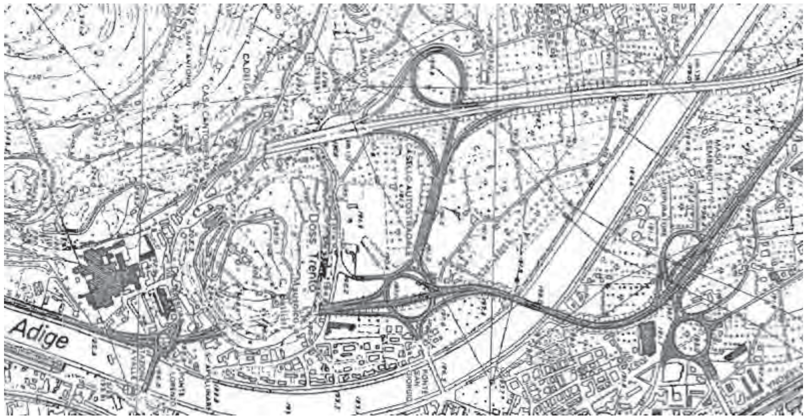
43. Current day conditions corroborate the imperative: sudden power outages across the Northeastern United States and Canada in 2003, the disastrous hurricanes on the Gulf Coast and subsequent spiking of oil prices in 2005, the deferred maintenance programs across North America, the resulting bridge failures in 2007 mark a decisive shift in conventional practices whereby the unchecked globalization of generic, end-of-pipe engineering and uncoordinated, reactionary planning have reached a tipping point.

Originally published in Ecological Urbanism *edited by Mohsen Mostafavi and Gareth Doherty (Baden, Switzerland: Lars Müller Publishers, 2010): 332-349.*

>
Landscape of Junctions
Urbanism in Columbus is defined by intersections and interchanges. The city was originally named after the famed Italian explorer, Christopher Columbus, but the most under-recognized aspect of its urbanism is actually a junction: the confluence of the Scioto and Olentangy rivers that spawned the city's grid pattern where High Street crossed Broad Street in the late 1900s. Population growth at the turn of the 20th century soon led to the development of planned communities and the metamorphosis of the city grid with the introduction of cul-de-sacs (intersections with dead ends) that relied, much like Radburn in New Jersey, on the separation of vehicular and pedestrian traffic. With the development of the US Interstate Highway System in the mid 20th century, the construction of the Outerbelt Highway (I-270) circumvented the city grid altogether, laying down a new regional structure of roadways and junctions based on speed and transportation. From highway interchanges to river crossings 140 to cul-de-sacs, intersections can therefore be considered the infrastructural glue that holds together the metropolitan landscape of townships, suburbs, rivers and roads throughout Columbus. (OPSYS, 2008)



Landscape of Speed.



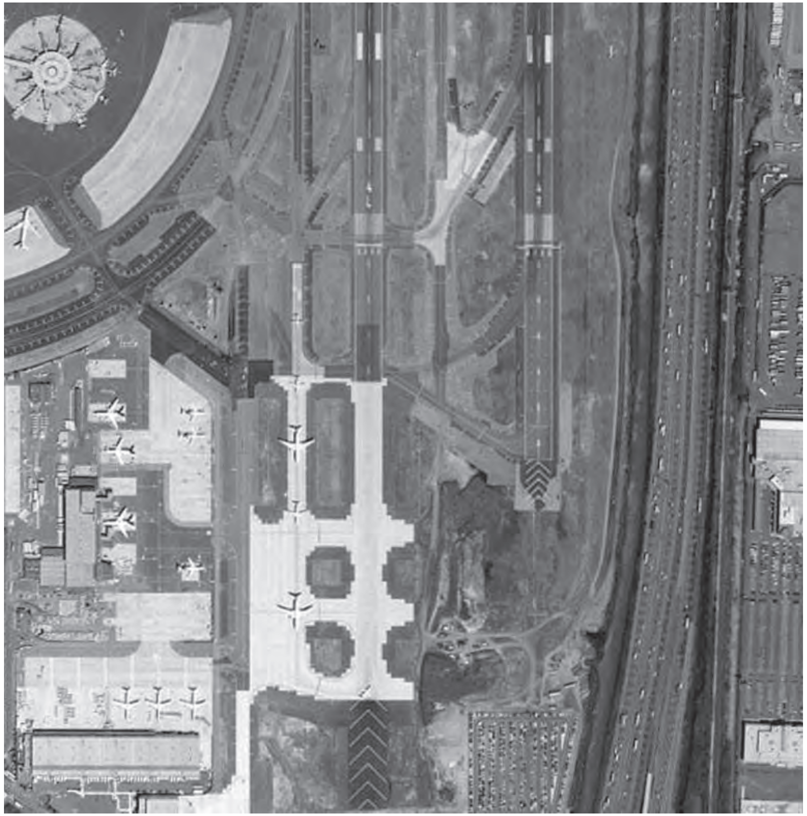
Casabella 553-554, Jan-Feb 1989.

“The importance of mobility and access in the contemporary metropolis brings to infrastructure the character of collective space. Transportation infrastructure is less a self-sufficient service element than an extremely visible and effective instrument in creating new networks and relationships”.

Alex Wall, “Programming the Urban Surface”, 1999.[1]

“the emphasis in the future must be, not upon speed and immediate practical conquest, but upon exhaustiveness, inter-relationship and integration. The coordination and adjustment of our technical effort… is more important than extravagant advances along special lines, and equally extravagant retardations along others, with a disastrous lack of balance between the various parts.”

Lewis Mumford, Technics and Civilization, 1934.[1]



Courtesy of the United States Geological Survey

Foreign Trade Zone No. 49, New Jersey, 2003. Orthoimagery detail. Across from left: Newark Liberty International Airport (EWR) Terminal A; Pier 3, FedEx Cargo Bay; Runway 4L-22R; The Peripheral Ditch; New Jersey Turnpike; and Port Newark/Elizabeth Container Terminal New Jersey, USA, 2003

<
Extensively referenced in his essay "Programming the Urban Surface", Alex Wall cites the work of Vittorio Gregotti in a Special Issue of Casabella (Jan-Feb 1989), exclusively dedicated to The Road / La Strada, featuring other several notable others including the work of Vittorio Gregotti, Bernardo Secchi, Willem Neutelings, Joan Busquets, Jean-Louis Cohen, André Guillerme, and Jean-Pierre Gaudin.

Asphalt may be among the most ubiquitous, yet invisible materials in the North American landscape. Its scale and form practically render impossible the conception of it as a single bounded system, yet its function depends precisely upon the singular continuity of a horizontal surface. Highways, terminals, interchanges, off-ramps, medians, sidewalks, and curbs are such pervasive components of the built environment, that they are often overlooked as influential characteristics of contemporary culture in North America.[2] These seemingly disconnected elements form a distinctly engineered operating system that supports a multitude of regional processes, and generates a wealth of contemporary programs. Many of these lie outside of the conventional axioms of European influenced theories of urban design and planning. How then do we account for, and articulate the logic of urbanism in North America? An examination of the synthetic processes of contemporary urbanization may shed some light on this question and its potential for contemporary landscape practice.[3]

Recently, the discourse surrounding 'landscape infrastructure' and 'landscape urbanism' has emerged in North America to elaborate upon the role of landscape in many architects and urbanists' thinking on the contemporary city. Several authors have recently attempted to articulate the logic of North America's spatial structure as a way of understanding contemporary urbanization. Stan Allen for example, compares the evolution of the North American urban landscape to "a radical horizontal urbanism...developed as a vast, mat-like field, where scattered pockets of density are knit together by high-speed, high-volume roadways."[4] Alex Wall, an architect and urbanist, refers to this transformation as "the extensive reworking of the urban surface as a smooth continuous matrix that effectively binds the increasingly disparate elements of our environment together."[5]

At the smaller scale, a growing number of authors are discussing the influence of material technologies on the conditioning of the urban surface, understood as a landscape. Again, Allen is instructive, articulating the role of synthetic surfaces of landscape as to the materiality of urbanism:

> ...the surface in landscape is always distinguished by its material and its performative characteristics. Slope, hardness, permeability, depth and soil chemistry are all variables that influence the behavior of surfaces.[6]

One of the most underrepresented materials, and one deserving of greater attention, asphalt may be among the most important in the history of North American urbanization. Though the history predates Ancient Rome, one example of the topic's more recent cultural relevance can be found in its inclusion in the Milan Triennale with an exhibition curated by Mirko Zardini titled "Asfalto". With visual acumen, Zardini's installation examined the synthetic attributions of this usually gray surface by uncovering the historical, technical, cultural and visual layers of the mundane material "commonly considered an undesired yet necessary skin."[7]

The ultimate impact of this material on the built realm would not be fully inscribed across the North American landscape until the advent of the 20th century. No other material has been found to be so flexible and so adaptable, capable of absorbing so many functions, enabling so many uses and producing so many effects.[9] This singular material innovation, coupled with the reflective mechanism it supports, can be traced back as the source of some of the most generic and ubiquitous aspects of the North American landscape today – those aspects that are gaining increasing attention by the practices articulated through the prism of landscape urbanism.

Pre-Conditions

The history of urbanism in North America starts in the mud.[10] Well before the advent of oil, steam, coal or the invention of the airplane, the train or the motor car, America was characterized more or less by an agonizing unevenness, a topography primarily composed of potholes and ruts that did very little but pose as obstacles to regional mobility and communication. Modern industrialization would soon dismantle the resistance sustained for so long by the environmental medium of mud, dust and darkness. Slowness, the agonizing paradigm of the 19th century landscape, quickly gave way to speed[11] – the essence of modernity. Henry Adams no less, described this state of arrested development at the end of the 19th century:

> America is required to construct, without delay, at least three great roads and canals, each several hundred miles long, across mountain ranges, through a country not yet inhabited, to points where no great markets existed—and this under constant peril of losing her political union, which could not even by such connections be with certainty secure. [...] Between Boston and New York is a tolerable highway, along which, thrice a week, light stagecoaches carry passengers and the mail, in three days. From New York a stagecoach starts every weekday for Philadelphia, consuming the greater part of two days in the journey, and the road between Paulus Hook, the modern Jersey City, and Hackensack is declared by the newspapers in 1802 to be as bad as any other part of the route between Maine and Georgia . . . . In the Northern States, four miles an hour is the average speed for any coach between Bangor and Baltimore. Beyond the Potomac the roads become steadily worse, until south of Petersburg even the mails are carried on horseback.[12]


Courtesy of the Iowa Department of Transportation and the Farewell T. Brown Photogprahic Archive (Ames Public Library), Ames, Iowa.

Material Resistance: US Route #1, 1911

The state of the roads was indicative of a state of geographic and civic emergency. A letter from the League of American Wheelman by Isaac B. Potter in 1891 outlines the economic imperative:

> The United States is the only country in the world, assuming to be progressive, that is so poorly provided with highways; that their condition is a source of amazement to the foreigner; showing by a series of pictures of the splendid roads of Germany, France & Italy, and other European countries, and by way of contrast, some typical pictures of the lines of sticky mud, with ruts hub-deep at certain seasons, that go by the name of country roads, in the most populous and prosperous States of the Union.[13]

Frost Action

What differentiated the North American situation from the European context most fully was frost.[14] With mild winters, no European surface was ever exposed to permanent cycles of freezing and thawing that by and large destroyed dirt highways. Water could therefore be used as the primary binding and compaction agent in European road construction. But a more resilient material was required to combat the swampy muddy surface of the New World, a material that would be capable to withstand deep freeze cycles of northern temperate climates and more ro-

Courtesy of The Washington State Department of Transportation

Steam powered roller on asphalt pavement, 1934

Courtesy of Kenneth C. Downing photo Collection, the Smithsonian Institute, Washington, DC.

War Game: Transcontinental Motor convoy, 1919

bust than the inferior European techniques. Charles Goodyear had already developed the perfect paving material as early as 1844 - vulcanized rubber, a confection that could be heated without melting or cooled without cracking[15] - but the material would ultimately prove too expensive for the scale and the scope of an intercontinental highway enterprise. Asphalt[16] came to the rescue of an economy that was anxiously awaiting a drier, smoother future. Cultural Historian Jeffery T. Schnapp describes the paradox of asphalt as an urban catalyst in European cities:

> Asphalt erupts on the scene of modernity to redeem the world of industry of the banes of friction[17] and dust. Dust clouds have been around since the beginning of time. But the coaching revolution of the nineteenth century transformed them into signifiers of accelerated movement long before the appearance of the stream or motion lines that would indicate velocity in twentieth century cartooning and graphics. Dust was also what differentiated driver passengers from pedestrians, the enfranchised from the disenfranchised, within the contours of a nation-state now defined as a transportation grid....Dust was the pollutant of the nineteenth century. Asphalt came to the rescue. It cleaned up speed.[18]

Surface Economies

The prospect of weatherproofing North America's roadways was first conceived the day Edward Joseph De Smedt, a professor from Columbia University, applied for the first time in the world, a modern, engineered, graded, maximum-density asphalt pavement.[19] Laid out in 1872 in front of City Hall in Newark, New Jersey, the Belgian chemist irreversibly launched, with the construction of a 1400 ft. segment on William Street,[20] the industry of roadbuilding as we know it today. Joining the ranks of the "grandfathers of roadbuilding" such as the Scottish inventors John Metcalfe, Thomas Telford and John Loudon Macadam, De Smedt's technique distinguished itself from his predecessors,[21] in that it synthesized 1000 years of material developments into a simple reproducible technique. The surface technique proposed a hot-in-place, semi-liquid asphalt mix application that could be laid down in a series of lifts, according to a desired thickness and density. A technique that could only emerge from the geographical circumstance of the New World – a continent over 100 times the size of Scotland – where issues of scale and operational logistics supersede issues of material quality and resource availability. De Smet's technique also meant that the surface could be engineered according to types of vehicles and volumes of traffic flow for a range of topographical conditions. De Smedt's 1870 Patent describes the mat-like technique with technical precision:

> [T]he surface on which the road or pavement is to be laid is properly graded and I first put a thin layer of hot sand upon it, about half an inch in thickness, and upon this layer of sand I put a layer of hot sand and asphalt, that which was previously mixed, under a comparatively moderate degree of heat, this last layer being about one inch in thickness. Over this layer...I pass a hot roller, and then apply a thin layer of hot sand, half inch thick, and over the latter a layer, an inch thick...which is rolled with a hot roller, as before. This is repeated until the desired thickness for the road or pavement is obtained. By this process or mode of laying, I obtain in the road or pavement the proper proportions of sand and asphalt without any difficulty whatsoever, and insure that the proper thorough incorporation of the sand and asphalt, and sand layers, so that a homogenous mass is obtained throughout.[22]

De Smedt's overlay technique utterly transformed the road building industry. According to the first complete survey of America's roads, completed in 1904, of the more than two million miles of rural public roads, fewer than 154,000 miles were surfaced usually with gravel, stones, or crude paving materials. But soon after the standardized guide-

©2003 The State Museum of Pennsylvania; courtesy of the Nassau County Museum, Roslyn Harbour, New York.

The revolutionary tournapull, 1948. The first integral, articulated wheel tractor scraper earthmover, developed by Robert G. Letourneau

lines of the Federal Road Act of 1916[23], 4,500 miles of blacktop would be laid down. With better tensile strength than concrete and equally good surface traction, asphalt pavement replaced all other forms of road construction. What eventually made it so effective was its regional adaptability. By mid-century, asphalt could be refined from coal or crude oil, blended with virtually any locally available aggregates, from quartzite to granite, to produce a versatile waterproof trafficable surface anywhere on the continent.[24]

Expeditions

In the summer of 1919, a young Lieutenant Colonel named Dwight D. Eisenhower joined a U.S. Army convoy whose objective was to locate and traverse by motorized vehicle a transcontinental route joining the east and west coasts of America. Dubbed the 1919 Transcontinental Convoy, the expedition spanned the continent over 62 days. The expedition, echoing and outdistancing the previous military expeditions of Lewis and Clark among others, [25] consisted of 37 officers and 258 enlisted men astride 81 motorized vehicles traversing 3200 miles from Washington D.C. to San Francisco. [26] The convoy reached San Francisco via the Lincoln Highway over a treacherous surface terrain of dirt roads, rutted paths, dark winding trails and shifting desert sands. Less than ten percent of the country's roads were surfaced with gravel, stone or some other crude paving materials.[27] The rest was just mud, dust or sand. Traveling at an average of 6 miles per hour, Eisenhower witnessed firsthand the frontier like conditions of the existing roads. "Passing through 350 communities in eleven states," he wrote, "approximately 3,250,000 people witnessed the convoy and its pioneering triumphs. Local publicity exposed the convoy to an additional 33,000,000 people across the country while steadily increasing the number of recruits and good roads partisans."[28] The line traced by the transcontinental expedition would later resurface as a preliminary sketch of Eisenhower's greatest and most important achievement.

Automation

By the late 1920s, following further developments of De Smedt's technique, the pace was set for the construction of over 4,500 miles of highways. As mechanization took command, concrete construction equipment[29] was rapidly adapted to withstand high temperature liquid emulsions for the purposes of asphalt paving. Everything from dozers, scrapers, graders, millers, screeders and rollers was enlisted for the cause. Spreading from the roadbuilding industry to manufacturing and housing, no sector of the industry was spared the supremacy of mass production. Harper's Magazine reported the work of Willliam Levitt in the 1920s, a brilliant example of streamline progress, using machinery whenever possible in the name of efficiency:

> Beginning with a trenching machine, through transit-mix trucks to haul concrete, to an automatic trowler that smooths the foundation-slab, Levitt takes advantage of whatever economies mechanization can give him. The site of the houses becomes one vast assembly line, with trucks dropping off at each house the exact materials needed by the crew then moving up. Some parts - plumbing, staircases, window frames, cabinets - are actually prefabricated in the factory at Roslyn and brought to the house ready to install. The process might be called one of semi-prefabrication.[30]

Now that mass-production permeated almost every aspect of the construction process, unprecedented levels of cost-efficiency and speed were now in sight.

Mobilization

Hot-mix asphalt was now center stage for a theater of explosive invention. Along with the internal combustion engine, vulcanized rubber, refined petroleum, the air tube, the pneumatic tire, the ball bearing, cold pressed steel, diecast metal, hydraulics and lubricants led to the eventual motorization of almost every component of the North American landscape: horse drawn carts were being replaced with motor-wagons,[31] coaches with motorized buses,[32] and bicycles[33] with motorized quadricyles.[34] Crossbred with industrial manufacturing techniques, vehicles were almost surpassing the speed of trains, and with this, came the demand for a smoother, more extensive and more connected system of roads and highways. Now that asphalt roads could be streamlined, highway networks had to be planned. Following the Federal Road Aid Act in 1916, State authorities were now empowered to carry out federal highway projects, so road building companies could now apply De Smedt's technique on a geographic scale.

The early transformation of dirt to asphalt was slow. Foreign conflicts abroad entirely diverted labor, equipment, and materials toward the efforts of the two world wars, placing the road building project on hold. But soon after World War II, New Jersey Governor Alfred E. Driscoll mobilized the necessary means to spearhead the development of modern freeways. Again, speed was of the essence. So, a World War II Brigadier General, William Wesley Wanamaker, was enlisted to expedite the construction of North America's first paved superhighway, the New Jersey Turnpike.[35] Like an allied front, Wanamaker divided the massive project into seven separate contacts with, as the caption to a 1949 map of the turnpike declared, a sole purpose and objective "118 miles safely and comfortably, without a stop!"

That's what this modern 'magic carpet' being built by the New Jersey Turnpike Authority will provide vehicle owners when it is completed late in 1951. Long sight distances, wide travel lanes and shoulders, easy curves and no crossroads assure safety and comfort. With fifteen traffic interchanges where vehicles may enter or leave, the turnpike will connect with leading highways to famous seashore resorts east and to other points west. North-south travelers also will be served more quickly and more economically. Savings in travel time on the Turnpike are estimated at as much as 40 percent versus travel on existing highways.[36]

Mobilizing equipment, extracting aggregates and mixing materials on site precipitated the

Courtesy of The Dwight D. Eisenhower Library, Abilene, Kansas.

1911
Pre-highway era map

Courtesy of The U.S. Department of Transportation, FHWA, Washington, DC.

1947
United States Interstate & Defense Highway System

next pivotal development: the batch plant.[37] Paragon of road building logistics, the batch plant process effectively reduced transportation costs and fast-tracked construction schedules by centrally locating all necessary equipment required to construct roadway infrastructure.[38] Round-the-clock dredging operations brought in 5 million cubic meters of silt material from as far as Coney Island to lay the base course for the 324-foot wide roadbed on high ground. In its path were the Newark Meadows. Turn-of-the-century ideals of land reclamation epitomized the solution to growing urban density, as illustrated in a press release from the Turnpike Authority:

> The prejudicial effect of the proximity of these marshlands upon the healthfulness of the cities on their borders and on the salubrity of the adjacent country districts is the strong argument for their drainage and improvement. They are not only insalubrious, but also comparatively non-productive in an agricultural point of view. The possibilities of these meadows when drained and the sanitary advantages of their reclamation, aside from the aesthetic setting, make a strong impression upon all who have seen the rich and beautiful polders of Holland.[39]

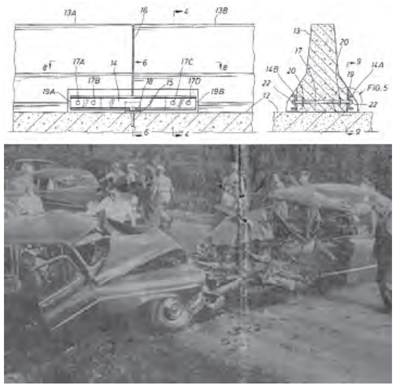
Dubbed as "Operation Sand', the pairing of modern hopper dredgers and three hundred year-old land reclamation techniques handed down from the Europeans proved useful for one of the final segments of the turnpike. So-called 'unproductive' marshlands and surrounding pig farms were irreversibly drained and filled to make way for what are today the New Jersey Turnpike, Newark Liberty International Airport and Port Newark/Elizabeth. Built in a record 23 months, the country's worst swampland – ironically called the Garden State - was turned into the world's most modern express highway route. Aimed at passing through the nation's most densely populated state, the new line – more or less a supersize metropolitan bypass - shaved two hours off the trip between New York and Philadelphia. As proclaimed by Governor Driscoll near the turnpike's completion, the economies of time afforded by the synthesis of transportation surfaces seemed irrefutable:

> In 1949, we determined to build in New Jersey the finest highway in the world, linking the interstate crossings of the Hudson River with the interstate crossings of the Delaware River, for the convenience of the citizens of New Jersey and our sister states. The project is called the New Jersey Turnpike. Our Turnpike Authority has substantially completed the project with incredible speed…The Turnpike is designed to strengthen the economy of New Jersey and to promote the general welfare of our country. Its importance to the defense effort is obvious.[40]

Boasting 13 toll plazas, 12-foot-wide lanes, 10-foot-wide shoulders and 6 lanes, the implementation of the New Jersey Turnpike resulted in the standardization of highway geometries that are found today in the California Highway Design Manual[41]. Adopted as a road building bible, the highway design standards would serve as a model reproduced throughout the United States, Canada, Mexico, and nearly everywhere else in the paved world. By the time the Turnpike opened, asphalt covered more than 5,000 square kilometers of surface area, one foot deep over two feet of stone and sand. As retired Turnpike Authority engineer R. Bruce Noel put it, "we probably had the most outstanding pavement. The Turnpike's original pavement…never had to be torn up [or] replaced. And it will be there forever."[42] The original Jersey Freeway model, epitomized by its novel rest-stops, toll booths, gas stations and drive-in movie theaters would soon become the basis of a road-based culture that is today, in one form or another, generic infrastructure.

SYSTEMATIZATION

However modern, the New Jersey Turnpike was less than perfect. An engineering test bed, the Jersey Turnpike was marred by corrective S-curves "because of positioning errors resulting from the inattention (of local surveyors) to official geodetic references."



Reprinted from Hancock County Journal & Carthage Republican; scanned by Marcia Farina; (top) courtesy of the U.S. Patent & Trademark Office, Washington, DC.

The New Jersey Turnpike Authority's heavy vehicle median barrier (top); Head-on collision, August 27, 1952 (bottom)

Courtesy of The New jersey Turnpike Authority.

Tri-level construction on the turnpike: Route 4 Parkway & Woodridge Avenue Interchange, 1950

Pulitzer preize-winning science correspondent for *The New York Times*, John Noble Wilford recounts in his 1981 book *The Mapmakers* that the official survey markers had been established by Ferdinand R. Hassler - the Swiss engineer that was enlisted by Thomas Jefferson to lead the National Geodetic Survey - some hundred years prior. "The curves were the only way for the turnpike to connect to some of its cloverleaf turnoffs."[43]

Networks

The 1956 Federal Aid Highway Act emerged as the nation's infrastructural palliative. Thirty seven years after his cross country military expedition of 1919, President Eisenhower laid out a monumental standard - a 43,000 kilometer surface network with a minimum 24-feet width for two lanes in each direction. Originally charted by Franklin D. Roosevelt in the late 1930s, the interregional highways would follow existing roads wherever possible:

> More than two lanes of traffic would be provided where traffic exceeds 2,000 vehicles per day, while access would be limited where entering vehicles would harm the freedom of movement of the main stream of traffic. Within the large cities, the routes should be depressed or elevated, with the former preferable. Limited-access belt lines were needed for traffic wishing to bypass the city and to link radial expressways directed toward the center of the city. Inner belts surrounding the central business district would link the radial expressways while providing a way around the district for vehicles not destined for it.[44]

Over the course of those 37 years, Eisenhower would be absorbed with visions of continental seamlessness. His presidency singularly focused on surveying the surface of the United States to map the highway system and to raise funds to build it. The U.S. Interstate and Defense Highway System was marshaled as a strategic organizational device. Underpinned by military defense objectives, the basis of the superhighway system was intended to connect major cities spread out across the United States and to overcome five major shortcomings of the existing transportation, spelled out by Eisenhower's Vice-President Richard M. Nixon:

> [T]he annual death and injury toll, the waste of billions of dollars in detours and traffic jams, the clogging of the nation's courts with highway-related suits, the inefficiency in the transportation of goods, and the appalling inadequacies to meet the demands of catastrophe or defense, should an atomic war come.[45]

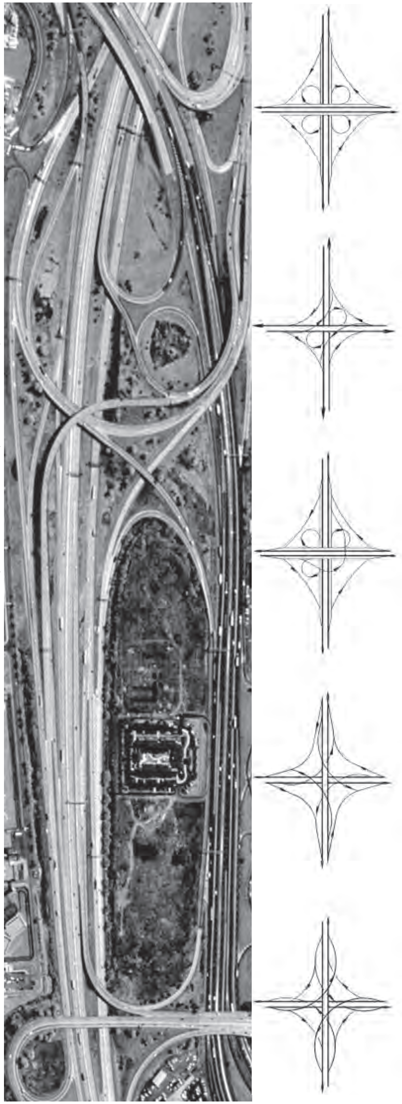
Eisenhower had apparently witnessed first-hand how smooth highway surfaces had been clear advantages to the Germans in World War II. Pre-war Germany claims, that construction of the Autobahn alone would rapidly invigorate their auto economy and also diminish unemployment, were quickly proven to be a gross understatement.[46] Conceived coincidentally six months before the Suez Canal Conflict, Eisenhower's 1956 National System of Interstate and Defense Highways is without a doubt the most significant, and perhaps most understated, public works project in the history of America.[47] Master planned as a national imperative conditioned on geographic accessibility, Eisenhower insisted that the system would recast the role of America:

> [T]he amount of concrete poured to form these roadways would build 80 Hoover Dams or six sidewalks to the moon…To build them, bulldozers and shovels would move enough dirt and rock to bury all of Connecticut two feet deep. More than any single action by the government since the end of the war, this one would change the face of America with straight-aways, cloverleaf turns, bridges and elongated parkways. Its impact on the American economy - the jobs it would produce in manufacturing and construction, the rural areas it would open up - was beyond calculation.[48]

Barriers

The effect of Eisenhower's diagram was exponential. The construction of the super-

Courtesy of The California department of Transportation, Division of Geometric Design, Sacarametno, CA.



Ensuing highway landscape of the "mixing bowl" interchange in Newark, New Jersey (left); Typical freeway-to-freeway interchanges (right)

highways propelled the United States into five decades of relentless motorization. With smoothness at a grand scale came speed. In less than fifty years, surface speeds had grown over 1000%, from 6 to 65 miles per hour. The geotechnical challenge of road-building was now solved, increasing traffic flows resulted in the foreseeable: governance of speed took the controls. As early as 1954, President Eisenhower described the paradox of speed and mobility during his July 12 Grand Plan speech:

There were 37,500 men, woman and children killed in traffic accidents last year, and those injured totaled another 1,300,000. This awful total presents a real crisis to America. As a humane nation, we must end this unnecessary toll. Property losses have reached a staggering total, and insurance costs have become a real burden.... Our first most apparent penalty is an annual death toll comparable to the casualties of a bloody war, beyond calculation in dollar terms. It approaches 40 thousand killed and exceeds one and three-tenths million injured annually.[49]

The first concrete median barrier used in New Jersey was installed in 1955, standing at only 18 inches tall. An expanded roadside edge, it looked like a low vertical wall with a curb on each side, functioning as a protective divider between opposite traffic flows. From operational observations rather than crash testing, the shape changed and evolved, increasing from 24 inches in 1932 and to 32 inches in 1959. Going upward from the horizontal, the first 2 inches from the pavement rose vertically, the next 10 inches at a 55-degree angle, and the remainder at an 84-degree angle.[50] With modern slip forming technologies, the commonly seen shape would be found almost everywhere in North America, now known as the Jersey barrier.[51]

Separations

Jersey barriers prevented collisions, but also prevented crossings. As soon as the u-turn disappeared, the 'jughandle' emerged. A spatial invention, this traffic device was conceived to allow unimpeded flow in a practically infinite number of directions, by simply raising the surface of a traffic lane over another. The premier engineering strategy, at grade separations were adopted wherever two roadways crossed or two transportation modes overlapped. Intended to prevent collisions and fatal accidents at grade, the jughandle evolved into a more standard, vertical format of the highway intersection known as the interchange, or the fly-over. Its most classical form, the four-way cloverleaf, allowed for non-stop flow between two high-volume roadways. Unless the interchange was congested, no stopping was required. The first cloverleaf was opened in New Jersey in 1929, on what are now US Interstate 1/9 and NJ State Highway 35. That typology has grown to infamous proportions with junctions on the New Jersey Turnpike such as the Merge, the Tri-Level Interchange and the Mixing Bowl.

Foreign Trade Zones

Urbanism's next obstacle was capacity. By 1995, ninety percent of the system had surpassed its designed life. Since the interstate highway system was built to accommodate twenty years of traffic growth for over 100 million people, the capacity of the system was severely overtaxed with a population nearing the 300 million mark in less than fifty years. To address urban congestion, mass transit and aging infrastructure, a series of surface transportation programs were enacted in the late twentieth century, such as the Intermodal Surface Transportation Efficiency Act in 1991 and Transportation Equity Act for the Twenty-First Century in 1998. By providing federal funds for state and local projects, the acts demonstrated the extricable bond between transportation and economies to maximize the capacity of existing transportation systems across the continent. The initiatives ranged in scale and in scope: new intermodal travel corridors such as the AirTrain projects established at Newark Liberty and John F. Kennedy International Airports by the New York/New Jersey Port Authority and new highway trade corridors were being forged with the implementation of the National Corridor Programs and the Coordinated Border Infrastructure Program between Mexico, the United States, and Canada by the North America's Superhighway Coalition. Reacting to the growing need for seamless circulation, these intermodal surface programs were synonymous with what Alex Wall refers to as "the reworking of movement corridors as new vessels of collective life".[53]

The accelerated development of "foreign trade zones" across the United States is a concurrent critical development that took place as a response to the needs for capacity and intermodality. Foreign Trade Zones are not considered part of the United States' customs territory. Within the zones, companies maintain inventories, factories, or assembling and manufacturing facilities and therefore may defer, reduce, or eliminate import duties. Decentralized and distributed, these zones signal the incubation of a synthetic infrastructure: a poly-modal system that fuses truck stops, train stations, harbours and airport terminals into one undifferentiated land mass of streets, roads, highways, railways, tunnels, shipping lines, and flight paths.

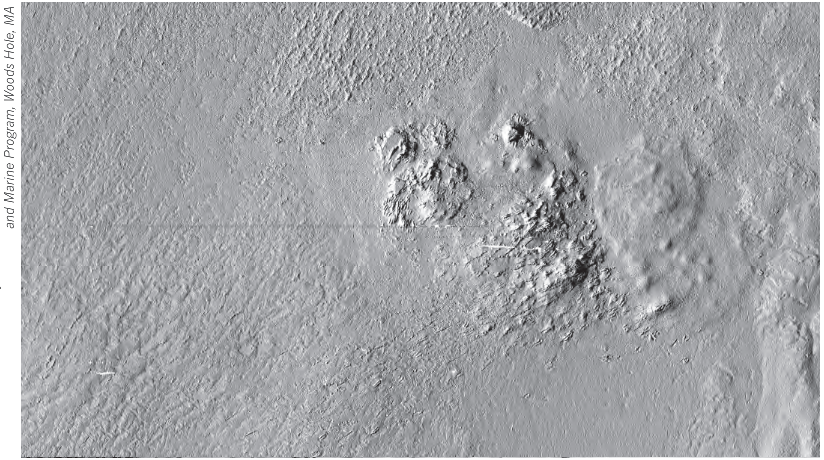
One of the most notable examples is Foreign Trade Zone No.49 (FTZ) in Newark, New Jersey. Located at the convergence of 7 major roadways, two of the busiest commercial airports in the world and the largest seaport in the Western Hemisphere, all linked by the New Jersey Turnpike - FTZ No. 49 stevedores over 7 billion dollars of cargo every year, and employs 80,000 people, making it the largest most active in the country, with Houston's FTZ No. 84 in close competition. The staging ground for courier companies like FEDEX and UPS, as well as luxury vehicle manufacturers like BMW and Mercedes, the proliferation of foreign trade zones is stunning: from 1950 onwards the number has increased from 5 to 243 across the United States, handling cargo by air, rail, truck and sea worth over 225 billion dollars. At almost 10,000-acres in size, the six foreign trade zones in the New Jersey/New York Metropolitan region are almost equal the size of Manhattan.[54] Once America's largest suburb, New Jersey has suddenly become its biggest warehouse.

Foreign-Trade Zone No. 49, New Jersey, 2003. Orthoimagery detail. Across from left: Newark Liberty International Airport (EWR) Terminal A; Pier 3, FedEx Cargo Bay; Runway 4L-22R; The Peripheral Ditch; New Jersey Turnpike; and Port Newark/Elizabeth Container Terminal New Jersey, USA, 2003

© 2005 , Earthworks LLC and Theoretical & Applied Geology.

Kill van Kull, Newark Bay: Three dimensional sonar image with draped stratigraphy showing depositional zones in the channel bottom. The protruding topography at the base illustrates the bedrock diabase outcroppings that are scheduled for removal by drilling and blasting.

Courtesy of The Woods Hole Field Center, USGS Coastal and Marine Program, Woods Hole, MA



Mud Dump: The 12 Mile Dumping Ground, now known as the Historic Area Remediation Site (HARS). Shaded relief of seafloor topography. (bottom)

Surface Pressure

The multiplying effect of Eisenhower's highway system did not simply end with the proliferation of multi-modal transportation. From the abundance of access networks on land emerged an unforeseen consequence 'off land'. With the advent of the North American Free Trade Agreement in the mid 1980s and the rapid increase in trans-Pacific trade during the 1990s, significant pressure was being placed on the surface capacity of port facilities of FTZ no.49.[55] Three million tons of cargos were being funneled through the Port of New York and New Jersey each year heading towards the richest consumer base in the world with a net worth of 80 billion dollars annually. Known as Atlantica, the trade network radiates from New York as far out as Illinois and Ontario reaching 80 million people lying within a 24-hour truck trip off the mid-Atlantic coast.

Mud & Silt

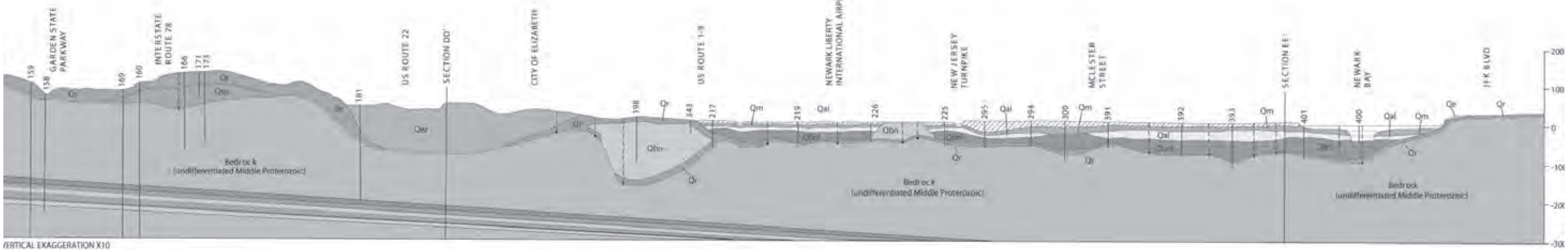
Squeezed in by a major inter-tidal system, the harbor's precarious situation is nothing new. Since the first recorded landing in New Amsterdam nearly three hundred years ago, port facilities have always contended with the pressure from upstream sediment flow that irreversibly fills the harbor's main shipping channels.[56] What differentiated the past from the present however, is the growing size of vessel drafts. At full capacity, Post-Panamax ocean freighters require clear channel depths of at least 15 meters, nearly double of the harbor's natural depth. With an annual depositional rate of 2 million cubic meters of mud and silt filling its harbor, port authorities were now bound by a material conundrum.

To resolve this pressure above and below the surface of its waters, the main administrative body of the harbor – the Port Authority of New York and New Jersey – embarked on a massive deepening project of its shipping channels for the rapidly growing fleet of Super-Post-Panamax deep-draft ocean freighters that were transforming international maritime trade.[57] Tripling channel depths from a 6-metre to an 18-metre mean low water level posed a unique logistical complexity.[58] Joseph Seebode, environmental engineer and chief of New York/New Jersey Harbor of the United States Army Corps of Engineers summarized the paradox in 2001: "Dredging the channels poses an environmental and engineering challenge. There's a lot of blasting, drilling, and dredging to be done, (but) all that material must to be disposed of."[59]

Dredging

Up until the early 1990s, dredging consisted in little more than digging and dumping. The United States Army Corps of Engineers made use of offshore sites for spoil materials within the vicinity of the Bight of New York for over 200 years and well in the early 1990s.[60] Sites known as the 12 Mile Dumping Ground were used for sewage waste, the Mud Dump for dredge sediment and the Cellar Dirt Dump for blasted rock from the New York subway system. Those operations came to a grinding halt at the end of the 1990s.[61] Triggered by what is referred to the 'Amphipod issue', the 1997 Ocean Dumping Act placed a unilateral ban on dumping of contaminated sediments in open waters.[62] Diminishing landfill space and skyrocketing landfilling costs on the East Coast near the turn of this century, exhausted all past practices engendering an important shift of in the operational sites and the material flows.

Authorized by the Water Resources Development Act, the Dredged Materials Management Program came to the rescue. Monumental in scale, the program aimed at a "superior industry-standard ocean access to accommodate the demand for international cargo through (the) region."[63] Boiling down to building underwater super highways, the program would effectively result in synthesizing port activities, environmental operations and urban land uses into one large cohesive landscape operation. Quantitatively, the first phase project required the dredging, re-processing and distribution of approximately 5 million cubic meters of mud, silt and sediment to a multitude of inland sites.[64] Logistically, the program entailed the mobilization of large pieces of equipment to safely remove large volumes of mud and silt from the shipping channels, dry docks, berths, public marinas of the harbor. With the centralized efforts of the New Jersey Depart-



Geological cross-section of Foreign Trade Zone No 49. From left: Garden State Parkway, Interstate Route 28; US Route 22; US Route I-9; Newark Liberty International Airport; The Peripheral Ditch; New Jersey Turnpike; McLester Street; DENJ Landfill; Jersey Gardens Shopping Center; Port Elizabeth marine Terminal; and Newark Bay (top).

Strategic placement sites of dredged material (bottom, right) including the HARS Mud Dump off the coast of New York, Bark Camp Mine in Pennsylvania, OENJ Landfill in Elizabeth (now the Jersey Gardens Mall), and the Meadowlands in New Jersey ; Hydrodynamic mesh, model of the dredging contract area in New York Harbor (bottom, left).

Courtesy of the US Army Corps of Engineers, and The Port Authority of New York and New Jersey

Photo by Captain Steve Nagiewicz, courtsey of njscuba.com

Diversion Strategies: Tipping of a 1962 Redbird rail car to enhance the Shark River Reef, 2003. To date, the New Jersey Artificial Reef Program has made use of 20 rail cars for the creation of fish havens and recreational dive sites (top); Shipping of dredged material from Newark Bay by rail, en route b truck to a pug mill for amendment near the Bark Camp abandoned coal mine in Pennsylvania, 2000 (bottom)

Courtesy New York/New Jersey Clean Ocean & Shore Trust

ment of Transportation, the Office of Maritime Resources and the U.S. Environmental Protection Agency, the Army Corps set out a diversion strategy and upland placement of the dredged materials from offshore dumping sites towards productive urban functions in the region of New York and New Jersey.[65] The dredging operations and the materials management program were therefore divided into 9 different contracts to be performed over the course of a decade.

Geotechnics

The sheer scale and magnitude of the operations is compelling.[66] Whereas the Central Artery Tunnel Project in Boston generated a mere 10 million cubic meters of overburden,[67] the Port Authority was now dealing with a geological volume of nearly 5 times that size, distributed over an equal period of time. What further differentiates these two regional situations is the finite aspect of the construction process in downtown Boston compared to the infinite process of sedimentary processes in Newark Bay. For the first phase of deepening projects in the Arthur Kill and the Kill van Kull in the Port of Newark/Elizabeth, the Army Corps of Engineers enlisted some of the largest dredging machines. The fleet of equipment was robust and versatile: three backhoe dredgers (the New York, the Tauracavor, and the Maricavor), two deep water drill boats (the Apache and the MB 301), and two clam shell diggers (the Michigan and the Bean II) operated by choice contractors like Great Lakes Dredge and Dock Company of Oak Brook, Illinois and Bean Stuyvesant Dredging from New Orleans, Louisiana.[68] Equipped with real-time kinematics technologies and global positioning systems, dredging operations were precisely undertaken on a non-stop 7 days a week, 12 hour a day rotation.

Diversion strategies soon followed the dredging operations. Coupled with sediment decontamination technologies like soil washing, photo-stabilization, cement binding and thermal destruction, the economies of scale offered by the program led to the recapitulation of a multitude of infrastructural landscapes[69] with an almost endless array of transformative land uses.[70] Most importantly, the geotechnical characterization of the 7 different types of materials - determined the logic of post-dredging use within closest possible proximity: red-brown clay towards subaqueous pit encapsulation, silt towards non-aquatic upland sites and the remaining bedrock (glacial till, serpentinite, diabase, sandstone and shale) towards artificial reef construction. Once the bane of the highway system, mud was by now resurfacing as a rather visible and transformative medium.[71] Five major disposal locations were specifically planned for the diversions as a final decisive result: the Historic Area Remediation Site (HARS, formerly the Mud Dump), the EN-CAP landfill, the Shark River Reef (Shark RR), the GATX or Port Reading or the National Lead site (GATX/PR/NL), and the Pennsylvania Mines and New York and New Jersey Quarries (PAM/NYQ/NJQ). Any overflow materials would then be diverted to a subsidiary site.

Site Manufacturing

With this consolidation, 200 acres of quarries across New Jersey – mostly from the Turnpike era - were encapsulated for surface reclamation,[72] embankments and spillways were constructed for geotechnical stabilization at the Newark Container Terminal,[73] and base courses were laid for highway expansion projects in Atlantic City in the past decade. The versatility of this strategy even spanned the boundaries of the state. Pennsylvania found use for 4 million cubic meters of amended mud and silt for the localized surface encapsulation of the Bark Camp abandoned coal mine[74] as well as laying the base course of a new 5,000 foot runway at the Philadelphia International Airport.

In total, over 42 million cubic meters of material are planned for the drilling, blasting, siphoning and dewatering of dredgeate from the harbor at a cost of just over 1 billion US

Terminal distances and driving times across Canada, US, and Mexico

dollars. Over the next decade between 1997 and 2005, estimates show that these operations will keep over 230,000 people working, while maintaining access for millions more.[75] With Pennsylvania's capacity to receive of over a billion cubic meters of material for its 365,000 abandoned coal mines, and the consolidated cost savings of over 100 million US dollars, the future 'mining' of mud as 'raw feed material seemed endless'. [76]

SYNTHESIS

Future projections are staggering. Over the next four decades, more than 10 billion dollars will be spent on over 200 deep-draft seaports to ship and process over 2 billion annual tons of cargo requiring the relocation of an estimated 2 billion cubic meters of dredged material at an annual bill of just over 2 billion US dollars. Enough material to bury the entire state of New Jersey, New York and Pennsylvania under a 1-meter thick layer of mud.[77] The prospects on land is no less dramatic. By 2006, the United States Federal Highway Administration will have spent over 100 billion dollars on highway infrastructure and will employ close to 28 million people, keeping 300 million Americans travelling more than 1 billion miles every year. Thirty years after Apollo 11's first lunar landing, the United States will have constructed 4 million miles of roadways and laid down enough asphalt to build a 100-lane expressway to and from the Moon. From the 7 mph Duryea Motor Wagon in 1896 to Noble's Thrust Supersonic Class 763.035 mph land speed record, the United States will have increased its surface speed by over 2000 percent in less than 100 years; fast enough to travel around the world in less than 2 days.[78]

In its century long search for unimpeded seamlessness, asphalt has therefore become more than a technological panacea. It has effectively become a binding agent whose flexible surface has spawned the growth of what can be called a bionic system - a synthesis of biological, mechanical and electronic resources[79] - that now spans the entire continent, reaching deep across the sea, the air and the ground effectively interlocking global commercial activities, regional transportation infrastructures and contemporary land uses.

Seen from space, the consolidated surface of North America looks less like a landlocked continent and much more like a borderless construction site. Its transportation network resembles a circulation diagram taken from the blueprint of an incomplete factory floor where the circuitry of highways and shipping channels functions as a load bearing mechanism and traffic as the surface grease: infinitely optimizing internal urban functions and seeking out new channels of distribution for new inventories of material and access to new sources of energy.[80]

From the sand pumping and asphalt paving operations that have led the construction of the transcontinental highway system, to the mud dredging and materials management operations of the deepening of New Jersey's seaport in the early 21st century, the coupling of transportation networks across north America with the reflexive mechanisms that support them and the topographies they generate, suggest the latent effectiveness of these synthetic surfaces. The contemporary, reciprocal project of landscape infrastructure and landscape urbanism suggests that ongoing attention to the seemingly banal surfaces of urban operation, from speed to synchronization, is a crucial critical task.

Endnotes

1. Alex Wall, "Programming the Urban Surface", in Recovering Landscape: Essays in Contemporary Landscape Architecture, James Corner, ed. (New York: Princeton Architectural Press, 1999), 238; Lewis Mumford, Technics & Civilization (New York: Harcourt, Brace & Company, 1934), 372.

2. Kevin Lynch strongly advocated for the organizational capacity of circulation systems, and their different constituent parts, throughout his career as author and practitioner. In Site Planning (Cambridge, MA: Massachusetts Institute of Technology, 1962), Lynch dedicates an entire chapter on systems of movement, establishing "access (as) a prerequisite to the usefulness of any block of space. Without the ability to enter, to leave, and move, within it, to receive and transmit information or goods, space is of no value, however vast or rich in resources. In one sense, a city is a communication net, made up of roads, paths, rails, pipes and wires. This system of flow is intimately related to the pattern of localized activities, or land use. The economic and cultural level of a city is roughly in proportion to the capacity of its circulation system…" (p.118). The recent recapitulation of the discourse on the organizational capacity of circulation systems is owed to two contemporary practitioners: Alex Wall and Keller Easterling. In Organization Space: Landscapes, Highways and Houses in America (Cambridge, MA: Massachusetts Institute of Technology, 1999), Easterling clearly articulates this latent capacity: "Generic spatial production, for instance, amplifies small adjustments by way of its own banality."(4)

3. Charles Waldheim was the first urbanist in North America to articulate this point of view with the formulation of 'landscape urbanism'. See Waldheim, "Landscape Urbanism: A Genealogy," in Praxis Journal 4 (2002): 4-17, and Waldheim's Landscape Urbanism conference at the Graham Foundation in Chicago (1997) and traveling exhibition mounted at the Storefront for Art and Architecture in New York (1997). See also Grahame Shane, "From Ford to Field: The Emergence of Landscape Urbanism" in this collection, and Julia Czerniak, "Challenging the Pictorial: Recent Landscape Practice," Assemblage 34 (1998): 110-120.

4. Stan Allen, "Mat Urbanism: The Thick 2-D," in Case: Le Corbusier's Venice Hospital and the Mat Building Revival, ed. Hashim Sarkis (Munich: Prestel / Harvard Design School, 2001), 118-126.

5. Alex Wall, "Programming the Urban Surface" in Recovering Landscape: Essays in Contemporary Landscape Architecture, James Corner, ed. (New York: Princeton Architectural Press, 1999), 221.

6. Stan Allen, "Mat Urbanism: The Thick 2-D," 124.

7. See Mirko Zardini ed., Triennale di Milano, Asfalto: Il Carattere Della Città / Asphalt: The Character of the City (Milan: Electa Editrice, 2003).

8. Jeffrey T. Schnapp, "Three Pieces of Apshalt," Grey Room, no. 11 (Spring 2003): 5-21.

9. Two distinct meanings of the term synthetic are employed in this article. In its first and more commonly understood use, synthetic references a state of substitution for a natural occurrence. Underpinning this article, the second meaning is broader in scope since it relates to synthesis, the process of the combination and the composition of different elements to form a whole or a complex of parts. The critical meaning of 'synthesis' is explored in depth by entomologist Edward O. Wilson in Consilience: Towards a Unity of Knowledge (New York: Knopf, 1998) which is based on Julian Huxley's Evolution: The Modern Synthesis (London: George Allen & Unwin, 1942). See Massimo Negrotti, Towards a General Theory of the Artificial (Exeter: Intellect, 1999) for a comprehensive distinction between the 'synthetic' from the 'artificial', the 'substitute' and the 'fake'.

10. See Maxwell G. Lay, Ways of the World: A History of the World's Roads and of the Vehicles that Used Them (New Brunswick, N.J.: Rutgers University Press, 1992), for an encyclopedic survey on how mud, dust, drainage, erosion, sediment and transport were central to the transformation of the North American landscape up until the early twentieth century.

11. The impact of speed – and accelerated forms of movement - on the contemporary landscape has produced two generations of researchers in the latter half of the twentieth century. Philosopher and architect Paul Virilio is one of the most notable proponents. In Vitesse et Politique / Speed & Politics: An Essay on Dromology (Paris: Éditions Galilée, 1977), Virilio is particularly instructive regarding the geo-political agency of paved surfaces: "Can asphalt be a territory? Is the bourgeois State and its power the street or in the street? Are its potential force and expanse in the places of intense circulation, on the path of rapid transportation?" (p. 4). Dr. Matthew T. Ciolek is another notable practitioner whose research involves the field of 'dromography' that involves the synthesis of geography, history and logistics of trade routes, transportation and communication networks. See Ciolek (1999), "Global Networking: A Timeline" (http://www.ciolek.com/PAPERS/milestones.html).

12. Henry Adams, History of the United States during the Administrations of Thomas Jefferson and James Madison (1889 – 1891), p.xx. By 1902, Adams withdrew from politics and converted to the amenities of an 18 horsepower Mercedes-Benz, he spent more and more time away from Washington; instead, he explored France in his new motor car. Expressed at the end of the 18th century, Henry Adams' ideals are a premonition of the future: "My idea of paradise is a perfect automobile going thirty miles an hour on a smooth road to a twelfth-century cathedral."

13. Isaac B. Potter, "The Gospel of the Good Roads: A Letter to the American Farmer from the League of American Wheelman" in Manufacturer & Builder 23 (New York: Western and Company, 1891), 1.

14. Frost action refers to the cyclical process of freezing and thawing in soils. Freezing produces frost heaves, which lift up the surface layers of the soil or the pavement. The heaves are caused by the growth of ice lenses between the soil particles. See Alfreds R. Jumikis, Thermal Soil Mechanics (New Brunswick, N.J.: Rutgers University Press, 1966), 3-4. For this reason, wood – an orthotropic material - was the primary building material throughout the continent for bridges and railroads. "Wood was a desirable construction material for several reasons. It is a renewable resource that is resistant to the effects of deicing agents and can sustain substantially higher loads over a short period of time. It is lightweight and easier to fabricate and construct, and it can be constructed in any type of weather without affecting the material." See Robert Fletcher and Jonathan Parker Snow, "Paper No.186: A History of the Development of Wooden Bridges," in Proceedings of the American Society of Civil Engineers 60 (1934).

15. Charles Goodyear, "Improvement in India-Rubber Fabrics" in United States Patent No. 3,663 (New York, N.Y.: June 15, 1844): 1-2.

16. Asphalt is not to be confused with coal tar. Asphalt is a highly viscous liquid that occurs naturally in most crude petroleum. Asphalt is separated from the other components in crude oils (such as naphta, gasoline and diesel) by the process of fractional distillation. It is sometimes confused with tar, which is an artificial material produced by the destructive distillation of organic matter. Both tars and asphalts are classified as bitumens, a classification that includes all materials entirely soluble in carbon disulphide. A known carcinogenic, coal tar or "pitch", was gradually phased out of the road building industry in mid-century, as the petroleum industry made refined asphalts more available. Coal tar is still commonly used for as a waterproofing agent for roofs. See The Apshalt Handbook (Lexington, Kentucky: The Asphalt Institute, 1947).

17 More than the wheel, Robert Leibensperger attributes the growth of the north American mechanical industry to the emergence of tribology, the science that deals with the design, friction, wear, and lubrication of interacting surfaces in relative motion, such as bearings and gears. See Leibensperger, "The Conquest of Friction" (Mechanical Engineering, November 2003).

18. Jeffrey T. Schnapp, "Three Pieces of Apshalt," in Grey Room 11 (2003): 5-21.

19. Previous innovations were developed by Thomas Metcalfe and John Loudon Macadam using a variety of aggregates and physical shapes to determine the most effective morphology for building dry roads. The most critical one deals with raising the surface through "crowning", creating positive drainage and ensuring dryness. See Irving Brinton Holley, "Blacktop: How Asphalt Paving Came to the Urban United States" in Technology and Culture 44 (2003): 703-733.

20. See Edward Joseph De Smedt, "The Origins of American Asphalt Pavements," in Paving and Municipal Engineering 5 (December 1879): 251.

21. John Loudon Macadam wrote extensively on his findings. An extensive description of his work can be found in his "Remarks on the Present System of Road-Making" (1816) and "Practical Essay on the Scientific Repair and Preservation of Roads" (1819). In contrast, Thomas Metcalfe's discoveries possessed a special advantage that granted him greater freedom to experiment with material coarseness and densities: he was blind.

22. See Edward Joseph De Smedt, "Improvement in Laying Asphalt or Concrete Pavements or Roads", United States Patent No. 103,581 (New York, N.Y.: May 31, 1870): 1.

23. The 1916 Federal Highway Administration empowered each state with a highway agency and a team of engineering professionals to carry out federal-aid highway projects.

24. See Hugh Gillespie, A Century of Progress: The History of Hot Mix Asphalt (Lanham, MD: National Asphalt Pavement Association, 1992).

25. On the order of Thomas Jefferson, Meriwether Lewis and William Clark led an expedition to survey natural resources and water courses across the American North West for transportation and communication purposes. Their 1804-1806 expedition led to a succession of 4 major surveys of the American West later giving birth to the United States Geological Survey in 1879. See U.S. Geological Survey - U.S. Department of the Interior, "From Lewis and Clark to the U.S. Geological Survey", http://www.usgs.gov/features/lewisandclark/LC_USGS.html (accessed February 3, 2005).

26. Captain William C. Greaney - Expeditionary Adjutant & Statistical Officer of the Transcontinental Convoy, "Principal Facts Concerning the First Transcontinental Army Motor Transport Expedition, Washington to San Francisco, July 7 to September 6, 1919". Dwight D. Eisenhower Archives.

27. See Joyce N. Ritter, The History of Highways and Statistics, U.S. Department of Highway Administration (1994) and United States Bureau of Public Roads, Highway Statistics: Summary To 1955 (U.S. Government Printing Office, 1957).

28. Dwight D. Eisenhower, At Ease: Through Darkest America with Truck and Tank (New York: Doubleday & Company, 1967) pp. 166-167.

29. Although more durable, concrete paving was overcome by the asphalt industry due to its cost effectiveness, homogeneity and construction speed. The use of concrete made a major comeback with the advent of slipforming technologies in the 1970s.

30. Eric Larrabee, "The Six Thousand Houses That Levitt Built" in Harper's 197 (1948): 79-83.

31. The multiplying effect of highways and the motorization of transport vehicles radically changed the freight-moving industry. In the early 1900s, Dan Tobin recognized this trend and set out to organize the fast growing motorized truck delivery and warehousing industry with the country's largest union, known today as the International Brotherhood of Teamsters. See "The Teamster Century" (http://www.teamster.org/about/history.htm)

32. As a passenger-pooling strategy, the first intercity buses were introduced in the early 1920s. The buses were dubbed "greyhounds" because of their gray paint and streamline appearance. See Larry Plachno, "Greyhound Buses Through the Years" in National Bus Trader (2002): 17-24.

33. The Good Roads Movement was ironically founded by a bicyclist in 1902; a period when bicycles were hated as much as automobiles. President of the American League of Wheelmen, Horatio Earle also co-founded the American Road & Transportation Builders Association. See Horatio Sawyer Earle, The Autobiography of 'By-Gum' Earle (The State Review Publishing Company, 1929).

34. Henry Ford was infatuated with the process of synthesis. One of his major innovations was a direct result of it. By deciding not to attach an engine to an existing carriage, he constructed a four-wheel body based on the principles of bicycle manufacturing, making a quadricycle. The combination of different components synthesized a new whole, effectively resulting in the invention of the motor-car. See Henry Ford, "Motor-Carriage" in United States Patent No. 686,046 (Detroit, MI.: November 5, 1901): 1-2.

35. In the Cement and Concrete Reference Guide (Washington, D.C.: The Portland Cement Association, 1997), the Portland Cement Association reports "newer, more refined developments with concrete emerged during this period while the Portland concrete cement for the Pennsylvania Turnpike Authority. However, it was found that scaling and flaking of the surface of concrete pavements occurred with freeze/thaw cycles and de-icing agents. The studies showed that the introduction of tiny air bubbles in the concrete mix could reduce the problem. This led to the development of air-entrained concrete, now used in virtually all U.S. road building. [...] The invention of the slip-form paver in 1949 was another milestone in the development of concrete paving technology, as it allowed road crews to place wide sections of concrete continuously, and therefore far more efficiently than before. Slip-forming is now used for highway paving projects in almost every state".

36. Caption, 1949 New Jersey Turnpike Map, New Jersey Turnpike Authority.

37. One of the largest quarries to supply the construction of the New Jersey Turnpike was owned by Passaic Crushed Stone in northern New Jersey. In operation since the beginning of the interstate system in 1956, it yields over 1 million tons of aggregate annually. Passaic Crushed Stone, the last large productive quarries in the county owned by Tilcon, is located in the Highlands, a geological formation predominantly underlain by granite and gneiss of the Precambrian age, the oldest rock formation in New Jersey formed 1.3 billion and 750 million years ago. Granites and gneisses are excellent aggregates for hot mix asphalt and concrete mixtures.

38. Chief Engineer of the Asphalt Institute, Vaughan Marker provides an in-depth perspective on the developments of the pavement industry over the past fifty years in Dwight Walker, "A Conversation with Vaughan Marker', Asphalt Magazine (Summer 2002): 20-25.

39. See DPR, "Operation Sand", New Jersey Turnpike Authority - Press Release, Department of Public Records (Trenton, N.J.: October 12, 1950):1. For a broader explanation of the 300 year old unbroken trend of the perception of marshlands as wastelands, a perception that is widely reversed today, see William Cronon, "Modes of Prophecy and Production: Placing Nature in History. Journal of American History, 76, 1121–1131.

40. See Paul J. C. Friedlander, "High Road from the Hudson to the Delaware", The New York Times (25 November 1951).

41. The geometry of interstate highways is essentially based on a theoretical design speed standard made visible by three main characteristics: flatter horizontal curves, longer vertical curves and greater sight distances.

42. See DPR, "Construction Progress Updates", New Jersey Turnpike Authority - Press Release, Department of Public Records (Trenton, N.J.: November 12, 1956):1.

43. In 1969, a similar circumstance ensued "in Pennsylvania, when the state highway department, used its own reference points on each side of a river, instead of the Geodetic Survey's; construction of a bridge started from each shore, and in midstream the two sections were four metres apart." See John Noble Wilford, The Mapmakers (New York: Vintage Books, 2001), 356.

44. Dwight D. Eisenhower, "Message to the Congress re Highways", (Abilene, Kansas: Dwight D. Eisenhower National Presidential Library Archives, February 22, 1955), 1. and Richard F. Weingroff, America's Highways 1776-1976, (Washington, D.C.: Federal Highway Administration, 1976).

45. Vice-President Richard M. Nixon citing Eisenhower. Eisenhower, Dwight D. "Telegram To Richard Milhous Nixon, 12 July 1954", The Papers of Dwight David Eisenhower, Doc. 976, World Wide Web Facsimile, The Dwight D. Eisenhower Memorial Commission (Baltimore, MD: The Johns Hopkins University Press, 1996) http://www.eisenhowermemorial.org/presidential-papers/first-term/documents/976.cfm (accessed July 1, 2004)

46. There are diverging accounts of the geographic and the economic benefits of the German highway system during the middle of the twentieth century. See Eckhard Gruber and Erhard Schütz, Mythos Reichsautobahn, Bau und Inszenierung der "Straße des Führers 1933-1941 (Berlin: Ch. Links Verlag, 1996) for a compelling interpretation of German military highway infrastructure as tactical propaganda.

47. Jacqueline Tatom investigates this idea further in her essay "Urban Highways and the Reluctant Public Realm," in this collection.

48. Dwight D. Eisenhower, Mandate for Change 1953-1956 (New York: Doubleday, 1963), 548-549.

49. Dwight D. Eisenhower. "July 12 1954 Speech", delivered by Vice-President Richard M. Nixon to the Nation's Governors. This speech was given only three months after his famous Domino Theory Speech on April 7, 1954 which discussed the effects of atomic energy research and the arms race. See Richard F. Weingroff, President Dwight D. Eisenhower and the Federal Role in Highway Safety, Washington, D.C.: Federal Highway Administration, 2003).

50. The geometrical objective of the New Jersey profile is to redirect a vehicle upon impact and minimize damage to its wheels and car body. See Charles F. McDevitt, "Basics of Concrete Barriers: concrete barriers appear to be simple, but in reality, they are sophisticated safety devices" in Public Roads Magazine 5 (March/April 2000). Another innovation in the configuration of the road surface was the "suicide lane". In the 1920s and 30s, roads were built with three lanes: one lane for each direction and a shared middle lane for passing vehicles in both directions. This presented the very real possibility of head-on collision. The concept behind this lane is similar to the dashed yellow line found on two-lane highways, which permits passing. Suicide lanes were finally phased out by the 1960s, with the roadways being widened to full four lanes or more.

51. Left-hand turn islands and safety islands are more commonly found in urban areas since the 1930s.

52. Foreign Trade Zones are not considered part of the United States' customs territory. Within the zones, companies maintain inventories, factories, or assembling and manufacturing facilities and therefore may defer, reduce or eliminate import duties. See Foreign Trade Zone Manual (U.S. Customs Service, 2004).

53. Alex Wall, "Programming the Urban Surface", 234.

54. "Foreign Trade Zone No. 49 Fact Sheet", The Port Authority of New York / New Jersey (2004):1-2.

55.See Eric Lipton, "New York Port Hums Again With Asian Trade", The New York Times (November 22, 2004).

56. The average depth of the Port Elizabeth and Newark harbour is 6 metres. The Port District of New York and New Jersey comprises the Hudson River to Croton Bay, the Upper Bay, the East River, the western end of Long Island Sound, Newark Bay, the tidal Passaic and Hackensack Rivers, the Kill van Kull, the Arthur Kill, Lower Bay (to the Rockaway-Sandy Hook transect) and the tidal Raritan River (Source: The Port Authority of New York and New Jersey).

57. The beam length of Post-Panamax and Super-Post-Panamax ships exceeds the maximum allowable width of 32.3 meters of the Panama Canal. These ships navigate the Suez Canal for transoceanic shipping. In the Port of New York and New Jersey deep-draft ships currently operate at 75% of their capacity due to the shallowness of the waters resulting in significant losses for both the sea liners and the ports. See Drewry Shipping Consultants, Post-Panamax Containerships - The Next Generation (London, 2001).

58. See Andrew C. Revkin, "Shallow Waters: A Special Report - Curbs On Silt Disposal Threaten Port Of New York As Ships Grow Larger", The New York Times, (March 18, 1996): A1.

59. Joseph Seebode, Chief of the New York/New Jersey Harbor Programs Branch for the Army Corps of Engineers in Gayle Ehrenman, "Digging Deeper in New York", Mechanical Engineering (November 2003).

60. Dredged material is mostly sediment that has settled into waterways through natural erosion and depositional processes. Sediment can be divided into several geologic types: sand and gravel, silt and clay and glacial till and rock (Source: New Jersey Department of Transportation – Maritime Resources). Its dark green to black colour oringates from the diabase rock that underlies in the upper reaches of the harbor, part of what is known as the Newark Supergroup basins that trail along the coastal reaches of north America. See Paul E. Olsen & Robert E. Weems, "Synthesis and Revision of Groups within the Newark Supergroup, Eastern North America, The Geological Society of America Bulletin 2 Vol. 109 (February 1997): 195-209.

61. Since the 1970s, The New York District of the USACE and the US EPA selected an underwater site about 10 km off Sandy Hook in NJ at the mouth of the Hudson Canyon in the Bight of New York. This 6.5 km area, affectionately known as "the Mud Dump", became the sole repository of dredged material for the next 30 years.

62. Amphipods are crustaceans used as bio-indicators for heavy metals in marine environments. See Miller Associates, "Dredging - The Invisible Crisis", CQD Journal for the Maritime Environment Industry 1 (January 1996) http://www.cqdjournal.com/html/env__2_1.htm (accessed March 11, 2005)

63. "Channel & Berth Deepening Fact Sheet", The Port Authority of New York and New Jersey (March 2005): 1.

64. USACE NY District. "Beneficial Uses of Dredged Material" http://www.nan.usace.army.mil/business/prjlinks/dmmp/benefic/habitat.htm

65. The State of New Jersey has a long-standing tradition in the effective relocation of residual materials for productive renewed uses. Over the past two decades, the New Jersey Artificial Reef Program has created a vast repository of aquatic havens, fishing reefs and recreational diving sites with the safe disposal of over consolidated material including 130 military vessels and 250 subway cars off the coastline of New Jersey. See New Jersey Department of Environmental Protection - Division of Fish and Wildlife, "Study Reveals Reefs Enhance New Jersey's Marine Environment", New Jersey Reef News (2000): 1-4, and "State Deploys Decommissioned Subway Cars" In Artificial Reefs: Final Round Of 50 Cars Splashed At Shark River Reef Site, New Jersey Department Of Environmental Protection News Release (October 14, 2003)

66. Dredging primarily consists in two activities: removal of sediment material from sea channel bottoms and management of that material for constructive purposes. See W. Scott Douglas, "The Use of Sediment Decontamination Technologies for the Management of Navigational Dredged Materials" (Newark, NJ: Maritime Resources Program - Society of American Military Engineers Society of American Military Engineers (November 20, 2002).

67. Excavated material from the Central Artery Tunnel Project was re-located for the surface remediation of Spectacle Island, a former landfill, while the rest was trucked to surrounding inland sites for encapsulation and surface remediation. The surface of three adjoining landfills - formerly the granite quarries for building and me-

morial construction in since the early 1800s - were re-profiled into a major recreational complex. Now part of the 7000-acre Blue Hills Reservation, a segment of the Boston Metropolitan Parks System, founded in1893.69 These reconstituted surfaces and their new topographic configurations essentially signaled the synthesis of complex infrastructural logistics, material transactions and large urban operations.

68. See USACE, "World's largest fleet of machinery working in New York/New Jersey Harbor", U.S. Army Corps of Engineers Fact Sheet (January 2003): 1.

69. See Elizabeth Mossop, "Landscapes of Infrastructure", in this collection.

70. See USACE, "Dredged Material Management Plan for the Port of New York and New Jersey,Implementation Report" (New York: NY District U.S. Army Corps of Engineers, NY District, New York, NY, 1997).

71.The amendment of dredgeate with Portland cement and coal ash yields three benefits: it binds contaminants to sediment particles, removes excess water and improves the structural characteristics of silt and clay particles.

72. See USACE, "Dredged Material Management Plan for the Port of New York and New Jersey", U.S. Army Corps of Engineers Fact Sheet (June 2005):1.

73. The New Jersey Department of Transportation Berm Project is a case in point. "The project involved the design, construction and evaluation of two model embankments built entirely from 50,000 cubic meters of sediment dredged from the Union Dry Dock in Hoboken. The dredged material was stabilized to form a soil-like matrix utilizing 8-12 percent Portland Cement." See Sadat Associates, "Use Of Dredged Materials For The Construction Of Roadway Embankments" Vol. I-V (Newark, N.J.: New Jersey Department of Transportation, December, 2001): 1-1465.

74. See Joseph McCann "Scrap Exporter's Expansion Solves Environment Problem", American Metal Market (Sept 27, 2001). Surface encapsulation of mine sites in Pennsylvania involves the reengineering of topography for four reasons: the effective control of drainage, the creation of vegetal micro-sites, the improvement of accessibility, and the elimination of exposure from sulfur-bearing rock to the elements, which has been shown to cause acid runoff. See "The Use of Dredge Materials in Abandoned Mine Reclamation Final Report on the Bark Camp Demonstration Project" (Newark, N.J.: New York / New Jersey Clean Ocean And Shore Trust Pennsylvania, Department of Environmental Protection, Bureau of Abandoned Mine Reclamation Bureau of Land Recycling and Waste Management, 2001): 1-57. Alan Berger discusses the emerging networks of space recoverable from ongoing processes of deindustrialization in greater depth. See Allen Berger, "Drosscapes", in this collection.

75. See USACE NY District, "U.S. Army Corps of Engineers and Port Authority of N.Y. and N.J. start $79 Million Deepening Project - Investments Build Underwater Super Highways in Port of New York and New Jersey", Press Release (April 28, 2005).

76. The project of post-industrial remediation is divided into two main practices. On the one hand, there are practitioners of site-level remediation that rely on measures of inward looking strategies of spatial beautification or surface concealment, employing renderings and property plans aimed solely at visualizing the immediate or short term benefits of design. The other, perhaps more informative practice, lies with regional-scale materials management strategies resulting from logistical, environmental, social and financial complexities. Usually associated with a distribution of sites, in varying sizes and conditions, with a higher magnitude of complexity. These sites often involve the synthesis of regional transportation infrastructures and ecosystems where strategies must rely on incremental transformation, broader physical impacts and long term effects. See Niall Kirkwood, Manufactured Sites: Rethinking the Post-Industrial Landscape (London: Spon Press, 1991). The case of the Dredged Consolidated Materials Management Program at the scale of the mid-Atlantic Region points towards the potential effectiveness of this broader strategy, which simultaneously relies on a border time-scale. Initiated by the U.S. Army Corps of Engineers and the Port of New York and New Jersey as several other environmental agencies with multi-disciplinary experts, the overall financial savings balanced by net ecological and social gains, suggests an intelligent strategy for large, complex and open-ended projects. Recently, James Corner has referred to this strategy as 'design intelligence' which offers the potential to unlock and seize "opportunism and risk-taking" in contemporary landscape practice. See James Corner, "Not Unlike Life Itself: Landscape Strategy Now" in Harvard Design Magazine 21 (Fall/Winter 2004): 32-34, and James Corner, "Terra Fluxus" in this collection.

77. Based on facts and figures from the following sources: Committee on Contaminated Marine Sediments, Marine Board, Commission on Engineering And Technical Systems, National Research Council. "Contaminated Sediments In Ports And Waterways - Cleanup Strategies And Technologies" (Washington, D.C.: National Academy Press, 1997): 20, and American Association of Port Authorities & Maritime Administration, "The North American Port Container Traffic – 2003 Port Industry Statistics" & "United States Port Development Expenditure Report" (U.S. Department Of Transportation May 2004).

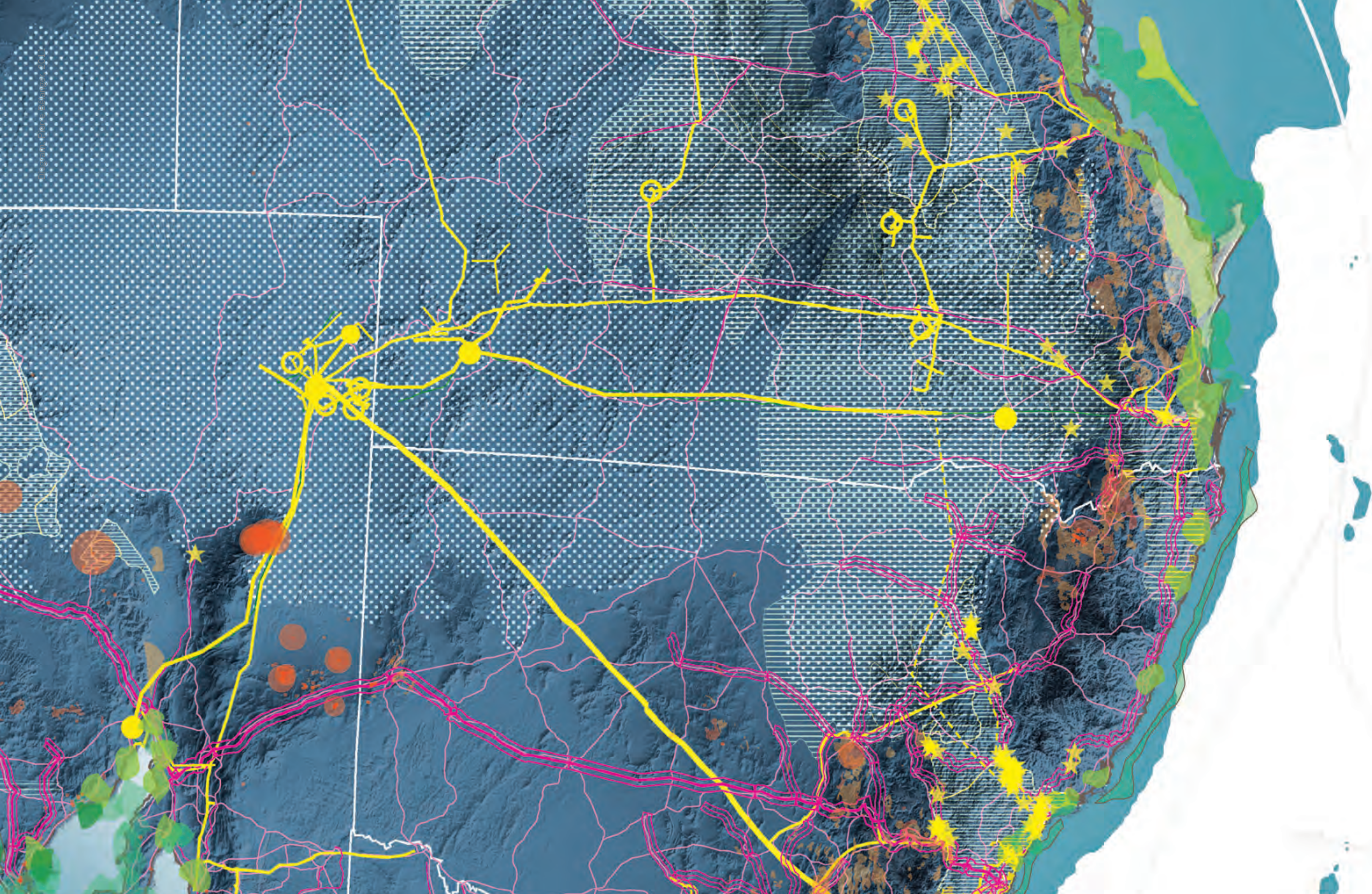
78. See Pierre Bélanger & Dennis Lago, "Highway Surface: A Brief History of the United States Interstate & Defense Highway System" in Mobility: A Room with a View, Francine Houben & Luisa Calabrese, eds. (NAI Publishers: Rotterdam, 2003), 409.

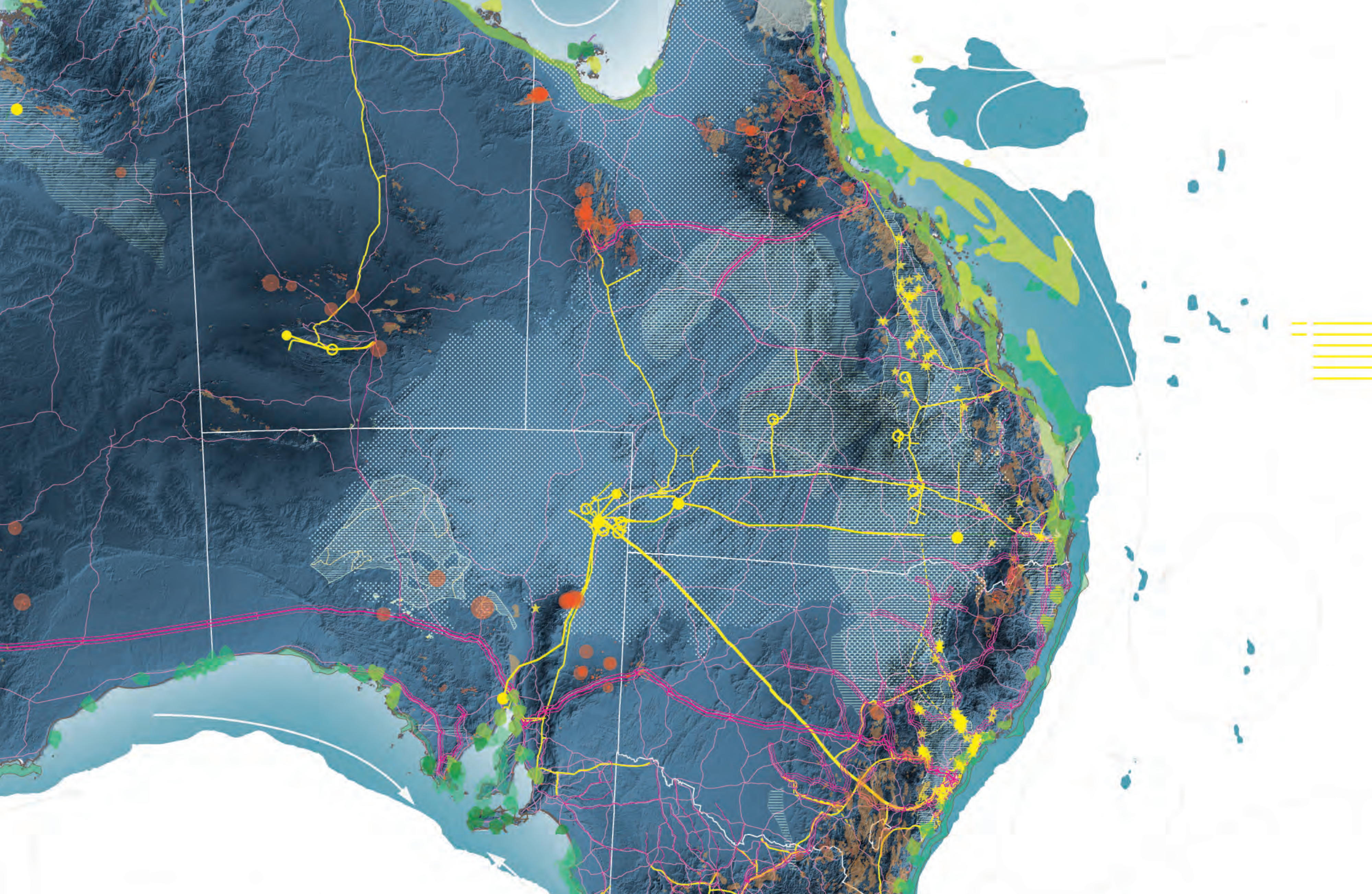
79. John Brinkerhoff Jackson was an early proponent of landscape as a fusion of different environmental, cultural and urban systems. In "The Public Landscape (1966)" he formulates the idea of an 'environmental megastructure' to synthesize this condition. See Landscapes: Selected Writings of J.B. Jackson, Ervin H. Zube, ed. (Amherst, MA: The University of Massachusetts Press, 1970), 153-160. Jackson's idea responding to the failure of the Megastructures Movement in the field of architecture and urban design at the end of the 1960s, a movement comprehensively inventoried by Reyner Banham in Megastructure: Urban Futures of the Recent Past (London: Thames & Hudson, 1976).

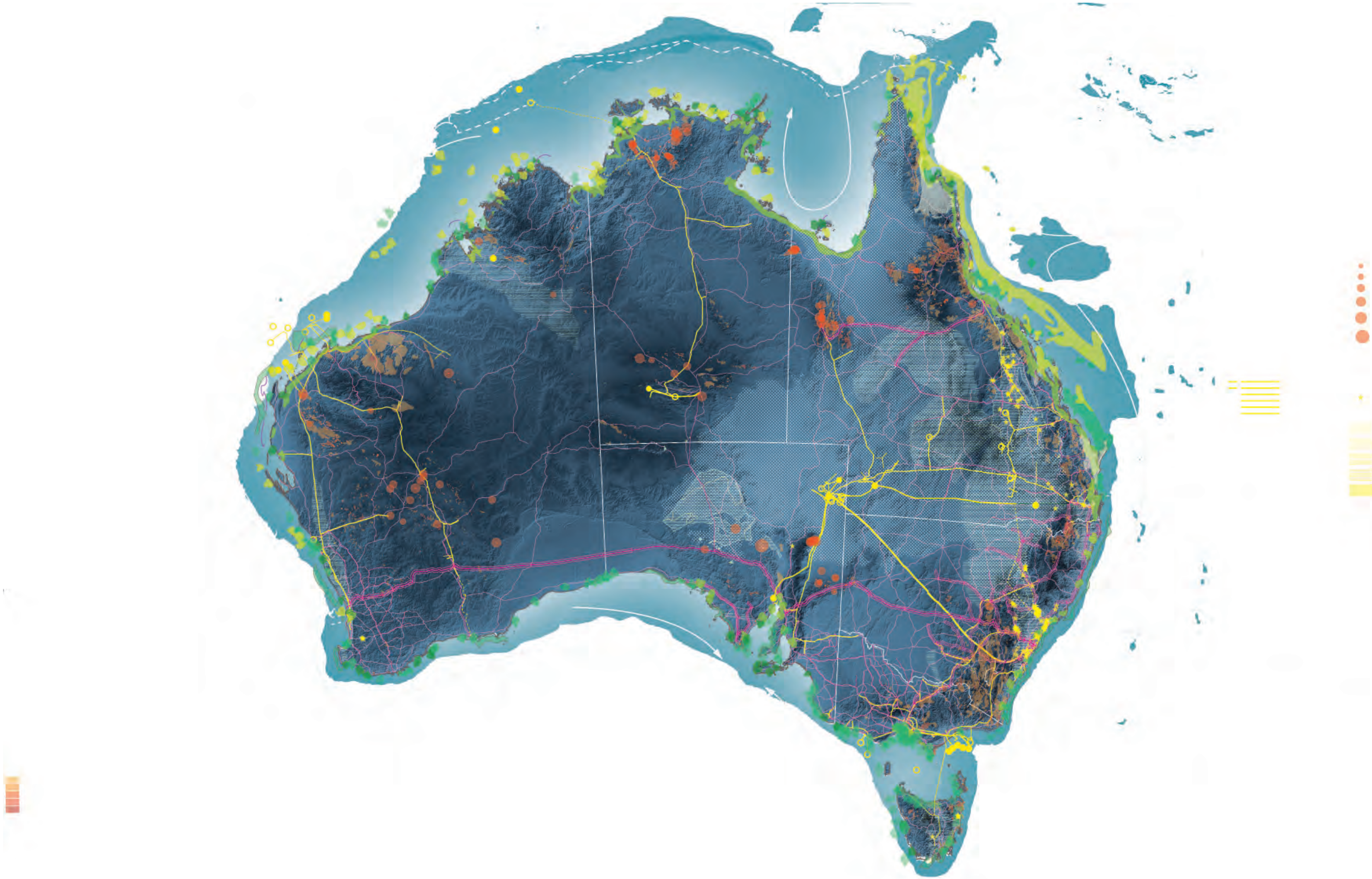
80. Clare Lyster investigates this process in greater depth in her essay "Landscapes of Exchange", in this collection. In "Programming the Urban Surface" (238), Alex Wall is again instructive: "The importance of mobility and access in the contemporary metropolis brings to infrastructure the character of collective space. Transportation infrastructure is less a self-sufficient service element than an extremely visible and effective instrument in creating new networks and relationships".

Originally published in The Landscape Urbanism Reader, *edited by Charles Waldheim (New York: Princeton Architectural Press, 2007): 239-265.*

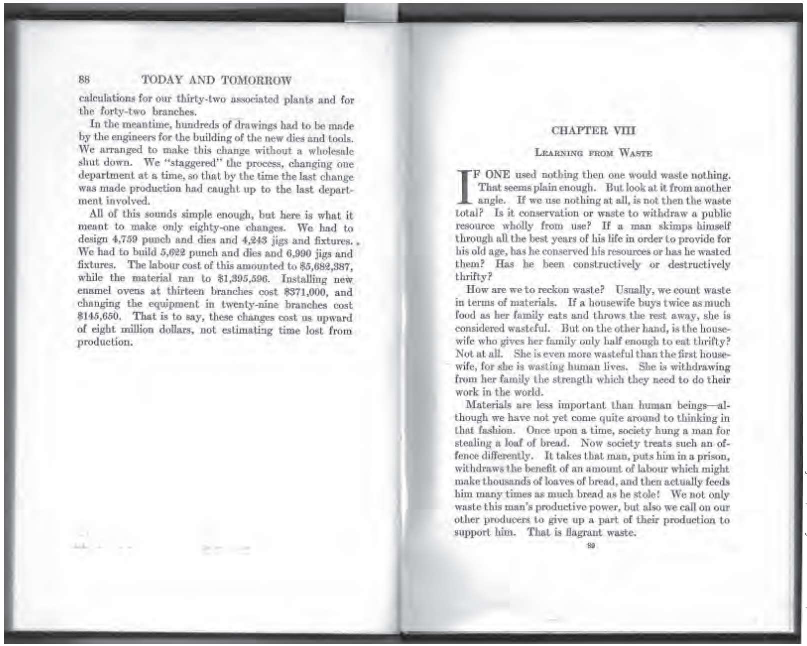
>
Tropicalization
Projecting the Resources, Climates and infrastructures of the Australian Continent for the Next Urban Century as Australia becomes tropical and undergoes a series of changes including rising sea levels and increasing frequencies of drought. The moderate climate that cities like Sydney have enjoyed during the past two centuries is rapidly shifting from the inherited temperate urbanism of its European forbearers to a dynamic, subtropical urbanism in the next century.







Landscape of Disassembly.



88 TODAY AND TOMORROW

calculations for our thirty-two associated plants and for the forty-two branches.

In the meantime, hundreds of drawings had to be made by the engineers for the building of the new dies and tools. We arranged to make this change without a wholesale shut down. We "staggered" the process, changing one department at a time, so that by the time the last change was made production had caught up to the last department involved.

All of this sounds simple enough, but here is what it meant to make only eighty-one changes. We had to design 4,759 punch and dies and 4,243 jigs and fixtures. We had to build 5,622 punch and dies and 6,990 jigs and fixtures. The labour cost of this amounted to $5,682,387, while the material ran to $1,395,596. Installing new enamel ovens at thirteen branches cost $371,000, and changing the equipment in twenty-nine branches cost $145,650. That is to say, these changes cost us upward of eight million dollars, not estimating time lost from production.

CHAPTER VIII

LEARNING FROM WASTE

IF ONE used nothing then one would waste nothing. That seems plain enough. But look at it from another angle. If we use nothing at all, is not then the waste total? Is it conservation or waste to withdraw a public resource wholly from use? If a man skimps himself through all the best years of his life in order to provide for his old age, has he conserved his resources or has he wasted them? Has he been constructively or destructively thrifty?

How are we to reckon waste? Usually, we count waste in terms of materials. If a housewife buys twice as much food as her family eats and throws the rest away, she is considered wasteful. But on the other hand, is the housewife who gives her family only half enough to eat thrifty? Not at all. She is even more wasteful than the first housewife, for she is wasting human lives. She is withdrawing from her family the strength which they need to do their work in the world.

Materials are less important than human beings—although we have not yet come quite around to thinking in that fashion. Once upon a time, society hung a man for stealing a loaf of bread. Now society treats such an offence differently. It takes that man, puts him in a prison, withdraws the benefit of an amount of labour which might make thousands of loaves of bread, and then actually feeds him many times as much bread as he stole! We not only waste this man's productive power, but also we call on our other producers to give up a part of their production to support him. That is flagrant waste.

89

Henry Ford, Today & Tomorrow, 1926

"Picking up and reclaiming the scrap left over after production is a public service, but planning so that there will be no scrap is a higher public service."

Henry Ford, *Learning from Waste*, 1926[1]

"the real problem in waste utilization is more economic than technical. Many wastes do not occur in sufficient quantity at any one spot to make their use possible, or the cost of collection and storage defeats the project."

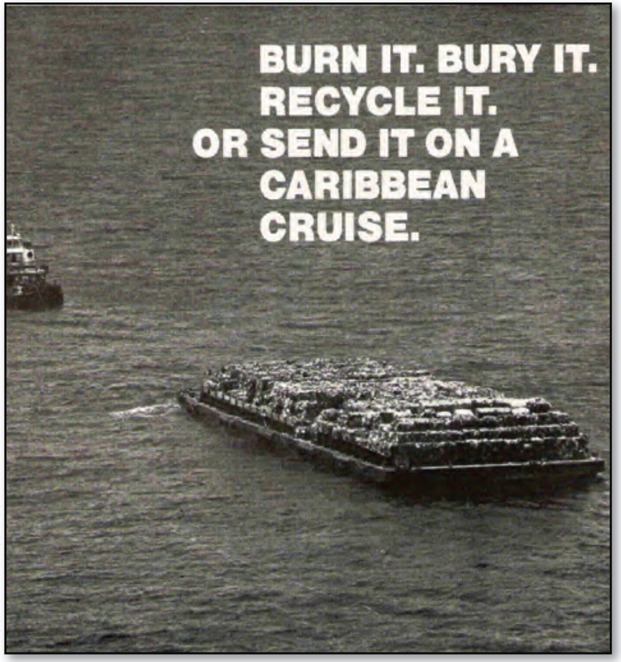
Harrison E. Howe, *Possibilities in Saving and Utilizing Industrial Wastes*, 1919

"Business is on the verge of a transformation, a change brought on by social and biological forces that can no longer be ignored or put aside, a change so thorough and sweeping that in the decades to come business will be unrecognizable when compared to the commercial institutions of today."

Paul Hawken, *The Ecology of Commerce*, 1993[2]

As the 20th century recently came to a close, a decisive transformation in environmental attitudes has occurred in fields ranging from business and economics to real estate and land development. Heightened by the pressures of globalization, this shift is principally the result of the convergence of economic and ecological imperatives towards closing the material loop in what are now known as circulation economies. From this level playing field is emerging the design of new industries, new organizations and new manufacturing processes are essentially focusing on producing more and more, with less and less. This shift has spawned a series of developments and practices that have been focusing on three underlying strategies to jumpstart the post-industrial economy of the 21st century: the dematerialization of waste, the utilization of brownfields and the generation of urban ecologies.[3]

One of the most notable advances, and one of the most promising, is the emergence of new waste ecologies forming on the peripheries of large metropolitan agglomerations, that are uniquely centered on the recycling of waste. Critically re-evaluating the underdeveloped relationship between waste, ecology and urbanism,[4] the following text proposes how a new landscape of disassembly is catalyzing the birth of novel ecologies in major urban agglomerations in different contexts and continents to discuss the significance of circular economies for city planners, citizen organizations, community entrepreneurs and city builders at large.[5]



Waste Streams

In 1987, a barge piled with 3,168 tons of garbage from a small town named Islip in New York, began a 162-day, 6,000-mile search for a port willing to dump its load. Barging its way into the media spotlight from North Carolina, Louisiana, Mexico, the Bahamas and Belize, the Mobro 4000, as is was named, eventually circled back to New York, dejected by a total of six states and three countries.[6] The garbage was finally (and controversially) incinerated in Brooklyn. Since the 1960s, New York City has faced a local, disposal crisis. All but one of the eleven incinerators and six landfills that serviced the city had shut down by the early 1990s. By then, the crisis had proven that centralized systems of planning and engineering had reached a tipping point and could no longer deal with the magnitude and complexity of urban waste streams in big cities. Fueling this crisis were concerns over the long-term risk of waste disposal from environmental accidents across the world such as the Chernobyl nuclear meltdown in 1986 and the Exxon Valdez oil spill in 1989.

<
Jankara Jetty Market, at the intersection of Idugmabo Road and the Third Mainland Highway looking south towards the Central Business District of Lagos Island.

Garbage Capitalism
Full page advertisement of the Mobro 4000 barge incident in the Wall Street Journal, 1987, paid for by the Steamfitting Industry Promotion Fund.

The garbage crisis reached its full depth in 2001 with the closure of the world's largest disposal facility, the Fresh Kills Landfill on Staten Island, New York. The capping of Fresh Kills – the Giza of America – has since rendered visible the real economic and ecological costs that landfills have so neatly concealed and masked for the past half century. When long-term post-closure remediation is considered, estimates now place the full cost of waste dumping, including downstream impacts and greenhouse gas emissions, somewhere between 50 to 100 times the original price paid at the scales. With increasing pressure for urban land development, demand for landfill space has skyrocketed throughout the Northeastern United States and, along with it, garbage tipping fees.[7] As a countervailing measure, North American cities established landfill diversion strategies at a breakneck pace in the early 1990s. As a result, the recycling industry exploded, shaving off about 25 per cent of the total volume of solid waste. The initial onslaught of recycling programs created a glut of materials, initially sending market prices for curbside recyclables down (plummeting from 50 to 30 US dollars per ton). The average price has since recovered to 90 US dollars per ton. Now that disposal prices are beginning to include the real costs of landfilling such as post-closure operations and downstream impacts, the cost advantages of material recycling are leveling the playing field of the waste economy.[8] Previously unforeseen economic and ecological synergies are growing between public regulatory agencies and private turnkey enterprises…where it matters the most: at the source, in urban areas.[9]

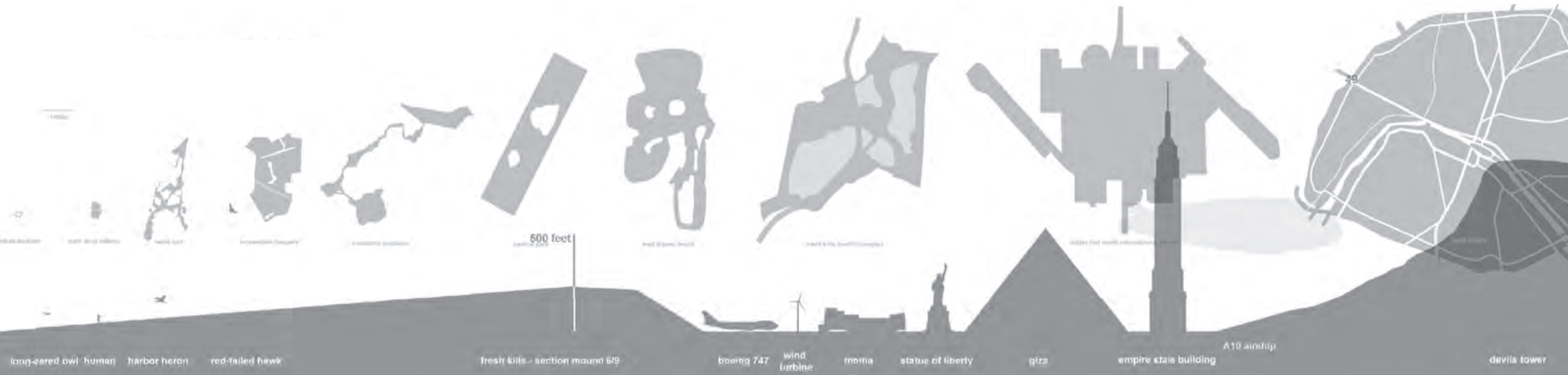


Diagram: Pierre Bélanger, 2008

The Giza of America
Size and height comparison of Fresh Kills Landfill to other historic monuments around the world.

From a distance, the famed return of the Mobro 4000 and the closure of the Fresh Kills Landfill mark a decisive milestone in the evolution of the solid waste industry in North America. They signal a major transformation in the structure of urban waste-sheds towards less centralized and more diversified economies of materials recovery that will soon dominate big cities.

Topography of Trash
A mega landfill near Detroit, Michigan, USA that receives an average of one tractor trailer from out-of-state, every three minutes during rush hour.

Photo: Pierre Bélanger, 2007

Garbage Devolution
Timeline of major milestones and highlights in New York City's waste handling and recycling industries during the 20th century.

U.S. Total Annual Municipal Solid Waste Generated

1805
0.5 million tons
(0.1 ton per capita)

1849
2.3 million tons
(0.1 ton per capita)

1690 Fibers: Rittenhouse Mill in Philadelphia recycles the first paper using fibers from wastepaper and rags.

1795 Prohibition: Georgetown, VA passes the first known U.S. garbage ordinance by prohibiting the dumping of waste in the streets.

1828 Chemical Synthesis: Friedrich Wöhler synthesizes urea from aluminum chloride and potassium cynanide, demonstrating the unity between organic and inorganic chemistry.

1842 Fertilization: Baron von Liebig discovers that plants require foods such as potassium, phosphates and nitrogen, leading to the development of commercial fertillizers.

1843 Vynil: Master of experimental physics Victor Regnault synthesizes several chlorinated hydrocarbons, precursors of vinyl.

1843 Vulcanization: Charles Goodyear discovers the process of vulcanization, which converts rubber into a non-stick, supple and soft surface.

1849 Grease: White and Reynolds establish Barren Island, NY waste processing site, soon become the world's largest, producing grease, fertillizer and nitroglycerine

1853 Oil: Crude oil distilled into kerosene by Ignacy Lukasiewicz, a Polish scientist. The fractional distillation process separates crude oil into its constituent hydrocarbon polymers by means of their distinct boiling temperatures.

1854 Cholera: Dr. John Snow deduces that contaminated water is the source of a London cholera epidemic. Although not accepted at the time, his conclusions would ulltimately strengthen the association between sanitation and health.

1858 Magenta: Von Hoffman develops magenta dye from coal tar, spurring research into organic chemistry

1859 Fuel: Edwin C. Drake discovers oil in Titusville, Pennsylvania; its primary use is as a lubricant and, refined into kerosene, as lamp fuel

1862 Germ Theory: Louis Pasteur develops with Claude Bernard a process in which liquids such as milk are heated to kill bacteria and molds.

1863 Refining: Clark & Rockefeller begin oil refining business in Cleveland, Ohio; by 1877 they would control 90% of oil refining in US

1865 Pipeline: First pipeline moves oil five miles from Pithole City to Oil Creek railway, Pennsylvania

1866 Health: New York's Metropolitan Health Law enacted following a survey of the city's sanitary conditions.

1868 Celluloid: In search of a synthetic material to replace the ivory in billiard balls, Hyatt invents celluloid, the first commercial synthetic plastic.

1869 Elements: Dimitri Mendeleev publishes the first version of the periodic table of elements.

1870 Combustion: First gasoline-powered internal combustion engine.

1872 Asphalt: E.J. de Smedt lays out a 1400 ft. strip of hot-in-place liquid asphalt paving in Newark, NJ

1874 Entropy: Thomson formally states the second law of thermodynamics, describing the inevitable increase of entropy in a closed system over time.

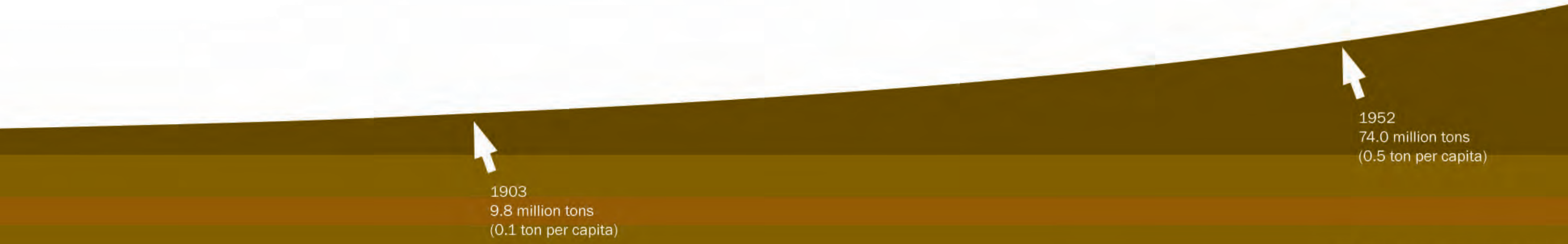
1874 Destgruction: In Nottingham, England, a new technology called "the destructor" provides the first systematic incineration of municipal solid waste in response to a cholera epidemic.

1880 Dynamite: Repauno founded by L. DuPont to produce dynamite, following Nobel's 1867 patent. Nitrocellulose, a byproduct of dynamite production, is a key component of early plastics such as Rayon; dynamito, meanwhile, becomes a crucial tool for mining and highway construction.

1884 Disposability: Völter pate for grinding wood into mechanical pul expire, sparking vast expansion in the North American paper industry. Over t next few decades, disposable paper products such as corrugated cardboa boxes, paper cups, and milk cartons enter the marketplace.

1885 Incineration: First perma incinerator in the U.S. is built on Governor's Island in New York Harbou

1886 Aluminum: Hall and Herou develop the electrolytic process of extracting aluminum from bauxite ore metal once rarer and more precious t gold becomes a basic industrial comm ity.



ucial tool for mining and highway nstruction.

884 Disposability: Völter patents r grinding wood into mechanical pulp pire, sparking vast expansion in the orth American paper industry. Over the xt few decades, disposable paper oducts such as corrugated cardboard xes, paper cups, and milk cartons ter the marketplace.

885 Incineration: First permanent cinerator in the U.S. is built on overnor's Island in New York Harbour

886 Aluminum: Hall and Heroult velop the electrolytic process of tracting aluminum from bauxite ore; a etal once rarer and more precious than ld becomes a basic industrial commod-

1895 Garbage: The New York City Street Cleaning Commissioner sets up the first comprehensive system for public garbage management in the U.S.

1896 Viennese Model: Waste reduction plants are introduced to the United States from Vienna, Austria; they compress organic wastes to extract grease, oils, and other by-products, but are later closed due to the noxious odors emitted.

1896 Dumping: 760,000 yards of municipal waste dumped into the Atlantic off Virginia coast

1899 Sorting: New York City's Street Cleaning Commissioner organizes the first rubbish sorting plant for recycling in the United States.

1900 Pigs: Piggeries are developed to eat garbage. Fifty years later, an outbreak of vesicluar exenthama results in the destruction of thousands of pigs that were fed raw uncooked garbage.

1900 Ash: The average Manhattan resident generates 1500 lbs of waste annually (more than the current per capita rate); 80% of which is ash from coal and wood burned for heating. This source of waste gradually becomes insignificant over the subsequent 50 years.

1904 Recycling: First major U.S. aluminum recycling plants open in Cleveland and Chicago.

1905 Bakelite: Dr. Leo Baekeland invents Bakelite, the first fully synthetic polymer, forerunner of nylon.

1908 Model T: Ford begins production of Model T; three years later the first commercial gasoline station opens in Detroit, Michigan.

1913 Linear Production: Ford Motor Company introduces the moving production line.

1914 Burning: 300 incinerators are operating in the U.S. for burning household waste.

1916 Standardization: Federal Road Act standardizes guidelines for paved highway construction.

1918 Sea Dumping: Violating the 1888 Marine and Harbour Protection Act, New York City resumes the dumping of waste at sea.

1919 Motor Convoy: Dwight D. Eisenhower leads a U.S. Army convoy that demarcates a cross-country highway route

1930 Nylon: DuPont corporation invents nylon. Material shortages caused by World War II spurs intensive research into plastics, with PVC, neoprene (synthetic rubber), polyethelene, polystyrene, and PFTE (Teflon) all developed by the end of the war. With the scarcity of silk, nylon finds its first commercial application in women's underwear.

1942 Collecting: US initiates the collection of rubber, paper, scrap metal, fats, and tin cans for use in wartime industry; a 25 percent diversion rate is achieved

1948 Fresh Kills: Robert Moses commissions the opening of the Fresh Kills Landfill in New York. Along with the Great Wall of China, it is the only man-made thing visible from space.

1954 Can Deposit: Olympia, Washington is the first place to offer a deposit on aluminum cans.

1955 Garburetor: Popularization o in-home garbage disposal

1956 Highways: Federal Aid Highway Act mandates the construction of the 43,000-km Interstate and Defens Highway System encompassing the who of the United States.

1959 Landfilling: The American Society of Civil Engineers publishes the standard guide to sanitary landfilling.

1960 Auto Shredder: First North American auto shredding facility established in Wayne County, Michigan.

1965 Action: the first federal U.S. solid waste management law, Solid Waste Disposal Act, is enacted.

1970 Protection: The U.S. Environmental Protection Agency (EPA) is create under the Nixon administration.

Diagram: Pierre Bélanger, 2008

2001
234.0 million tons
(0.8 ton per capita)

1952
74.0 million tons
(0.5 ton per capita)

l T: Ford begins production e years later the first oline station opens in n.

r Production: Ford introduces the moving

ng: 300 incinerators are U.S. for burning household

ardization: Federal ardizes guidelines for paved uction.

Dumping: Violating the nd Harbour Protection Act, esumes the dumping of

Convoy: Dwight D.

Eisenhower leads a U.S. Army convoy that demarcates a cross-country highway route

1930 Nylon: DuPont corporation invents nylon. Material shortages caused by World War II spurs intensive research into plastics, with PVC, neoprene (synthetic rubber), polyethelene, polystyrene, and PFTE (Teflon) all developed by the end of the war. With the scarcity of silk, nylon finds its first commercial application in women's underwear.

1942 Collecting: US initiates the collection of rubber, paper, scrap metal, fats, and tin cans for use in wartime industry; a 25 percent diversion rate is achieved

1948 Fresh Kills: Robert Moses commissions the opening of the Fresh Kills Landfill in New York. Along with the Great Wall of China, it is the only man-made thing visible from space.

1954 Can Deposit: Olympia, Washington is the first place to offer a deposit on aluminum cans.

1955 Garburetor: Popularization of in-home garbage disposal

1956 Highways: Federal Aid Highway Act mandates the construction of the 43,000-km Interstate and Defense Highway System encompassing the whole of the United States.

1959 Landfilling: The American Society of Civil Engineers publishes the standard guide to sanitary landfilling.

1960 Auto Shredder: First North American auto shredding facility established in Wayne County, Michigan.

1965 Action: the first federal U.S. solid waste management law, Solid Waste Disposal Act, is enacted.

1970 Protection: The U.S. Environmental Protection Agency (EPA) is created under the Nixon administration.

1970 Earth Day: On April 22nd, the first Earth Day is celebrated. The one-off event becomes an annual global celebration.

1971 Bottle Deposit: Oregon passes the first bottle deposit bill in the United States.

1971 WMI: Waste Management Inc. goes public. The company is formed by the merger of Wayne Huizenga's operations in Florida and Dean Buntrock's operations in Chicago.

1972 Banking: Section 404 Clean Water Act endorses wetland banking as a compensatory mechansim to support wetland preservation requirements.

1974 Curbside: The first citywide curbside recycling for newspapers starts in University City, Missouri

1976 Conservation: Resource Conservation and Recovery Act is drafted following the Oil Embargo and the Love Canal affair in the early 1970s. The act establishes the first federal regulations for waste management and disposal.

1977 Personal computing: Launch of Apple II, the first highly successful mass produced PC; ten years later an estimated 20 million personal computers would be obsolete.

1979 Oil Embargo: Iranian revolution temporarily reduces worldwide oil supply

1979 Landfilling: EPA prohibits open dumping and sets first standards for landfills.

1980 Superfund: The Comprehensive Environmental Response Compensation and Liability Act (Superfund) was passed. Six years later, the Superfund Amendments and Reauthorization Act is passed. Rhode Island is the first state to pass mandatory recycling laws for cans, glass, newspapers and plastic.

1986 Biggest: Fresh Kills Landfill becomes the world's largest landfill.

1987 Mobro: a garbage barge called Mobro sails from New York up and down the U.S. East Coast, looking for a place to dispose of its waste. Rejected by facilities in six states and three countries, the barge draws public attention to the perceived landfill capacity shortage in the Northeast. The garbage is finally incinerated in Brooklyn and the ash is disposed of in a landfill near Islip, Long Island.

1988 Ban: Ocean dumping is banned. The Plastic Bottle Institute develops a material identification code system for plastic bottle manufacturers (no.1-6).

1988 Merger: Wheelabrator, the largest incinerator company in the United States, merges with Waste Management Inc.

1990 Growth: Waste Management Inc.'s revenues exceed $6 billion, making it the largest waste management corporation in the United States

1991 Drop: In just 16 years the number of landfills operating in the U.S. dropped by 70 percent, from 63,000 down to 18,500. During the same time there was a 50 percent increase in the amount of trash generated.

1993 Specifying: RCRA regulations requiring more stringent landfill specifications (including liners, leachate collection and removal, groundwater monitoring) take effect. Six year laters, tougher standards for landfill containment force many small landfill operators to close; number of US landfills drops to 2314 (from 8000 in 1988).

2000 Plastics comprise 15.4% of municipal solid waste landfilled, up from 0.5% in 1960.

2001 Landfill to Landscape: Fresh Kills Landfill closes, to become a park.

Decomposing Strategies

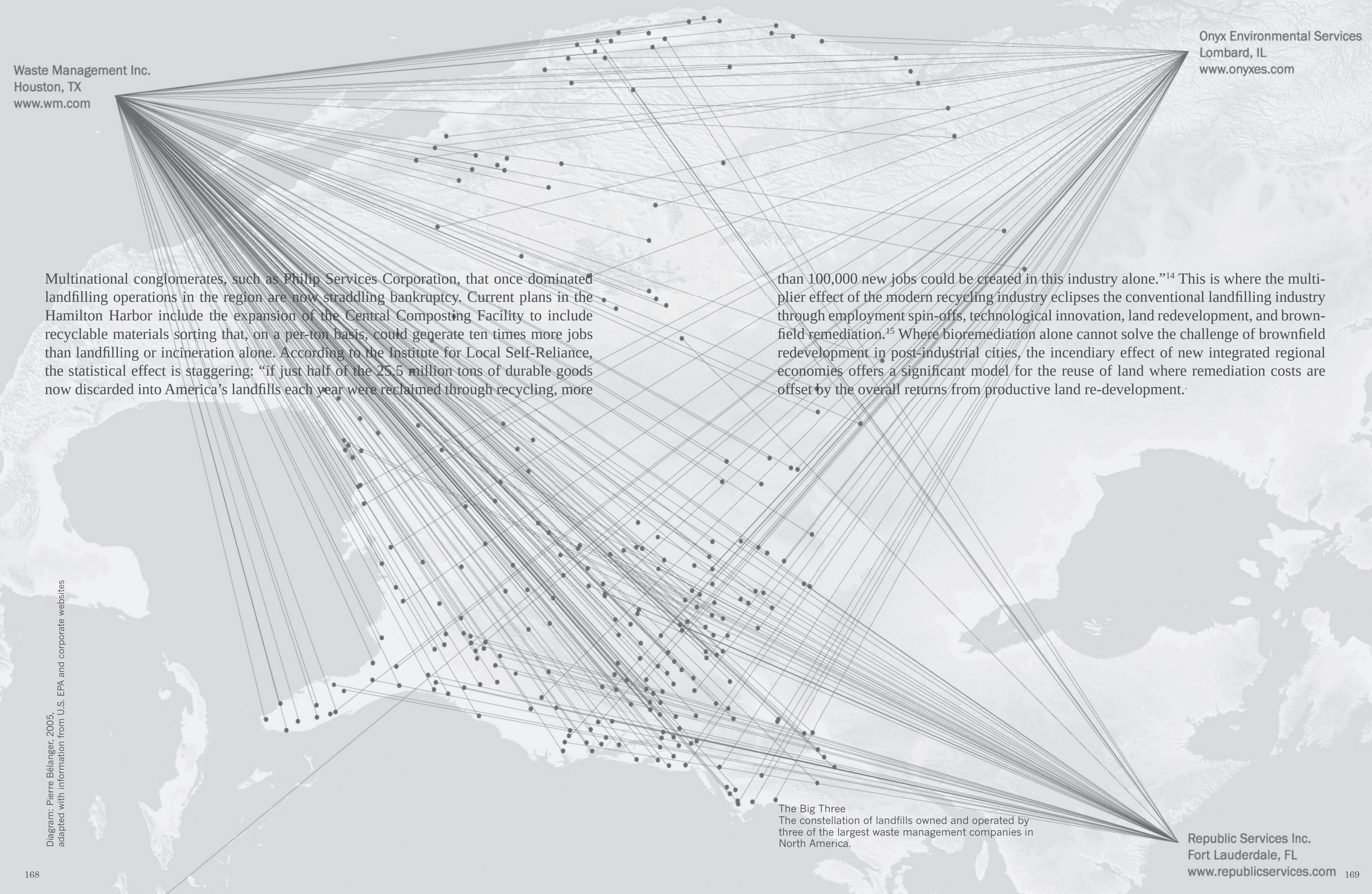
On the cutting edge of this shift is a new, state-of-the-art composting facility in Hamilton, Canada's most polluted harbor.[10] At full capacity, the 40-acre facility can process up to 90,000 tons of organic waste every year, enough for a city of almost one million. Operative costs of the facility are 30 per cent lower than conventional landfilling, and the process is 10 times faster and uses less than one tenth of the land base of conventional outdoor composting. This first indoor composting facility in North America was made possible through global collaboration between public agencies and private entrepreneurs: the City of Hamilton provided the land, a Dutch mushroom expert supplied the engineering, and a Canadian contractor built it. Located on a former tire manufacturing facility owned by Firestone Tire & Rubber, the site was contaminated with PCBs and PHCs, requiring the use of deep molasses injection for contamination hotspots within the sub-surface. The Great Lakes Commission, a transboundary regional watershed agency, oversaw the entire process, and within less than a year and for less than one tenth of one per cent of the full construction budget, the site was entirely decontaminated.[11]

Whereas municipal solid waste containing a mix of organics and inorganics was landfilled up until 2005, the composting operations have catalyzed an array of alternative industries based on the creation of different waste streams through separation. In other words, as Joel McCormick, Manager of the Facility explains: "waste is simply acknowledged as part of the process of urbanization … Diversion strategies are literally bringing waste back into the economic loop, squeezing waste handling giants out." [12] This shift is echoed by the Northeast Recycling Council, where "recycling provides the bedrock for large, robust manufacturing industries in the United States that use reusable materials. It provides manufacturing industries with raw materials that are less expensive than virgin sources,"[13] a long-term economic advantage that translates into value for consumers who ultimately spend less on products and packaging.

Photo: Pierre Bélanger, 2007

Hamilton Harbour Composting Facility, Aerating Grounds.

Multinational conglomerates, such as Philip Services Corporation, that once dominated landfilling operations in the region are now straddling bankruptcy. Current plans in the Hamilton Harbor include the expansion of the Central Composting Facility to include recyclable materials sorting that, on a per-ton basis, could generate ten times more jobs than landfilling or incineration alone. According to the Institute for Local Self-Reliance, the statistical effect is staggering: “if just half of the 25.5 million tons of durable goods now discarded into America’s landfills each year were reclaimed through recycling, more than 100,000 new jobs could be created in this industry alone.”[14] This is where the multiplier effect of the modern recycling industry eclipses the conventional landfilling industry through employment spin-offs, technological innovation, land redevelopment, and brownfield remediation.[15] Where bioremediation alone cannot solve the challenge of brownfield redevelopment in post-industrial cities, the incendiary effect of new integrated regional economies offers a significant model for the reuse of land where remediation costs are offset by the overall returns from productive land re-development.



The Big Three
The constellation of landfills owned and operated by three of the largest waste management companies in North America.

Diagram: Pierre Bélanger, 2005, adapted with information from U.S. EPA and corporate websites

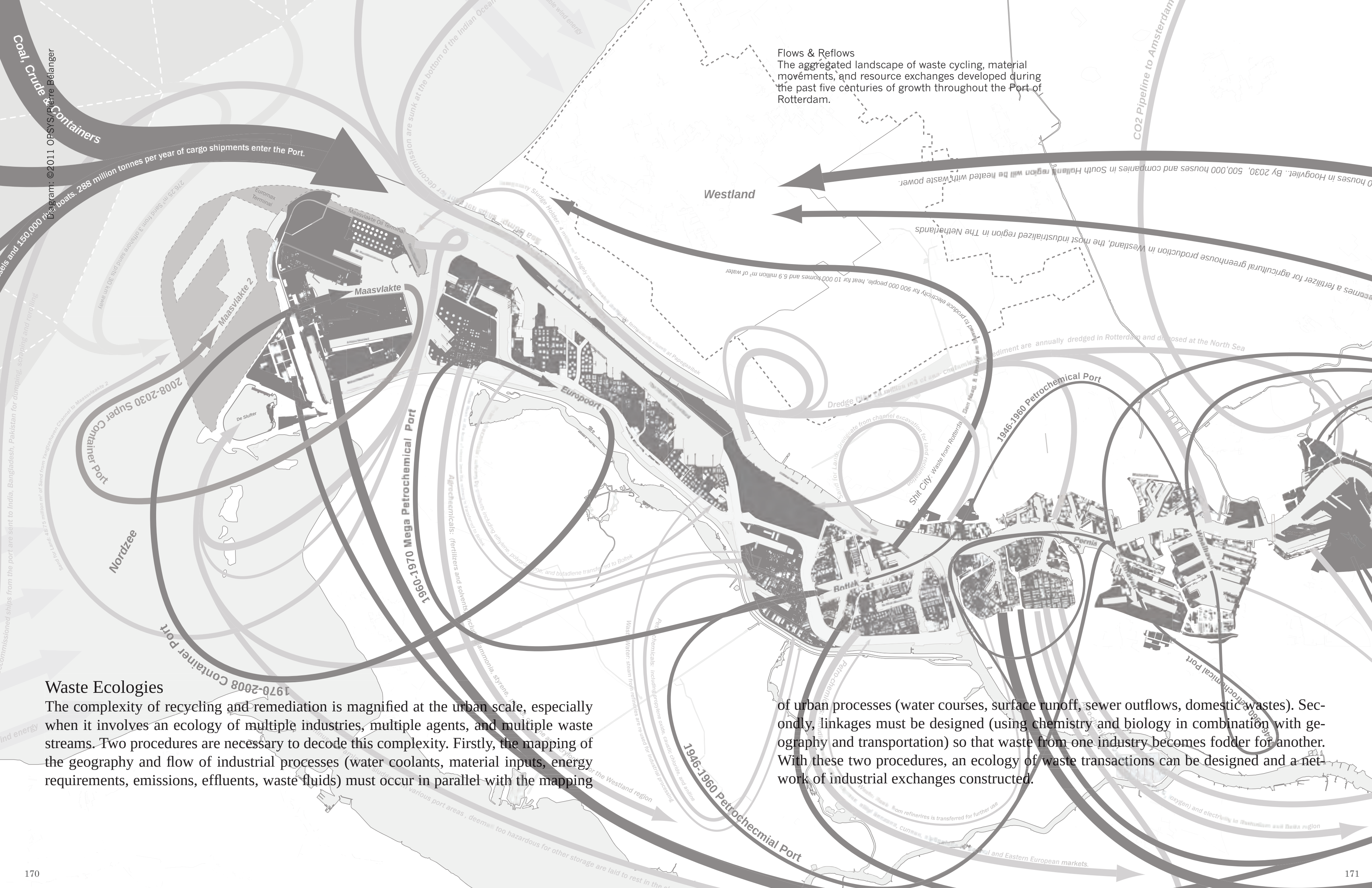


Diagram: ©2011 OPSYS/Pierre Bélanger

Flows & Reflows
The aggregated landscape of waste cycling, material movements, and resource exchanges developed during the past five centuries of growth throughout the Port of Rotterdam.

Waste Ecologies

The complexity of recycling and remediation is magnified at the urban scale, especially when it involves an ecology of multiple industries, multiple agents, and multiple waste streams. Two procedures are necessary to decode this complexity. Firstly, the mapping of the geography and flow of industrial processes (water coolants, material inputs, energy requirements, emissions, effluents, waste fluids) must occur in parallel with the mapping of urban processes (water courses, surface runoff, sewer outflows, domestic wastes). Secondly, linkages must be designed (using chemistry and biology in combination with geography and transportation) so that waste from one industry becomes fodder for another. With these two procedures, an ecology of waste transactions can be designed and a network of industrial exchanges constructed.

Pipeline Picturesque
View of the flue gas transmission pipeline from the main power plant to the Statoil Refinery, part of a landscape of pipelines and corridors dedicated to the conveyance of fluids and gases throughout the region.

Photo: ©2008 Pierre Bélanger

The prodigy of this waste ecology is in Denmark. Beginning in the 1970s, three regulatory initiatives benchmarked the Danish industrial landscape. The creation of the world's first Ministry of Environment (1971), the issuance of the Brundtland Report (1987) and the passage of the Environmental Protection Act (1992) each argued for the design, planning and long term management of the environment as a single, collective, multi-layered and complex public landscape. Because Denmark was faced with issues such as the depletion of disposal space, groundwater contamination and gas emissions, the wholesale impact of these regulatory measures usurped conventional end-of-pipe treatment technologies in favor of the design of upstream waste reclamation strategies. Industrial flows were recalibrated and a new waste handling hierarchy emerged: energy recovery first, material recycling second, incineration third and landfilling last.[16]

Ship Shape
The laydown areas of the Vestas blade factory in Nakskov (Denmark) and port of international shipping, in proximity of a regional materials sorting and recycling area.

Photo: ©2012 Aerodata International Data Surveys

Kalundborg, a small port town in Denmark, crystallizes the potential of this new order. Tucked in a deep fjord some 100 kilometers west of Copenhagen, Kalundborg garnered international recognition in the mid 1980s for the formation of a unique waste recycling network. In what is retrospectively recognized as the birthplace of contemporary industrial ecology, the driving force that underpins the network is the recycling of bulk chemical wastes as raw material inputs for other industries. At Kalundborg's core lie two of its largest industrial plants. In 1976, Novo Nordisk, the world's largest insulin producer, began diverting 10,000 tons of sludge and surplus yeast every year from the municipality's sewage plant to local farms for use as organic fertilizer and pig food. A decade later, the Asnæs Power Station, the country's largest energy supplier, began converting hot waste-water into high-pressure steam for residential heating, as well as providing fly ash for cement production and waste-gypsum for plasterboard manufacturing. Combined, the two plants experienced massive gains by energy cascading (the multistage process of using waste energy from one industry as a lower-power source of energy for another) and downcycling (the process of recycling a material into a material of lesser quality), recovering almost 70 percent of the typical loss experienced by large power generators.

Photo: Pierre Bélanger, 2007

Dual Farming
Synergistic land uses in the Kalundborg Region, where farmers lease out farmland space to district energy providers for wind generation.

Since then, a vast number of waste conversion methods have been engineered and industrial synergies forged into a network economy of recycled fuels, feedstock and composite building materials across the region. Due to its scale and magnitude, this network includes a vast containment landscape of laydown areas, retention basins, containment berms, storage tanks and warehouses. In between is an extensive circulation landscape of fixed and flexible connections (pathways, roads, channels, pipelines, forest corridors and truck, rail and barge connections) that bridge inputs and outputs between different industries. Neither native nor exotic, a prototypical ecology of waste flows, logistical transportation systems, land distributions and public spaces has since been irreversibly generated. What holds it all together, according to Noel Brings Jacobsen, Director of the Kalundborg Industrial Symbiosis Institute are “the weekly contacts between different plant managers constantly trying to find new streams for their industrial waste. It all happens by design.”[17]

Three significant effects have been produced over the past thirty years. From a global perspective, foreign material imports have been substantially reduced: more than 30,000 fewer tons of coal and 19,000 fewer tons of oil annually. Regionally, landfill waste has been reduced by over 75 percent through downcycling. Locally, the small town of 25,000 people saves 12 to 15 million US dollars every year, which triggers new urban investment and infrastructural upgrades on former industrial sites. Compounded, the whole process saves over 600,000 cubic meters of water annually through the reuse of graywater. With landfill reduction, net energy gains and economic spin-offs, this ecology of waste is currently being replicated worldwide in variations ranging from resource recovery plants to eco-industrial parks. Since then, the model of industrial ecology – with its emphasis on process-based modeling and the dematerialization of traditional linear industries – has been duplicated worldwide in variations essentially premised on the cycling of wastes into secondary and tertiary market economies.[18,19]

Industry Synergy
Headquarters of Danish industry, Copenhagen.

Photo: Pierre Bélanger, 2007

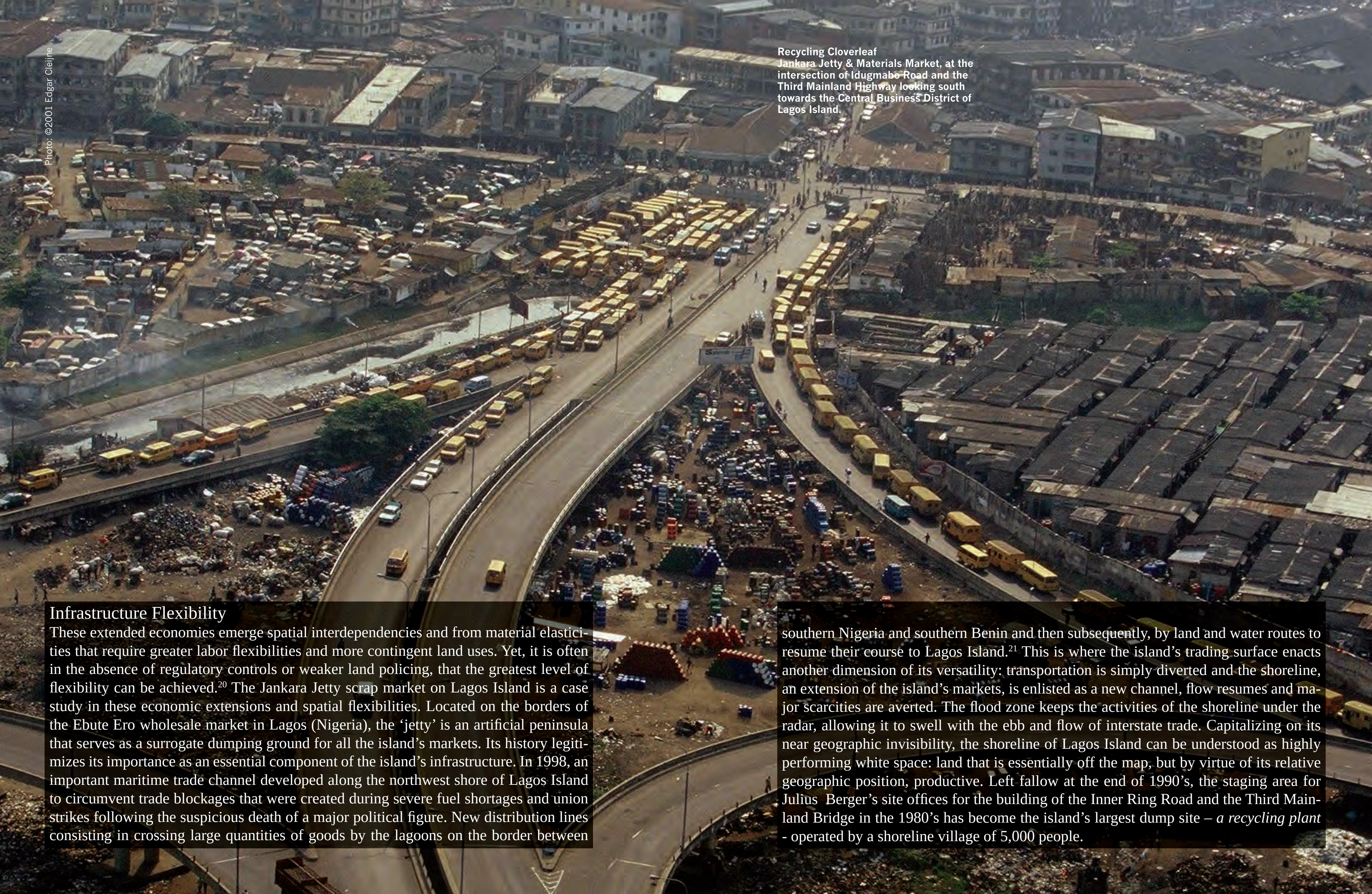


Photo: ©2001 Edgar Cleijne

Recycling Cloverleaf
Jankara Jetty & Materials Market, at the intersection of Idugmabo Road and the Third Mainland Highway looking south towards the Central Business District of Lagos Island.

Infrastructure Flexibility

These extended economies emerge spatial interdependencies and from material elasticities that require greater labor flexibilities and more contingent land uses. Yet, it is often in the absence of regulatory controls or weaker land policing, that the greatest level of flexibility can be achieved.[20] The Jankara Jetty scrap market on Lagos Island is a case study in these economic extensions and spatial flexibilities. Located on the borders of the Ebute Ero wholesale market in Lagos (Nigeria), the 'jetty' is an artificial peninsula that serves as a surrogate dumping ground for all the island's markets. Its history legitimizes its importance as an essential component of the island's infrastructure. In 1998, an important maritime trade channel developed along the northwest shore of Lagos Island to circumvent trade blockages that were created during severe fuel shortages and union strikes following the suspicious death of a major political figure. New distribution lines consisting in crossing large quantities of goods by the lagoons on the border between southern Nigeria and southern Benin and then subsequently, by land and water routes to resume their course to Lagos Island.[21] This is where the island's trading surface enacts another dimension of its versatility: transportation is simply diverted and the shoreline, an extension of the island's markets, is enlisted as a new channel, flow resumes and major scarcities are averted. The flood zone keeps the activities of the shoreline under the radar, allowing it to swell with the ebb and flow of interstate trade. Capitalizing on its near geographic invisibility, the shoreline of Lagos Island can be understood as highly performing white space: land that is essentially off the map, but by virtue of its relative geographic position, productive. Left fallow at the end of 1990's, the staging area for Julius Berger's site offices for the building of the Inner Ring Road and the Third Mainland Bridge in the 1980's has become the island's largest dump site – *a recycling plant* - operated by a shoreline village of 5,000 people.

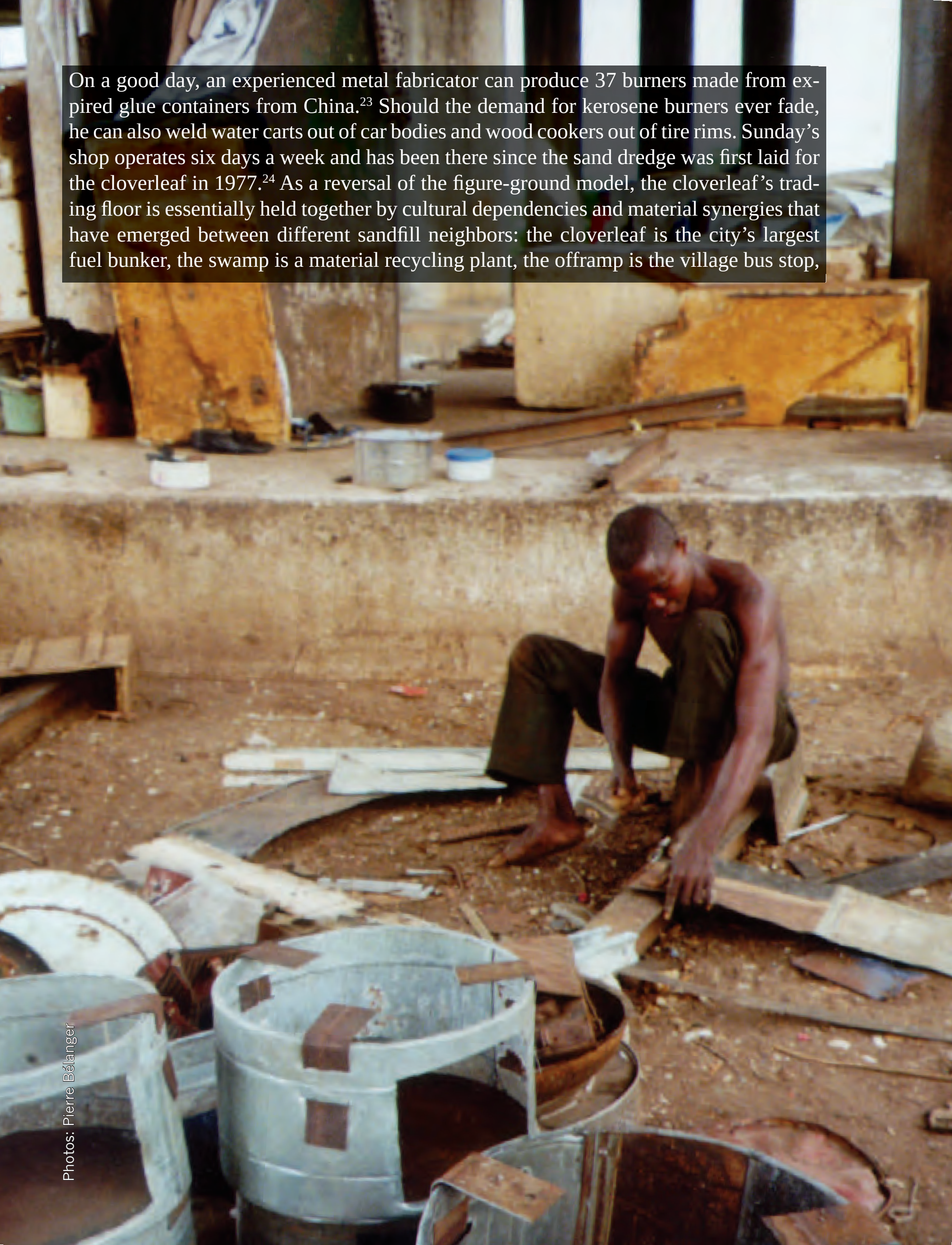
Infrastructure Underbelly
Diagram of surface functions, ground elements, and implied territorial divisions, where spatial planning below the Third Mainland Highway offramp takes place without plans.

While the entire cloverleaf is divided into four main uses, one in each ring (the northwest leaf is a football field, the northeast is a religious shrine, the southeast is a landfill) the space of the recycling quadrant in the southwest is highly differentiated and highly variable in size. The under-structure is used as a metal fabrication plant and block factory where shade is reserved for labor-intensive functions, never for warehousing. The recycling area between the on-ramp and off-ramps of the Third Mainland Bridge is allocated by the Association of Fabricators, Welders and Recyclers and each land assignment is based on the demands and pressures of the island markets. Because of its close proximity to these other island markets—particularly the building materials market at Jankara—the recycling cloverleaf is highly organized and seems to do brisk business. Territories for scrap collection are extensive and well established. Collection routes run through Jankara-Okearin-Ebute Ero slowly expanding or contracting according to local supply and availability of scrap effluent from the nearby market stalls. With a modified water carts equipped with long sideboards, market scrap like car panels, rims, fridge doors, cable, wire and bowls are collected from the entire western part of the island during the seven-day collection route. The collected scrap material is the first step in a multiple level processing plant that occupies the entire space of the cloverleaf.[22] Each arriving item is disassembled into its simplest, purest material denominator: ferrous and non-ferrous metal, plastic or foam. Sorted, cleaned and stockpiled, scrap is then converted into a wholesale material. Any metal with potential for added value, like sheet metal or tire rims, is resold to nearby metal repair shops for conversion into carts, cookers or burners. All remaining metals are then re-sold wholesale to industrial manufacturers for melt-down as iron reinforcement bars. Cracked plastic bowls, polypropylene bags and foam blocks are re-sold to local wholesalers where the material is then recycled into a second generation of food bowls and mixing containers. Wood has very little commercial value and is more efficiently used as a fuel than a building material.

At the center of the southwest cloverleaf, are huge stacks of 55-gallon blue food grade containers from France and 42-gallon steel drums from Pakistan and China. Deemed unusable by the International Organization of Standardization, the containers are dumped by food importers or solvent companies across the city, and taken out of the official regulatory cycle. Once the barrels and drums are washed in the cloverleaf's drainage soak pit, they're stacked into pyramids up to three meters high ready for resale. Between the quadrants, under the off-ramps, is a re-manufacturing area. The recycling plant houses a small factory equipped with a welding station, an electrical centre, a furniture shop, an appliance refurbishing area and even a telephone repair shop. The manufacturing zone follows the curving shade of the overhead on-ramp. Shaded areas are allocated according to the seniority of different tenants, each one manufacturing discrete, essential or logistical products such as cookers, carts and barrels.

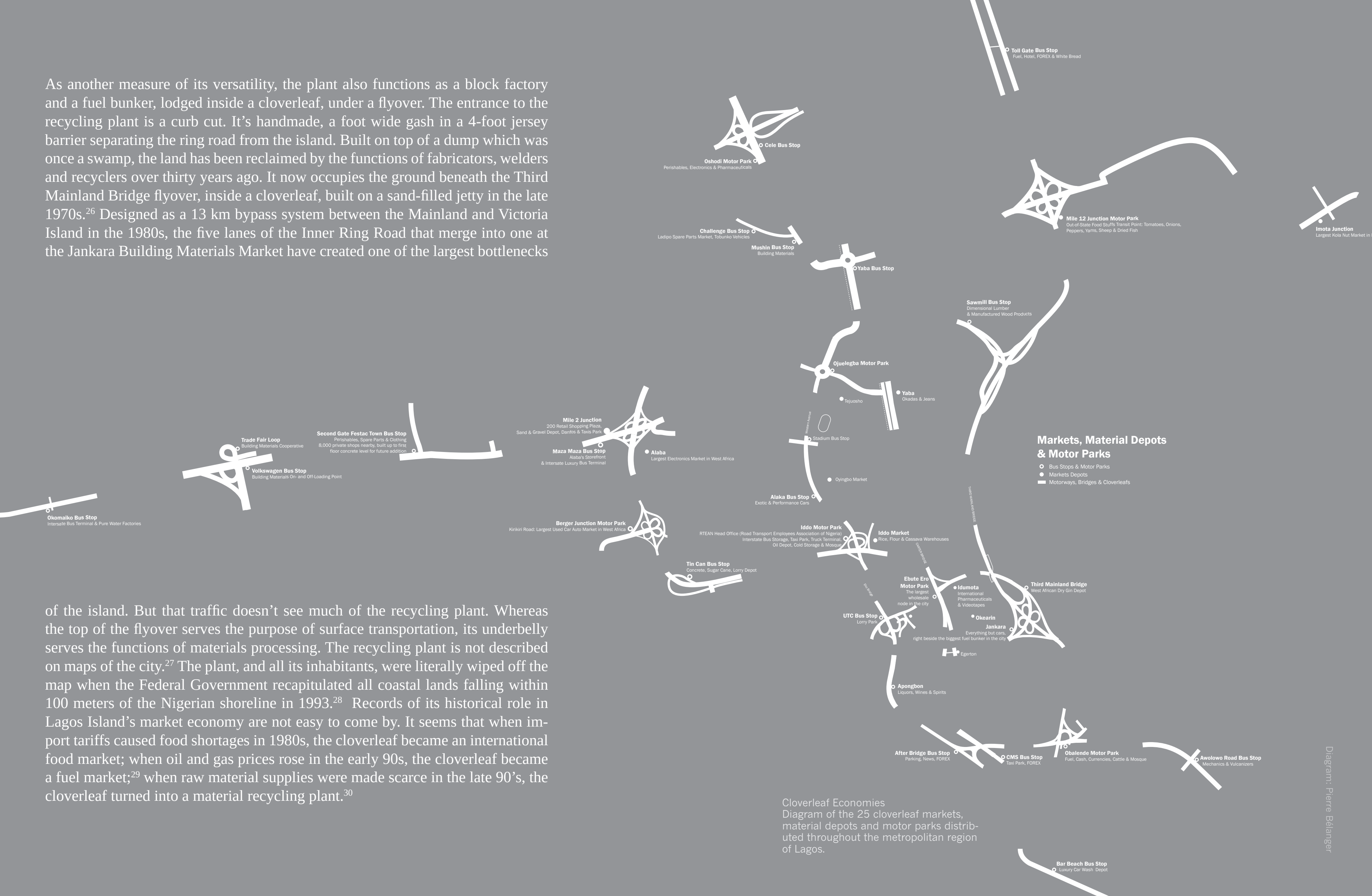
Cloverleaf Surface
Ground-level view of the steel drum cleaning zone (foreground) and plastic barrel storage area (land is owned by the Federal Government but the operations inside the cloverleaf are formally organized by a group of market associations connected throughout the city). An excess by-product of a nearby sawmill, the sawdust is continuously deposited and layered on the ground once a week to absorb the chemical run-off from the barrel cleaning operations.

On a good day, an experienced metal fabricator can produce 37 burners made from expired glue containers from China.[23] Should the demand for kerosene burners ever fade, he can also weld water carts out of car bodies and wood cookers out of tire rims. Sunday's shop operates six days a week and has been there since the sand dredge was first laid for the cloverleaf in 1977.[24] As a reversal of the figure-ground model, the cloverleaf's trading floor is essentially held together by cultural dependencies and material synergies that have emerged between different sandfill neighbors: the cloverleaf is the city's largest fuel bunker, the swamp is a material recycling plant, the offramp is the village bus stop, the village is an interstate port, the fishermen are the gatekeepers of the shoreline and the beach is an open-air warehouse staging the largest dry gin depot in West Africa.[25] The associations are not marked with permanent buildings, rather by what looks to be ambulant surface constructions enabled by a pre-existing infrastructure: overhangs, fuel barrels, material piles, curb cuts, landing decks, driftwood cubes and sand spits.



Photos: Pierre Bélanger

As another measure of its versatility, the plant also functions as a block factory and a fuel bunker, lodged inside a cloverleaf, under a flyover. The entrance to the recycling plant is a curb cut. It's handmade, a foot wide gash in a 4-foot jersey barrier separating the ring road from the island. Built on top of a dump which was once a swamp, the land has been reclaimed by the functions of fabricators, welders and recyclers over thirty years ago. It now occupies the ground beneath the Third Mainland Bridge flyover, inside a cloverleaf, built on a sand-filled jetty in the late 1970s.[26] Designed as a 13 km bypass system between the Mainland and Victoria Island in the 1980s, the five lanes of the Inner Ring Road that merge into one at the Jankara Building Materials Market have created one of the largest bottlenecks of the island. But that traffic doesn't see much of the recycling plant. Whereas the top of the flyover serves the purpose of surface transportation, its underbelly serves the functions of materials processing. The recycling plant is not described on maps of the city.[27] The plant, and all its inhabitants, were literally wiped off the map when the Federal Government recapitulated all coastal lands falling within 100 meters of the Nigerian shoreline in 1993.[28] Records of its historical role in Lagos Island's market economy are not easy to come by. It seems that when import tariffs caused food shortages in 1980s, the cloverleaf became an international food market; when oil and gas prices rose in the early 90s, the cloverleaf became a fuel market;[29] when raw material supplies were made scarce in the late 90's, the cloverleaf turned into a material recycling plant.[30]



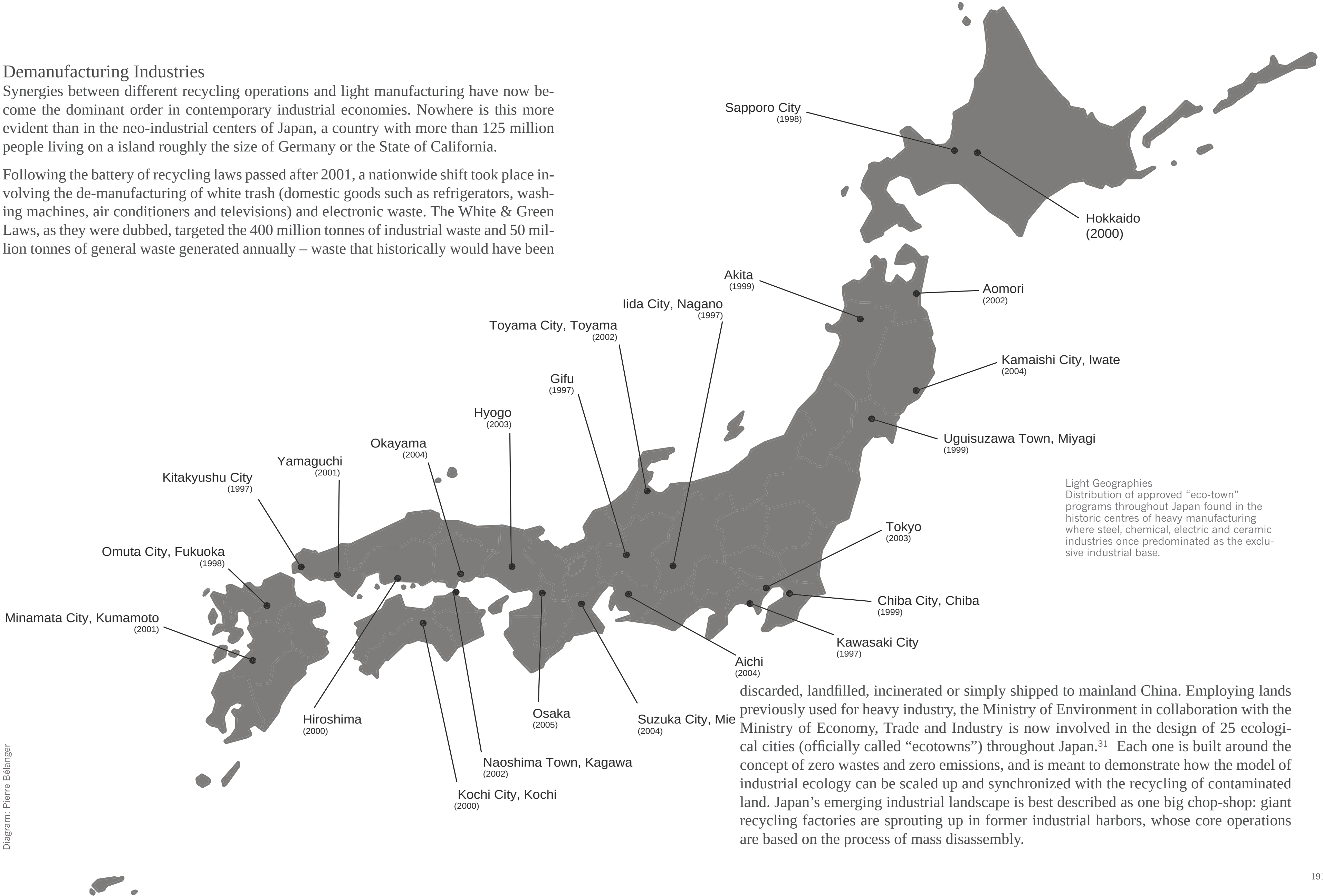
Cloverleaf Economies
Diagram of the 25 cloverleaf markets, material depots and motor parks distributed throughout the metropolitan region of Lagos.

Diagram: Pierre Bélanger

Demanufacturing Industries

Synergies between different recycling operations and light manufacturing have now become the dominant order in contemporary industrial economies. Nowhere is this more evident than in the neo-industrial centers of Japan, a country with more than 125 million people living on a island roughly the size of Germany or the State of California.

Following the battery of recycling laws passed after 2001, a nationwide shift took place involving the de-manufacturing of white trash (domestic goods such as refrigerators, washing machines, air conditioners and televisions) and electronic waste. The White & Green Laws, as they were dubbed, targeted the 400 million tonnes of industrial waste and 50 million tonnes of general waste generated annually – waste that historically would have been discarded, landfilled, incinerated or simply shipped to mainland China. Employing lands previously used for heavy industry, the Ministry of Environment in collaboration with the Ministry of Economy, Trade and Industry is now involved in the design of 25 ecological cities (officially called "ecotowns") throughout Japan.[31] Each one is built around the concept of zero wastes and zero emissions, and is meant to demonstrate how the model of industrial ecology can be scaled up and synchronized with the recycling of contaminated land. Japan's emerging industrial landscape is best described as one big chop-shop: giant recycling factories are sprouting up in former industrial harbors, whose core operations are based on the process of mass disassembly.



Light Geographies
Distribution of approved "eco-town" programs throughout Japan found in the historic centres of heavy manufacturing where steel, chemical, electric and ceramic industries once predominated as the exclusive industrial base.

Diagram: Pierre Bélanger

Major electronic companies such as Panasonic, Sony and Mitsubishi, are completely overhauling their current practices of shipping solid waste overseas to China and Taiwan towards new industrial parks where giant factories are unilaterally based on lines of reverse assembly. Compared to the European recycling market that rely on collective, centralized recycling systems, individual Japanese manufacturers develop and manage their own recycling programs for their brand name products. To this effect, Japanese manufacturers have more robust feedback loops between upstream and downstream agents. Premised on life-cycling, products are now designed for disassembly where end-of-life waste management costs are simply absorbed as an operational cost of the good at the point of purchase.

Of these, Kitakyushu is one of its first and biggest. Overturning a dark Dickensian past, Kitakyushu's century old history as a steel town is being rebuilt from the ground up with a conglomerate of recycling plants on a 300-hectare peninsula, formerly a toxic heap of slag and sludge left over from the operations of the Nippon Steel Corporation. Located in Japan's Rust Belt, Kitakyushu looks like a high-tech junkyard from the air: a field of large, horizontal, single storey sheds sprawled across a field of laydown surfaces on the edge of Dokai Bay, a water body known – much like Lake Erie in the 1960s – as a dead sea.

Photos: Pierre Bélanger

Lines of Disassembly
The reverse assembly process of electronics and automotives where, at the West Japan Auto Recycle Company in Kitakyushu for example, where passenger cars (a 1986 white Toyota Camry shown below) can be dismantled, chopped up and baled within 20 minutes, regardless of its size.

The organization of this massive landscape of disassembly is based on the singular hierarchy of material separation: organics from inorganics, fluids from solids, solids from gases. With the increasing costs of virgin resource mining and global transportation, everything from fast food grease to computers to cars to buildings is being recovered and recycled: completely broken down, dismantled, reorganized and reduced into its most basic constituent materials. When asked about the rather banal and generic appearance of the complex, Environmental Manager Yuji Tsukamoto has a simple answer: “the place is about production and performance, so time is always of the essence. Beauty here is in the turnover.”Mountains of plastic, paper, minerals, aggregates, woods, wires, cables and metals rise up, accumulate, and sprawl across this vast topography of reverse assembly. And without warning, the verticality can flatten out overnight revealing a vast horizontal field of operational surfaces. Sorted and separated materials are then shipped off to industries across the region to be remanufactured into second or third-generation products. Completing the process of disassembly through upcycling (the process of transforming a disposable good into a greater use and value), a new alchemy is forged: fats turn into fuels, waste wood into plastics, foams into additives, aggregates into concretes, plastics into textiles, scrap cars into spare parts. A portion of lease and operations fees is then recirculated to the Regional Environmental Alliance for the construction of wetlands and restored shorelines designed to eventually improve the hyper-eutrophicated waters of Dokai Bay. Aggregated yet decentralized, the Japanese system is quid pro quo: what goes into the economy must necessarily come out and what comes out goes back in. For all intents and purposes, the process is practically endless.

Photo: Pierre Bélanger

White Trash
Mechanical triage of domestic and industrial white goods in a sorting and separation zone of Kytakyushu, Japan. where aluminum and other non-ferrous metals are stored for re-processing, Kitakyushu.

Landscape Metabolism

A by-product of the logistics of city building, the Japanese model of neo-industrial planning provides evidence of a critical correlation between the cycles of industrial process and the manufacturing of contemporary land uses where post-industrial sites can serve as productive, multi-functional landscapes that hold urban economies in a synthetic equilibrium.[19] Though the historical and ecological contexts of the Europe, Asia and North America widely differ, they present unique and compelling cases for understanding how strategies of demanufacturing and recirculation – can re-structure patterns of land development. As a form of neo-industrialism, contemporary waste economies will further distinguish themselves from conventional industries that are typically linear, fixed and self-depleting as opposed to being networked, flexible and renewable. Compounded, emerging urban economic models throughout the world prove the effectiveness of how landscape-based strategies can potentially solve two challenges all at once with a dualized approach to the development of contemporary infrastructures.

Source: Google Earth, 2007

Source: City of Kitakyushu, 1960-1969

Recycling of Land as Urbanization
Once known as the Sea of Death with industries spilling chemical effluents and wastewaters directly into the Murasaki River, Kitakyushu's Dokai Bay has now become a productive 300-hectare peninsula with light manufacturing services, recycling plants, a technology research campus, a growing middle-class population and a robust aquatic ecology.

Constructed Ecology
Coastal view of the first wind energy project in Japan on the northern shoreline of Kitakyushu. The entire landscape is recycled: the landmass is built on a slag pile, the phytoremediation berm on metal-laden soils, and the permeable pavers from reprocessed concretes containing inoculated biomedical wastes.

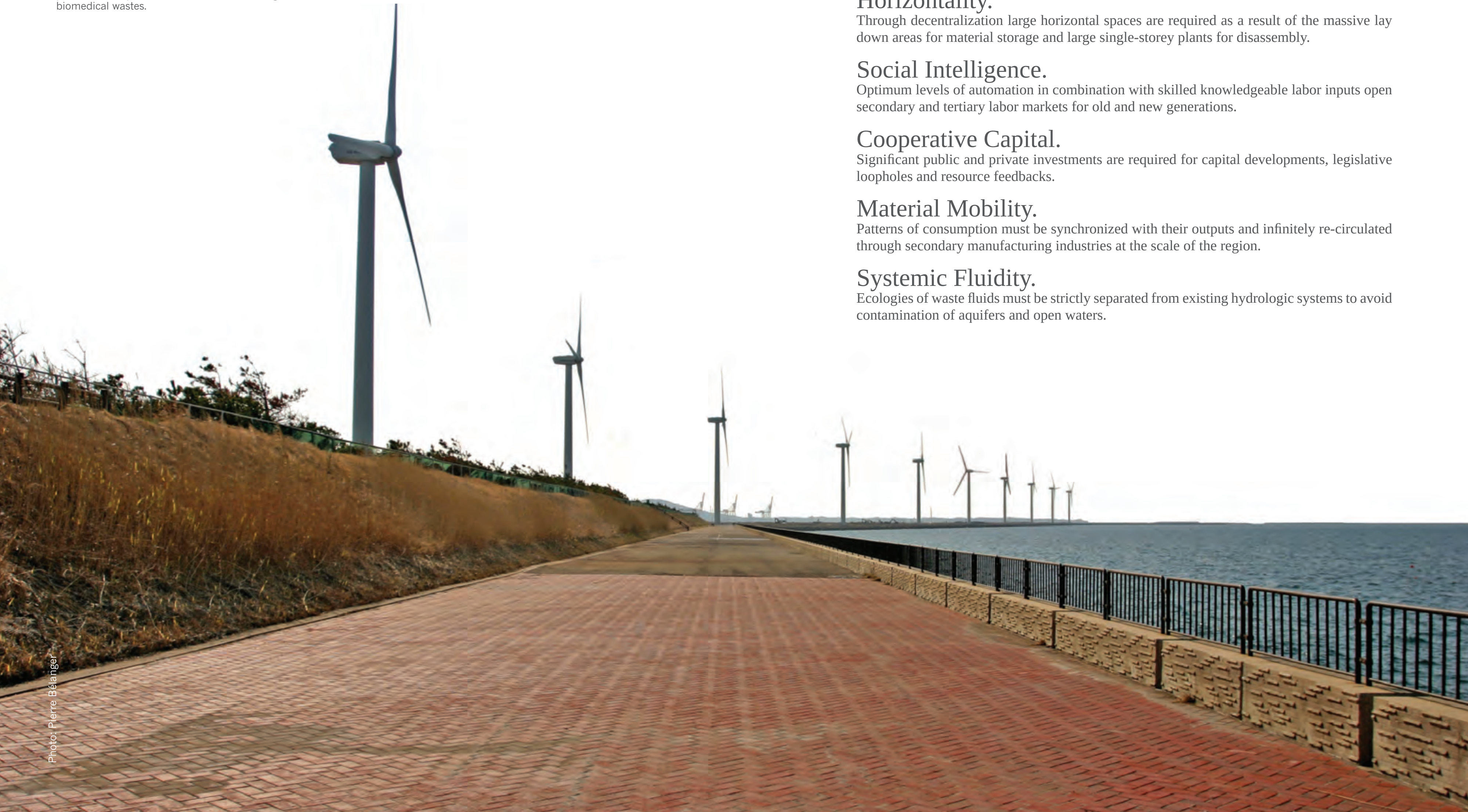


Photo: Pierre Bélanger

From this operative logic, five patterns can be deduced to better characterize this emerging landscape:

Horizontality.
Through decentralization large horizontal spaces are required as a result of the massive lay down areas for material storage and large single-storey plants for disassembly.

Social Intelligence.
Optimum levels of automation in combination with skilled knowledgeable labor inputs open secondary and tertiary labor markets for old and new generations.

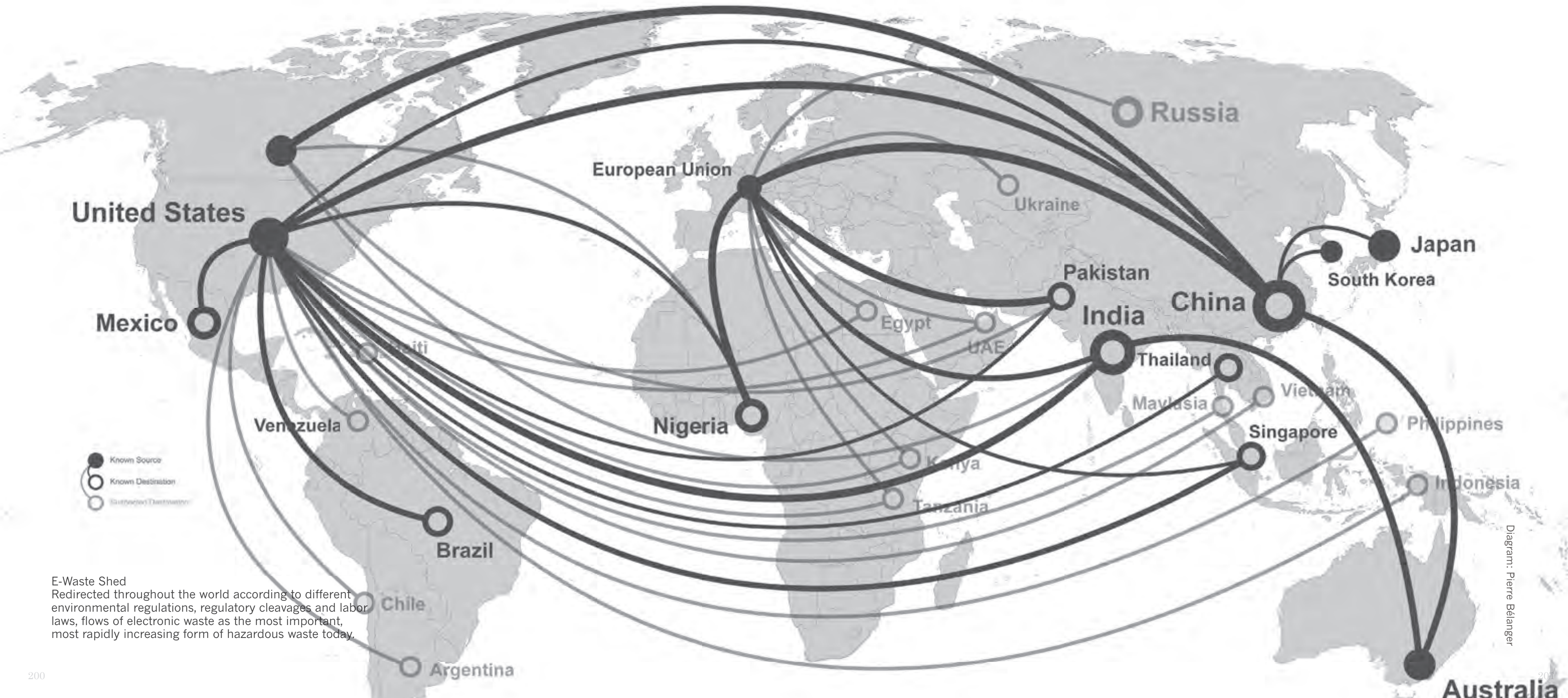
Cooperative Capital.
Significant public and private investments are required for capital developments, legislative loopholes and resource feedbacks.

Material Mobility.
Patterns of consumption must be synchronized with their outputs and infinitely re-circulated through secondary manufacturing industries at the scale of the region.

Systemic Fluidity.
Ecologies of waste fluids must be strictly separated from existing hydrologic systems to avoid contamination of aquifers and open waters.

Circular Economies

Though the economic and ecological histories of Europe, Asia and North America may differ, they all present compelling examples for understanding the latent reciprocity between industry, waste and urbanism. Closing the material loop is the second leap required of industry in the waste economy. At the urban scale, multilateral strategies that include *diversion, separation, recycling and composting* are proving effective as durable alternatives to conventional systems of waste management. As a result of global legislation – such as the 1992 Basel Convention that prohibited the transnational movement of hazardous wastes – the pre-eminence of waste colonialism in the 20th century is now a thing of the past. Multilateral strategies, including waste diversion, separation, recycling, composting and remanufacturing, are proving effective as durable alternatives to conventional systems of waste management that previously relied on consolidated forms of disposal. With skyrocketing costs of virgin materials, resource mining, surging fuel prices and growing patterns of urbanization, exhausted economies are being jumpstarted through combined strategies of economic regeneration and ecological reclamation, where water, land, energy and waste are becoming the bedrock of a new world economy. Dismantling the Old World notion of the city, urban-industrial synergies never before possible are forming beyond metropolitan areas, signaling the birth of a new and diffused urban economic pattern that is best described as an operational ecology held together by supply chains and distribution networks.



E-Waste Shed
Redirected throughout the world according to different environmental regulations, regulatory cleavages and labor laws, flows of electronic waste as the most important, most rapidly increasing form of hazardous waste today.

Diagram: Pierre Bélanger

In a dramatic reversal of 20th century Fordist dogma, typically linear, specialized, standardized modes of production are being overturned by emerging infrastructures that are networked, flexible and recursive.[32] But make no mistake: structural urban transformations require the proaction of, and sustained cooperation between long-term players from both the private and public sectors, as well as from corporate and citizen organizations.

To move growth beyond linear production, three factors will ultimately contribute to the potential of circular, urban economies: the global economics of resource mining, the planned shrinkage of post-industrial economies, and the design of waste ecologies. As the playing field of the global waste economy levels off, the golden age of mass-disposal is now being supplanted by the era of mass-recycling. Since the close of the 20th century, a decisive transformation in environmental attitudes has occurred in a range of sectors from business and economics, to real estate and land development. Heightened by the overexertion of globalization, this shift is the result of the convergence between economic and ecologic imperatives towards closing the material loop, optimizing energy use, and protecting natural resources. Through the management of energy flows or liquid effluents, the surpluses that are created by centralized infrastructure are now finding new pathways and new markets, re-circulating through alternate economies premised on the processes of disassembly, dematerialization, and deindustrialization. Underlying these complex, circular economies is the cultural rethinking of waste as a raw resource and natural process. This circular understanding of production underlies the nature of urbanization: for example, the invention of coal was the invention of tar, the invention of steel was the invention of slag, the invention of petroleum was the invention of plastic, the invention of cement was the invention of sulfuric gas and the invention of sewage was the invention of sludge. Premised on the understanding of material lifecycles, this major change is spawning a series of urban strategies where a renewed engagement of waste as virgin material is providing the basic building block for the creation of contemporary urban economies: upcycling and downcycling of material goods, the cascading of energy through backflows and reflows, the decoupling and diversion of organics and inorganics, as well as the recycling and remediation of contaminated land.

From the case of the Mobro 4000 trash barge in New York to the management of the 40 million tons e-waste generated globally, the construction of waste ecologies and the development of disassembly industries will enlist the dualization of urban infrastructure as a pressing and critical order. Put otherwise, the dematerialization of the industrial economy and the mapping of material geographies will become a pressing and critical task to effectively design the waste streams and the waste sheds of the 21st century.

Endnotes

1. Hawken, Paul. The Ecology of Commerce: A Declaration of Sustainability (Harper Collins Publishers: New York, 1993): 3. In a later chapter of his book, “Parking Lots and Potato Heads” (65-84), Hawken provides an important and early account of the genesis of industrial ecology citing the examples of Kalundborg (Denmark) and General Motors (Michigan, USA) with reference to Robert Frosch and Nicholas Gallopoulos influential article “Strategies for Manufacturing” in Scientific American (Vol. 261 No.3): 144-152.

2. Henry Ford, in collaboration with Samuel Crowther. “Learning from Waste”, in Today & Tomorrow (London: William Heinemann, 1926): 110.

3. Across the world, the 1970s and 1980s saw the results of nearly a century of industrialization from the onslaught of two World Wars and the fear of a third one during the Cold War. A second environmental renaissance is currently being experienced in North America as a result of what could be considered the failure of the environmental movement in the 1970s and 1980s to bring to justice the industrial polluters responsible and the failure to address the economic aspects of site reclamation of the more than 1600 Superfund Sites and 40,000 brownfields across America.

4. Critical to the future of this emerging landscape is the dismantling of the Old Word’s notion of the city where the industrial and the urban are strictly separated for a more horizontal, distributed nucleation of land uses that operate as ecologies held together by the logistics and mechanics of city building while exploiting the competitive forces of global outsourcing, automated manufacturing and just-in-time delivery. In North America, the separation between industrial and other urban land uses dates back to 1926 with the invention of zoning as a result of the seminal court case between The Village of Euclid and Amber Realty in Ohio. Pre-dating the utopian visions of the Ebenezer Howard’s Garden City, the writings of Peter Kropotkin (Fields, Factories And Workshops: or Industry Combined with Agriculture and Brain Work with Manual Work, Thomas Nelson & Sons, London, Edinburgh, Dublin And New York, 1912) are extremely in better understanding the geo-economic reciprocity between industry, agriculture and urbanism.

5. Most of these developments are occurring through legislation and politics, rather than by design or planning. The lack of attention given by landscape architects, urban designers and architects to this shift is owed to a lopsided focus on visual and aesthetic aspects of site design rather than the productive and performative parameters of urban and regional development. From a geo-economic perspective, four common denominators best substantiate this logistical and geographic reciprocity between industrialization and land transformation. Through the mass recycling of materials, these denominators show that the case of industrial parks throughout the developed world supports patterns of urbanization and bears considerable potential of generating them in the future.

6. Barbara Hogan “All Baled Up and No Place to Go - Barge Trip Underscores Our Solid Waste Crisis”, The Conservationist, January-February (1988): 36-39. For a different interpretation of the influence of the Mobro 4000 incident, see Jeff Bailey, Waste of a Sort: Curbside Recycling Comforts the Soul, But Benefits Are Scant, Wall. St. J. A1 (Jan 19, 1995) and John Tierney, “Recycling Is Garbage,” New York Times Magazine (June 30, 1996): 24.

7. For a more comprehensive account of this turn of the century phenomenon, see Pierre Bélanger “Airspace: The Ecologies and Economies of Landfilling in Michigan” published in TRASH (Cambridge, MA: MIT Press, 2006).

8. It is estimated that the real cost of landfilling is upwards of 300$ per ton, versus the current average price of $10.00 per ton in the United States, when considering the full, life-cycle of landfills.

9. The fact that cities in North America are running out of landfilling space is a myth. If Canada and the United States were to concentrate all the landfills it currently operates into one, it would only take on landfill 120 feet deep and measuring 44 miles square to adequately handle the needs for the entire United States for the next 100 years. The real issue concerning landfilling is less about lack of space, but rather a matter of economics.

10. While the Love Canal incident in Niagara Falls, New York remarkably catalyzed the era of post-industrial remediation in the United States, another lesser known dumpsite some 300 kilometers across Lake Ontario from Niagara Falls, tells the story of an entirely different yet equally informative story. For discussion of the Leslie Street Spit, see Pierre Bélanger in “Landscape as Infrastructure” published in Landscape Journal, Vol.28, No.1 (2009),

11. The Hamilton Harbor is one of the 43 sites (Areas of Concern) in the Great Lakes watershed currently undergoing massive clean ups spearheaded by the International Joint Commission of Canada and the United States.

12. The Taro East Landfill that services the Greater Hamilton Area is owned by Philip Services Corporation (PSC), a waste management giant dragging under a one-billion dollar debt load from environmental lawsuits. See Marley, Michael. “Philip, subsidiaries pursue bankruptcy cover in Canada” American Metal Market (23 September 2003).

13. Marian Chertow (Director, Yale Center for Industrial Ecology), “The Economics of Recycling”, Keynote, By-Products Beneficial Use Summit, Philadelphia PA (November 29-30, 2005).

14. See “The Five Most Dangerous Myths About Recycling” by Brenda Platt, The Institute for Local Self-Reliance (Washington, D.C.), www.grn.com/library/5myths.htm

15. Critical to this transformation is the hegemony of speed in modern industrial production. From mining to agriculture to construction, the acceleration of industrial processes has essentially underpinned Modernity in the 20th century. That underlying hegemony is currently being usurped by the combined paradigms of pace, synergy and synchronization that privilege co-operations, exchanges and inter-relationships. For a related discussion on the relevance of synergy, see Hermann Haken, *The Science of Structure: Synergetics* (Van Nostrand Reinhold Company, New York: 1981) and Buckminster Fuller’s *Synergetics I-II* (Macmillan Publishing Co.: New York, 1975 & 1979).

16. “A History of Environmental Policy in Denmark”. SusNord-Governance for Sustainable Development in the Nordic Region, 2003. http://www.prosus.uio.no/susnord/denmark/national_authorities/

17. Conversation with Noel Brings Jacobsen, Director, Kalundborg Industrial Symbiosis Institute, Denmark (December 2002).*

18. Second- and third-generation materials are being re-used as raw inputs as opposed to virgin resources that are proving to be more and more expensive with the increasing costs of resource mining, offshore exploration and global transportation.

19. What is often left underrepresented in the literature about Kalundborg is the importance of geography (proximity of industries), transportation (logistical synchronization and truck volumes) and lay-down areas (horizontal space required for storage and circulation of materials).

20. This section on Lagos is informed by four successive trips culminating in 20008, and is significantly informed by the work of urbanist, AbdouMaliq Simone, with specific reference given to two of his writings: A. Simone, *Urban Processes and Change in Africa* (CODESRIA, 1998) and A. Simone & D. Hecht, *Invisible Governance: The Art of African Micropolitics* (New York: Autonomedia, 1994).

21. The economic geographies of urban markets in Lagos are directly connected to trade and traffic along the Lagos-Abidjian 4000-kilometer West African Trade Corridor. See Dr. Bio Goura Soulé, “Prospects For Trade Between Nigeria And Its Neighbours (Déclassifié),” Club du Sahel, Organisation Pour La Cooperation et Le Dévelopment Économique, Club du Sahel (24 November 2000): p.31; & “Organisations et Stratégies des Commerçants” in Suivi Des Echanges Transfrontaliers Entre Le Nigeria et Les Pays Voisins (Bénin, Cameroun, Niger, Tchad), Echo Des Frontieres No. 15 (Juillet-September 2000).

22. Idelofun Market Women Association, Personal conversation with author, 2003, 2006, 2008.

23. Kayode “Sunday” Adeyemi, Tin Can Burner Fabricator, Personal conversation with author, 2003/2008.

24. Wilbur Smith and Associates, Master Plan for Metropolitan Lagos, United Nations Centre for Human Settlements (Habitat), 1980.

25. Security Watchman under the Carter Bridge Offramp, conversation with author (17 March 2000).

26. For a complete documentation of transportation master plans, see Lagos State Government, Lagos State Regional Plan 1980-2000 (Ikeja, Lagos: Ministry of Economic Planning and Land Matters, Urban and Regional Planning Division, 1981).

27. Urban scholar, Margaret Peil was one of the first to identify this dual condition. See M. Peil, *Lagos: The City and Its People* (London: Bellhaven Press, 1991).

28. The declaration of coastal lands in public trust by the Babangida Administration in the 1990s is part of long line of successive land use decrees and legislative policies that, to different extremes and

scales, have adversely affected Nigerians in the Lagos Lagoon region and especially the Niger Delta Region as a result of oil wealth, See Rhuks Temitope Ako, “Nigeria’s Land Use Act: An Anti-Thesis to Environmental Justice”, Journal of African Law, Vol. 53, No. 2 (2009), pp. 289-304.

29. “Pénuries Chroniques d’Hydrocarbures in L’Écho Des Frontières”, Sommaire No.13, Suivi Des Échanges Transfrontaliers entre Le Nigéria et Les Pays Voisins (Bénin, Cameroun, Niger, Tchad), Juillet-Septembre 1998; J. Adeyeye, “Fuel Hawkers: Without the Activities of Fuel Hawkers, Many Motorists Wouldn’t be Able to Keep Their Vehicles on the Road,” This Day (25 February 2001).

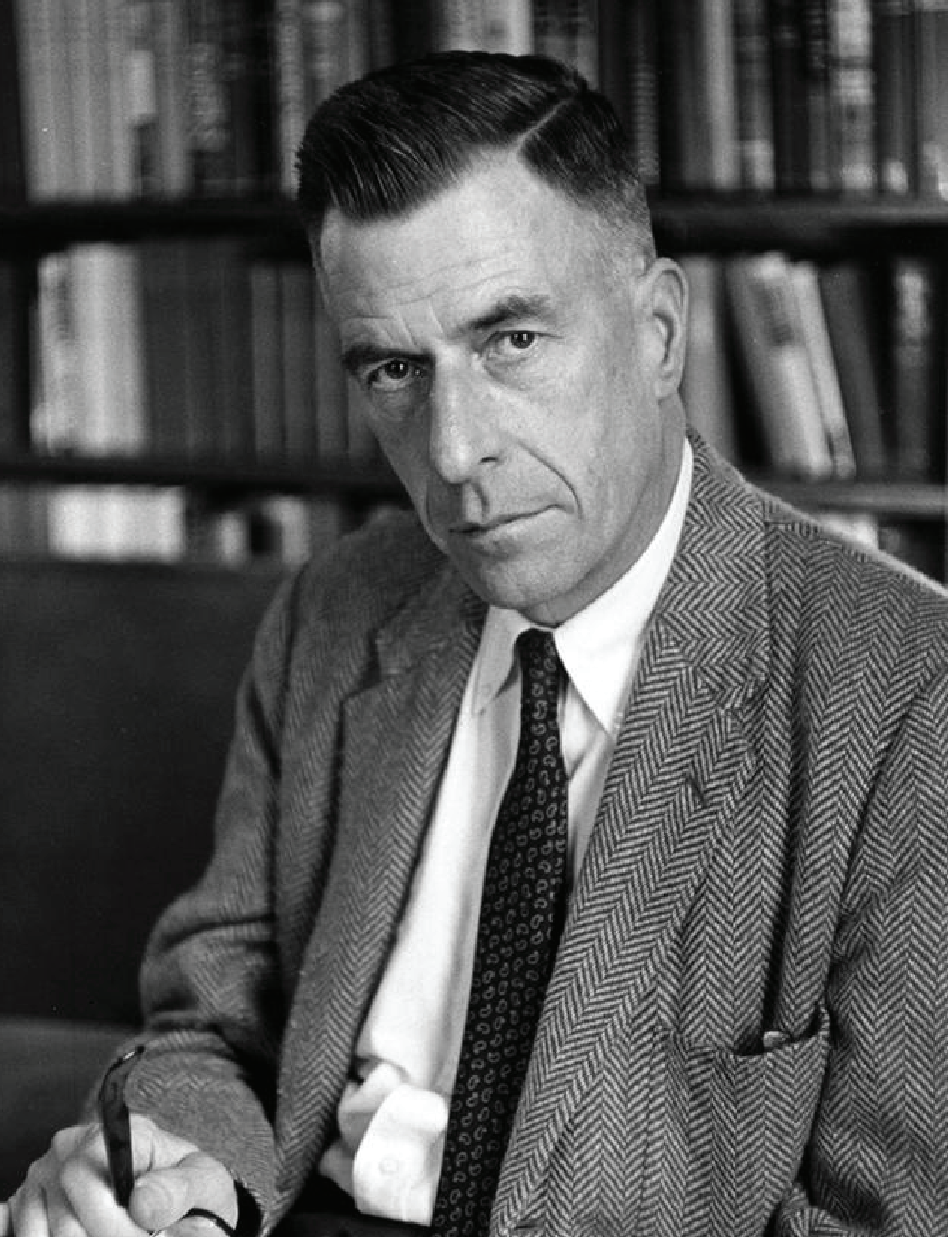
30. Dr. A.A. Ogunsaya, ”Urban Markets as Freight Nodes in the Lagos Metropolis,” Habitat International Vol.8, No.3/4, 1983, p.265.

31. See Global Environment Centre Foundation, “Eco-Towns in Japan: Implications and Lessons for Developing Countries and Cities”, June 2005.

32. Kevin Lynch was one of the first urbanists in North America to explicitly articulate the relationship between waste, ecology and urban patterns in Wasting Away: An Exploration of Waste & Urban Ecology (Sierra Club Books: San Francisco, 1991). This discourse has more recently been reclaimed by Alan Berger in his seminal book Drosscape: Wasting Land in Urban America (New York: Princeton Architectural Press, 2006).

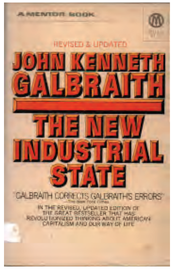
Originally published in Topos Magazine *No. 60 (October 2007): 83-91.*

Landscape as Infrastructure.



In the last century, capital [and power] became more important than land.

John Kenneth Galbraith, 1967[1]



1 . Galbraith, John Kenneth. 1967. The New Industrial State. New York: Houghton Mifflin Company.

Nineteen-sixty-seven, the year that renowned economist John Kenneth Galbraith released his revolutionary bestseller *The New Industrial State*,[2] was a year of landmarks. It was the year that marked the end of General Motors' two year long Futurama exhibition that attracted over 29 million people at the New York World's Fair. For the largest employer in the US, 1967 also saw the introduction of three new models including the Cadillac Eldorado, the Chevrolet Camaro and the Pontiac Firebird. While GM celebrated the production of its one millionth U.S. made car that same year, it also faced a major labor backlash outside its headquarters in Detroit, amidst a year of civil rights rioting across the country in cities like Newark, Plainfield, Cleveland, Cambridge, Buffalo and Milwaukee. The year was also 1967 that the Outer Space Treaty banned the use of nuclear weapons in space while underground nuclear testing continued in Nevada's Yucca Flat. This was also the year that the Vietnam War passed its midway mark, just before San Francisco's 1968 Summer of Love. It was also the year of Apollo 4, the first unmanned flight in earth's orbit returning never-before-seen images of planet earth.

More importantly, 1967 was the year that a small staff of five at the Milwaukee Journal, after successfully campaigning to stiffen the law against water pollution in Wisconsin and the Great Lakes, was awarded the Pulitzer Prize for Public Service. The award was a notable advance in the national effort for the conservation of natural resources against the dangerous trends of downstream contamination from Wisconsin's mainstay industries of papermaking, brewing, cheese making and vegetable canning. A decade later, as a result of those efforts in the "Genuine American City", President Jimmy Carter signed the Federal Clean Water Act, which had the ambitious goal of eliminating all wastewater discharges into the nation's waters by 1985. Though the statute has fallen short of its ambitious goal to end all pollution, largely from non-compliance and non-enforcement,[3] the Clean Water Act did cast light on a dark industrial age when Americans could not swim in major rivers like the Mississippi, the Potomac and the Hudson; an age epitomized by incidents in the Great Lakes like the fires on the oily surface of Cleveland's Cuyahoga River, the declaration of Lake Erie as a dead zone, the over-fertilization of Lake Ontario from sewage and detergent discharges and the mercury contaminations that closed fisheries on Lake Superior, Lake Michigan and Lake Huron.[4]

By the second half of the 20th century, a clear and visible correlation could be grasped between industrial processes and environmental resources especially around the Great Lakes, once the industrial manufacturing nerve centre of North America. Now, the region is burdened with the highest concentration of contaminated sites and waters in North America; second only to the state of California. Therefore, the year 1967 therefore represents a turning point in the history of North America as a period that "left a legacy of industrial production, infrastructure decay and pollutants on the contemporary landscape".[5] The failure to return land to productive reuse and reinvest in public works signals that conventional approaches to redevelopment and remediation have reached a tipping point. The financial magnitude and logistical complexity of the challenge facing the North American economy can no longer be resolved by singular, specialized or technocratic disciplines such as civil engineering or urban planning that once dominated 20th- century reform. How then can a different understanding of infrastructure — the collective system of public works that supports a nation's economy — jumpstart a new era of remediation and redevelopment across North America? This moment in history demands a reconsideration of the conventional, centralized, and technocratic practice of infrastructure and the discipline of civil engineering that have overshadowed the landscape of biophysical systems—as a decentralized infrastructure—that predates the dynasty of modern industry.[6]

FAILURES & ACCIDENTS

The quest for a more contemporary understanding of infrastructure in North America begins with a reconsideration of modern mass industry best revealed through a series of failures and accidents rather than by design or planning. In the Great Lakes Region there are two sites with two decisively different outcomes that exemplify the legacy of modern industry in the 20th century: the first is a chemical dumpsite in Niagara Falls, New York, and the second is a demolition dumpsite in Toronto, Ontario.

The Love Canal

In 1978, during the construction of the LaSalle Expressway in southeastern Niagara Falls, over 20,000 tons of toxic waste was discovered in what is now recognized as America's most notorious dumpsite. The 16 acre site - a one-mile long, fifteen foot wide and ten feet deep trench that was originally built by William T. Love as a hydroelectric and transportation project between the upper and lower Niagara Rivers -was used as a chemical dump for more than 10 years between 1942 and 1953 by the Hooker Electrochemical Company.[7] Prior to that, it was used as a weapons dump for the United States Army since World War I. Prior to its military-industrial use, the canal was bucolically used as a local swimming basin during the summer and as a skating rink during the winter. Once filled and capped, the site was then reluctantly sold to the City of Niagara for a dollar. With the baby-boom pressure after Word War II, the municipality built a school and a 100-home neighborhood on top and around the former dumpsite. From the mid 1950s through the 1970s, a record number

<
Orbital Representation, 1967
The orbiting Earth at an altitude of 9,745 nautical miles, this view was photographed from the unmanned Apollo 4 (Spacecraft 017/Saturn 501) on November 9, 1967, looking west towards the coast of Brazil, the Atlantic Ocean, West Africa, Sahara, Antarctica, unmanned, Earth-orbital space mission. Source: NASA Space Flight Mission, AS04-01-410

<
2 . Originally from a small rural agricultural community in Southern Ontario, John Kenneth Galbraith laid out in his revolutionary bestseller *The New Industrial State* at the end of the 1960s, six of the most noticeable cumulative aspects of modern mass industry with their corrsponding spatial morphologies included: A. large physical scale of production (horizontal plants), B. massive heavy equipment inputs (resource extraction & energy production), C. large capital investments (banks & credits), D. expanding labor divisions (management hierarchies, head offices & factory floors), E. increasing corporate organizations (corporate campuses, research laboratories, management systems) and F. long term planning (computing, forecasting software & data storage).

3. For a thorough discussion of water policies in North America and the Great Lakes over the past three decades, see John A. Hoornbeek's *The Promises and Pitfalls of Devolution: Water Pollution Policies in the American States* (2005) and and Jo Sandin's *30 Years Later, Water Cleanup Continues to Fight Current in Milwaukee Area* (2001).

4 . Not surprisingly, "the solution to pollution is dilution" was industry's most prevailing dictum for well over two centuries.

5. For an authoritative discussion on the subject and case studies involving brownfields remediation and landscape architecture, see *Niall Kirkwood Manufactured Sites: Rethinking the Post-Industrial Landscape* (2001).

6. The modern industrial landscape of North America originates from "Euclidean" planning principles. In a landmark federal court case dating back to 1926, Village of Euclid, Ohio vs. Ambler Realty Co. (272 U.S. 365), a U.S. Supreme Court judge approved an injunction deposed by a public authority to prevent the development of an industrial cluster adjacent to a town centre and residential neighborhood. The case led to the first legislated use of land classifications from which precipitated modern forms of planning through zoning. Reliant upon public ordinances, Euclidean planning has led to the widespread practice of land subdivision characteristic of the decentralized pattern of cities across the United States and Canada. To this day, zoning remains one of the most instrumental mechanisms in the social, spatial and economic structure of the North American landscape (Willhelm 1962, Pogodzinski and Sass 1990).

7. Chemicals found at the Love Canal were by-products from the commercial production of chlorine, a building block for the military and energy industries.

of illnesses were reported as a result of chemical exposure, including rashes, burns, miscarriages and birth defects and cancer.[8] Now infamous, Love Canal was the first contaminated site to gain national and international attention due to the scale and magnitude of its consequences. That recognition was instigated by the ground level research of Lois Marie Gibbs, a proactive mother who formed the Love Canal Homeowners Association in the mid 1970s after discovering the location of the dumpsite below her son's elementary school. Recalling the explosive nature of the Love Canal incident in the Spring of 1978, former EPA administrator Eckardt C. Beck observed a period of record rainfall in the region:

Corroding waste-disposal drums could be seen breaking up through the grounds of backyards. Trees and gardens were turning black and dying. One entire swimming pool had been had been popped up from its foundation, afloat now on a small sea of chemicals. Puddles of noxious substances were pointed out to me by the residents. Some of these puddles were in their yards, some were in their basements, [and] others yet were on the school grounds. Everywhere the air had a faint, choking smell. Children returned from play with burns on their hands and faces.[9]

That same year, the school was closed, pregnant women and children were evacuated, and home-grown vegetables were banned, from the discovery of dangerous leaching from the buried toxic materials. To prevent further risks of human and environmental contamination, the state purchased and leveled 239 homes near the canal, and relocated 900 families a year later. After President Jimmy Carter declared Love Canal a federal disaster emergency zone in October 1980, everyone in the Love Canal area was evacuated and relocated with money advanced by the state and federal governments.[10] For one of the first times in the history of North America, the incident signaled a clear and present association— an ecology—between industrial operations and the biophysical systems that underlie them.

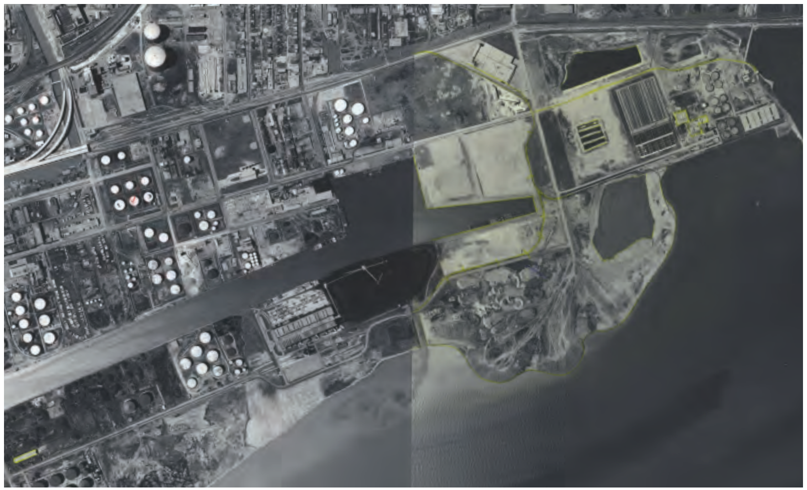
The toxic tragedy of Love Canal spawned the development of what would become one of the most important legislative programs in the

8. Between 1974 and 1978, defects occurred in 56 percent of births at Love Canal and have been attributed to high levels of dioxin, the most toxic chemical known to humankind according to the Love Canal Homeowner's Association (CHEJ, 2001). Disputed and debated, these results have been subject of countless government studies over the past two decades.

9 . Beck, Eckardt C. 1979. The Love Canal Tragedy. EPA Journal (January). www.epa.gov/history/topics/lovecanal/01.html

10. U.S. President Jimmy Carter declared Love Canal a federal disaster emergency zone in October 1980.

Toxic Topography
Aerial view of the Love Canal on the shoreline of the Niagara River, the site that spawned CERCLA in the 1980s, the Comprehensive Environmental Response, Compensation, and Liability Act, better known as the Superfund Law. Despite the abandoned lots and paved over properties surrounding the submerged fenced-in landfill, the site was delisted by the USEPA from the Superfund in 2004 after 20 years and 200 million dollars worth of demolition, remediation and encapsulation. (Source: Google Earth, 2008)



Constructed Ecology
The crenellated jetty of the Leslie Street Spit which projects 5 kilometers southward from the shoreline of Lake Ontario, near Downtown Toronto. Landfilling operations are still active on the eastern half of the headland, while the western half is used for recreational and ecological park use. Below, the origins of the Spit in 1964 as the fire dump where liquid effluents where set on fire on the edge of the shoreline within the vicinity of 400-hectare industrial area of the Portlands (Photo: Pierre Bélanger, City of Toronto Archives)

United States, the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), that aimed at reversing the dangerous trend of chemical dumping, groundwater contamination and air pollution.[11] The legislation heightened environmental awareness of incidents around the world from the Tar Ponds incident in Nova Scotia, Canada (1981), to the nuclear reactor accident in Chernobyl, Ukraine (1986). Known as Superfund, this 1.6 billion dollar program originally directed the US Environmental Protection Agency to clean up a list of 480 national priority sites. With the growing concerns over groundwater quality in the country, the program has grown to staggering proportions dealing with more than 1300 sites throughout the country. However, with its emphasis on the legislative attribution of blame and responsibility during the past twenty years however, the Superfund Program failed to gain traction on the actual remediation and clean up of sites. Despite its heroic intentions, the Superfund's "polluter-pays and one-size-fits-all" policy effectively failed due to mounting costs of litigation and generic remediation technologies applied to depressed local economies and site-specific ecologies.[12] Today, after a 200 million dollar lawsuit, the evacuation of over 200 families and 50 million dollars in site remediation, the remaining legacy of Love Canal's past is a bulldozed community, a razed school, a vacant street and a fenced-in berm.

The Leslie Street Spit
While the Love Canal incident remarkably catalyzed the era of post-industrial remediation in the United States, another lesser known dumpsite some 300 kilometers across Lake Ontario from Niagara Falls, tells the a different, yet equally informative story. Projecting southward from the shorelines of Downtown Toronto, the dumpsite is a linear headland constructed with waste materials, mostly concrete and rubble from urban operation such as the excavation of urban sites, the construction of subway tunnels, the demolition of buildings form the city centre and the dredging of the Toronto Harbor in the 1960s, 70s and 80s. Generically dubbed the Leslie Street Spit, the headland was initiated by the Toronto Port Authority as a shoreline disposal program in proximity to the downtown area that would simultaneously function as a coastal barrier for the city's inner harbor.

11. Environmental legislation in the United States emerged at a time of heightened environmental awareness around the world with incidents such as such as the Three Mile Island nuclear accident in Dauphin County, Pennsylvania (1979-80), the Ridderkerk toxic dumpsite in The Netherlands (1981), the Tar Ponds in Sydney, Canada (1982), the Times Beach dioxin spraying incident in Missouri (1983), the DOW chemical spill in Bhopal, India (1984) and the nuclear reactor accident in Chernobyl, Ukraine (1986).

12. The National Center for Policy Analysis provides a stinging indictment of the CERCLA program in "Superfund: A History of Failure" (1996).

>
Incidental Landscape
Sequence of accumulation and transformation of the Leslie Street Spit over the past 40 years showing the most recent access system and planning process by FIeld Operations/James Corner. (Diagram: Pierre Bélanger & Dave Christensen)

1956
1957
1958
1960
1961
1962
1963
1964
1965
1966
1967
1968
1970
1971
1972
1973
1974
1975
1976
1977
1978
1980
1981
1982
1983
1984
1985
1986
1987
1988
1990
1991
1992
1993
1994
1995
1996
1997
1998
2000
2001
2002
2003
2004
2005
2006
2007
2008

Furthermore, the silty clay geology underlying the city proved to be an ideal base material for the construction of the headland with excavated urban materials. During the forty year period that spanned the development of the downtown area, the headland slowly grew into what is now a five kilometer long peninsula.

Due to protracted neglect precipitating from the failure of the shipping boom, emergent vegetal and animal species slowly colonized the peninsular landmass in the 1980s and 1990s. Unplanned and undesigned, the accidental ecology of plants, birds and mammals that took over this large wasteland within walking distance of the downtown area, attracted considerable attention from a different constituency. As early as the mid 1980s, Michael Hough – urban ecologist and landscape architect – was one of the first to recognize the case of the Leslie Street Spit as "one of the most significant wildlife habitats in the Great Lakes region in an environment where industrial growth has destroyed many of the habitats bird require, and has rendered others toxic."[13] With the intervention of the Toronto and Region Conservation Authority in the late 1990s, the headland was preserved as one of the most unique constructed wildernesses in North America.

As a poly-functional infrastructure, the headland operates today as an active dumping ground during regular business hours an ecological recreation area during off-hours for the more than five million inhabitants of the Greater Toronto Area, while continuously operating as a coastal protection barrier for nearby island communities. As a by-product of the logistics[14] of city building, the headland model provides visible evidence of the underlying correlation between the mechanics of urban construction and land manufacturing. Dismissed as clandestine, accidental or temporary, field operations-such as excavation, demolition, de-engineering, dredging, backhauling, backfilling and storage-are all representative operations and sites forming a decentralized landscape found throughout North America that, may have previously seemed disconnected and disorganized. The cases of active lakeshore reconstruction and land reclamation over the past two hundred years and, of the more than 350 lakeshore disposal facilities in the Great Lakes currently in operation, testify to the longevity and endurance of this paradoxical practice.[15]

13. Hough, Michael. 2004. Cities and Natural Process (Second Edition). New York: Routledge. 139

14. Logistics are essential when working at large infrastructural scales. It connotes the planning and management of the flow of resources, goods and information including the energy, waste and people between points of production and consumption. When applied to the context of urban infrastructures, the logistical use of land entails the management, for example, of large volumes of fluids (hydrology) and large volumes of aggregates (topography). The value of logistics was applied early on in large scale earthworks by the Corps of Topographical Engineers, an organization that pre-dated today's well-known United States Army Corps of Engineers (Beers, 1942).

15. This program establishes policies and best practices for processing and diverting sewage and sludge from feedlots as fertilizer on farm fields to minimize water quality and public health impacts (USDA 2008).

16. According to the U.S. Environmental Protection Agency and Environment Canada, there are approximately 50,000 brownfields in the Great Lakes region with real or perceived levels of contamination that pose significant obstacles to re-development (USEPA 2007).

SHIFTS & PATTERNS

Their historical, industrial and environmental contexts of the Love Canal and the Leslie Street Spit widely differ, but they are not unique. From a distance, the historical reclamation of land in the Great Lakes Region lays the groundwork for better understanding how mass-industrialization has shaped the North American landscape. A brief re-examination of land patterns and economic shifts over the past two hundred years, along with prevailing ideologies, can elucidate how that relationship has changed and evolved.

The Rust Belt

The pattern of contaminated sites[16] in the Great Lakes Region for example is the result of economic shifts in a geo-political region historically known as the Rust Belt. That region spans Wisconsin and Illinois to Pennsylvania and Upper New York State. During and after the two World Wars, the region underwent a considerable rate of growth in the areas of weapons production, chemical processing and automotive manufacturing. The abundance of iron ore, coal and fresh water in proximity of the commercial nerve centre of the Northeastern Seaboard were primary resources feeding the development of large industrial cities. Several decades later, this rate of transformation was upset, and in fact, reversed: the U.S. steel industry for example fell from 509,000 workers in 1973 to 240,000 in 1983. The widespread de-industrialization and de-militarization of the region caused large-scale incendiary attrition across cities such as Gary, South Bend, Detroit, Flint, Toledo, Cleveland, Akron, Canton, Youngstown, Wheeling, Milwaukee, Sudbury, London, Hamilton, Buffalo, Syracuse, Schenectady, Pittsburgh, Bethlehem, Harrisburg, Wilkes Barre, Wilmington, Camden, Trenton, and Newark. This litany of names is associated with the post-industrial fallout in the wake of relentless globalization. Heightened by the international mobility of corporations, the deindustrialization of the Rust Belt stemmed from national trade deregulation policies beginning with GATT in 1946 (General Agreement on Tariff and Trade) and ending with

NAFTA in 1994 (North American Free Trade Agreement). Both policies opened international borders southward to Mexico and westward to Asia where labor and raw materials were cheaper and environmental laws less stringent. As a result of global outsourcing,[17] plant relocations led to industrial de-corporation, land un-development, population un-employment and de-urbanization across North America. Bangkok has replaced Detroit, Shanghai replaced Cleveland, Taipei replaced Toledo, and Mexico City replaced Milwaukee.[18]

Flint

This economic fallout further precipitated the population vacuums of inner cities in the Rust Belt from the 1950s onward, largely leaving them victims of decaying oversized infrastructure, contaminated vacant land and heavy tax burdens. In his award winning documentary "Roger and Me" , Michael Moore criticized the General Motors Corporation and CEO Roger Smith for closing down all the assembly plants in Flint, Michigan leaving over 40,000 people jobless and the entire city virtually bankrupt in the 1980s.[19] Despite big- idea regeneration projects, such as the $13–million Hyatt Regency Hotel or the $100–million AutoWorld theme park, tourism has failed to redress the generic landscape of General Motors plants and lots, now lying largely vacant and abandoned. Flint's economy was rendered immobilized by the inexorable force of global capital mobility.[20,21] Today, the most industrially active areas of the city are ironically two landfills that flank the city of Flint on the north and south ends. However, the overgrown banks of the Flint River are a testament to the imminent rebound of its biodiversity from neglect and abandonment. Decline seems to have become the progenitor of ecological regeneration. As a catalytic infrastructure, landscape is rendered visible at the precise moment at which the city fails.

Youngstown

The failure of Flint's urban recovery contrasts sharply with the case of Youngstown, Ohio. Today, a contemporary form of landscape regionalism[22] is being applied in the urban political work of Jay Williams was elected as the new, young mayor of Youngstown, Ohio in 2005. The former steel town lost more than half of its 170,000 residents in the past twenty years

17. On the effects of global outsourcing and its spatial manifestation in North America, see Thomas L. Friedman's The World Is Flat: a Brief History of the Twenty-first Century (2005).

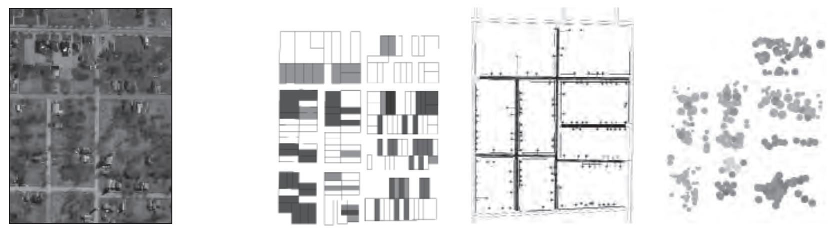
18. On the surrogate industrialization that usurped the Motor City, see Roland Jones' "As Detroit falters, Asian makers pick up speed" Toyota likely to surpass GM as world's top carmaker; China lurks in wings" (2006).

19. Moore, Michael. 1989. Roger and Me Film) USA.

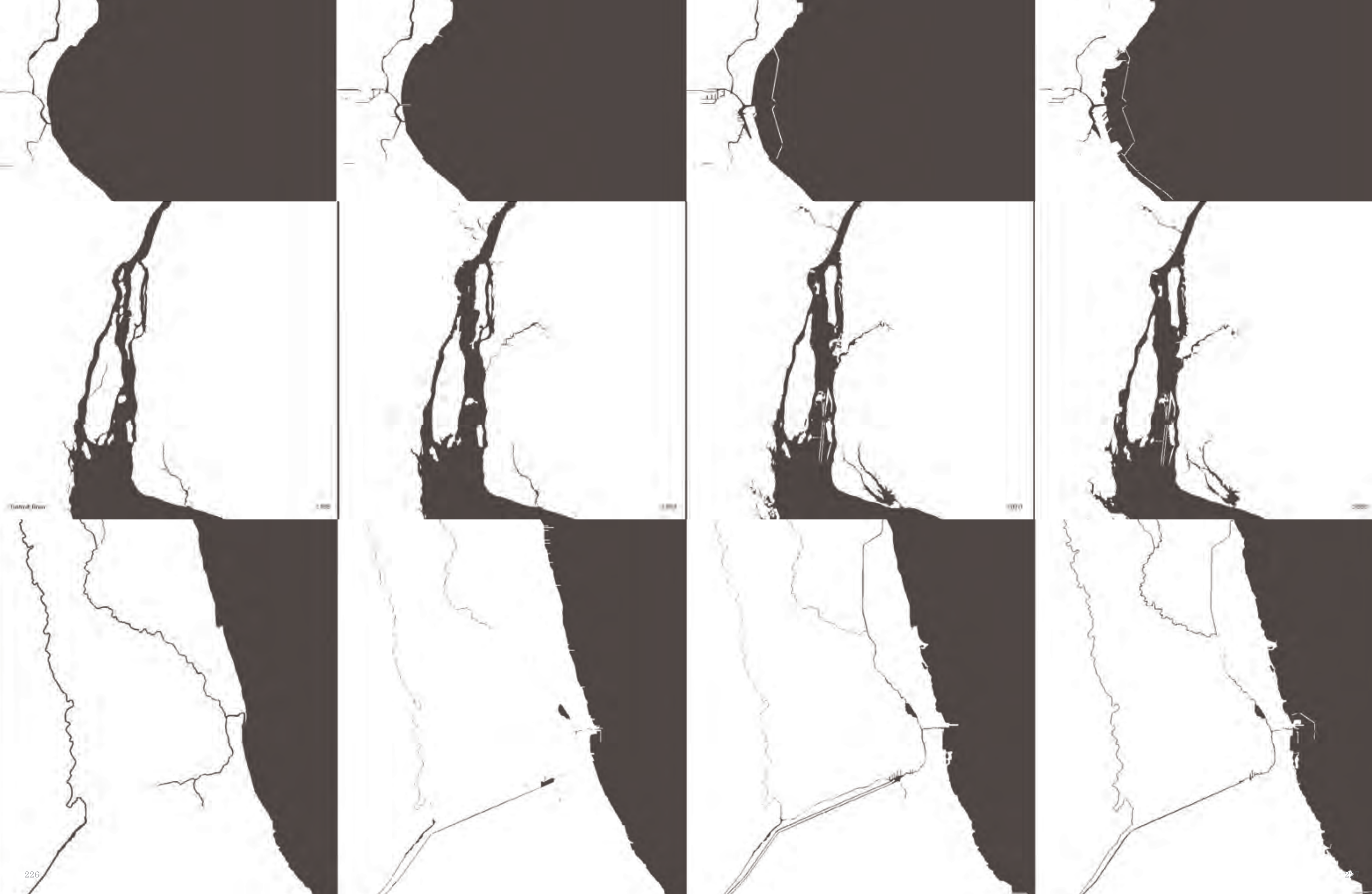
20. Harvey, David. 1996. Globalization and Deindustrialization: A City Abandoned. International Journal of Politics, Culture and Society 10(1) :175-191.

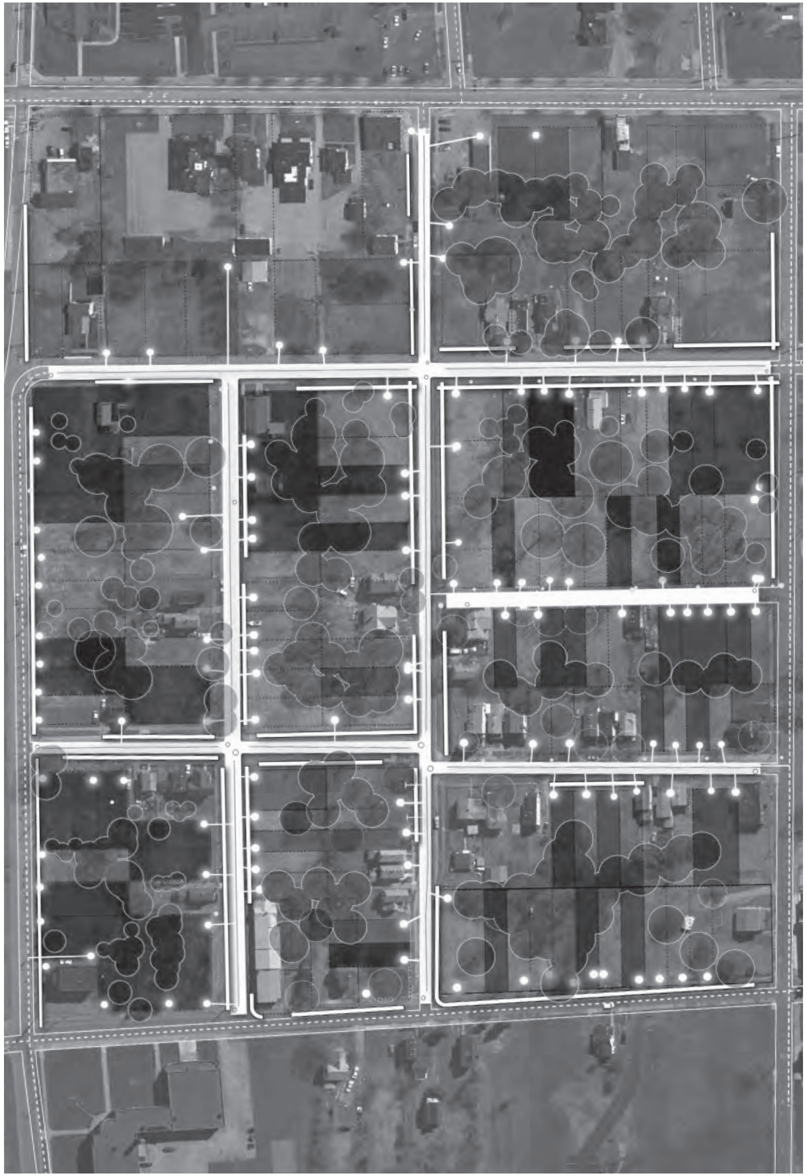
21. Dandaneau, Steven P. 1996. A Town Abandoned: Flint, Michigan, Confronts Deindustrialization. Albany: State University of New York Press.

22. Regionalism in the Great Lakes has also underpinned work by the Toronto Region Conservation Authority created after Hurricane Hazel in 1954. In the early 1990s, David Crombie - now President of the Canadian Urban Institute - proposed a landscape system for cities within the Lake Ontario watershed by simply delineating major bio-physical zones for non-development and other urban areas for redevelopment. Rather than control growth, the system privileged-much like Olmsted's planning of the Mont-Royal in Montréal and Mackaye Appalachian trail system-the preemptive and proactive conservation of large biophysical features such as the Oak Ridges Moraine and the Niagara Escarpment as an infrastructure (Crombie 1990).



Demobilization, Dezoning & Disurbanization
An evacuated area of Ward 3 in the former steel city of Youngstown, Ohio. The decentralized pattern results from subtracted layers of infrastructure – including buildings, lamp standards, power lines, sewer connections, sidewalks, and entire streets - which have been removed as a result of property abandonment, bankruptcies, foreclosures and other fiscal burdens. In exchange for back taxes, land stewardship and property upkeep is provided by neighbouring residents. Overall, the 45 to 75% reduction in stormwater runoff and sewage loading, coupled by the increase in permeable surfaces, result in a significantly lower infrastructure maintenance portfolio for the Department of Public Works. The area was formerly zoned as R1.0-1.5 and currently being rezoned for a range of more productive land uses. (Photo: Digital Globe 2008, Diagram: Pierre Bélanger & Hoda Matar)


Detroit River



because of countless plant shutdowns like Republic Steel and Youngstown Sheet & Tube Company. Lands abandoned after the fallout of heavy industry total more than 15,000 acres that John Young originally purchased in 1802 when he founded the city. In 2006, there were some 12,000 commercial and residential vacant properties. In a remarkably un-American, unindustrial way, Williams proposed a strategy of protracted shrinkage rather than growing its way back to prosperity. Williams' strategy is novel in that it calls for an overall downsizing of the city by razing derelict buildings, by cutting off infrastructure, banking vacant land or rezoning heavy industrial districts. Triggered by fiscal deficits and opportunistic land uses, the general realignment of the city's lands was made possible through the overlay zoning and land banking. Power and sewage is being removed from fully abandoned tracts of land. Vacant lots turned into pocket parks where back taxes are exchanged for land stewardship by neighboring residents. Remaining lands are assembled and amalgamated in one huge land bank for future re-organization.[23] In the mean time, these opened lands serve another unintended yet essential service: they expand permeable surface coverage area increasing groundwater infiltration when considering the 535 miles of asphalt pavements it must maintain. Stormwater collected in the pipe-and-gutter system is decreased, justifying the dismantlement of the system. In some areas, the strategic removal or closure of roads accommodate the construction of new plants further contributes to this objective by effectively enlisting transportation systems as part of the overall structure of the urban landscape.

The typical menu of mixed used housing with green space thus becomes irrelevant. Instead, old land uses are swapped for new designations, and uses can be swiftly superimposed. The traditional, sluggish process of legislative re-zoning bypassed with the opportunistic use of overlay zoning. One of the major outcomes of this legislative shortcut involves a 3,300-acre corridor of light industrial lands (for non-polluting green industries) lining the Mahoning River. Once the sewer of the valley's steel mills, the Mahoning now figures as the conduit of Youngstown's future.[24]

23. Permitted on residential lots larger than 3 acres, are agrarian land uses such as produce fields, horse ranches and cow pastures are spreading quickly (Associated Press, 2007).

24. City of Youngstown and Youngstown State University. 2005. The Youngstown 2010 Citywide Plan. http://www.youngstown2010.com/plan/plan.htm

Echoing Richard T. Ely's approach to land economics during the crisis of the Great Lakes Cutover in the 19th century, Williams's decommissioning strategy suggests a general process of de-urbanization, where industrial un-development and land un-incorporation will ultimately reduce the tax burden on citizens and maintenance burden on the public works department. Instead of romanticizing its industrial past, Youngstown hopes to capitalize on its high vacancy rates and under-utilized public spaces to become a culturally rich bedroom community serving Cleveland and Pittsburgh, both less than 70 miles away.[25] For Youngstown, suburbanization is necessary and imperative for recasting its urban future.[26]

25. Belinda Lanks' The Incredible Shrinking City (2006).

26. Robert Bruegmann's Sprawl: A Compact History (2006).

STREAMS & SYNERGIES

Although de-industrialization has been the dominant effigy in the history of the Rust Belt and the Cutover, mass-urbanization is currently causing considerable change. Geopolitical forces—such as trade deregulation, product outsourcing, automated manufacturing, biomedical research, and just- in- time delivery—signal a significant structural shift across North America. From former industrial states to new urban economies, this massive transition is, however, coinciding with erosion of national infrastructures. Isolated incidents such as bridge collapses, dyke failures, levee breaks, coastal flooding, power outages, water shortages, road cave ins, decaying sewers, and deferred maintenance, when considered together, provide evidence of the limited capacity of conventional infrastructure to deal with the complex challenges of mass urbanization. Historically, mono- functional approaches to the design of infrastructures have typically segregated the basic provisions of water, waste, transport, food, and energy into separate, unrelated departments. At large regional scales, bureaucratic separation of infrastructural services is proving costly and ineffective. Over long periods of time, it can also be dangerous.

As an alternative, the collective body of the ideas and strategies forwarded by Richard Ely (1854–1943), Frank Lloyd Wright (1867–1959), Benton Mackaye (1879–1975), Michael Hough (1928–), Lois Marie Gibbs (1952–), and Jay Williams (1971–) is relevant and informative. They provide a basic, albeit imperfect, understanding of how we conventionally perceive infrastructure as a mere collection of public utilities. As methods, this body of work provides a basic understanding of the efficiencies and synergies made possible through the de centralization of urban structure and the de- engineering of urban infrastructure made possible by design. Illustrated by the transformation of the Great Lakes Region over the past two centuries, those changes are inseparable from global- regional economic shifts and the ecological imperatives they face. Probing current sectors of economic change in the region provides insight into new, more flexible, and more efficient approaches to infrastructure. Along with the synergies they engender, three contemporary streams of development are explored briefly: urban ecologies, bio-industries, and waste economies. The shift from conventionally large, centralized industries of mass production to a decentralized pattern of production signals a new era for urban economic regeneration, land use distributions, and site redevelopment opportunities.

Urban Ecologies

Over the past two decades, the emergence of the field of landscape ecology[27] has contributed to a more in-depth understanding of the long terms effects of industrialization and urbanization on bio-physical systems. Together with late-century visualization technologies (from satellite photography, ground penetrating radar to deepwater sonar imaging) and explosion of the environmental sciences. These effects can now be better understood both at the macro- and micro-scale, especially with advances in the metrics of dynamic water flows and watersheds. Endogenous and exogenous processes such as eutrophication, combine sewer overflow, sediment contamination, exotic fish populations, depleting water reserves or seasonal floods can no longer perceived as isolated incidents but rather as part of large constructed hydrological ecology that is entirely and irreversibly connected to the process of urbanization.[28] The slow yet large scale accumulated effects of near water industries and upstream urban activities once considered solely at the scale of the city, are now more effectively understood at the scale of the region.

27. Forman, Richard T.T.. 1986. The Emergence of Landscape Ecology. In Landscape Ecology. Richard T.T. Forman & Michel Godron eds). New York: John Wiley & Sons.

28. In his controversial article, "Brave New Ecology" (2006, 46-48), Peter Del Tredici discusses the culturally flawed distinction between native and exotic species and claims that it has overlooked the importance of invasive species in cities. The use of the terms endogenous and exogenous systems are legitimate and more objective substitutes to the native-exotic dialectic.

Great Lakes Watershed

The 43 Areas of Concern (AOC's) in the watershed region of the Great Lakes, jointly designated by the US-Canada Great Lakes Water Quality Agreement (Annex 2 of the 1987 Protocol). These areas are defined by the International Joint Commission as "severely degraded geographic areas that fail to meet the general or specific objectives of the agreement where such failures has cause or is likely to cause impairment of beneficial use of the area's ability to support aquatic life." The U.S. and Canadian governments have identified 43 areas; 26 in U.S. waters, 17 in Canadian waters and 5 are shared between U.S. and Canada on connecting river systems. (Diagram: Pierre Bélanger, Dave Christensen).

At the centre of this ecological renaissance is a massive remediation program in the Great Lakes Region spearheaded by the International Joint Commission (IJC).[29] As a co-operative agency, its mandate is to advise on the use and quality of boundary waters in Canada and the United States. Two of the most pressing challenges addressed by the Commission are sediment decontamination and combined sewer overflow on water quality in the Great Lakes.[30] Recognized as the largest most important sources of contamination entering the food chain in Great Lakes rivers and harbors, polluted sediment from decades of industrial and municipal discharges has historically limited remediation and redevelopment efforts. As a result, the IJC has initiated a massive clean up program at the scale of the Great Lakes Region. Remedial action plans are currently underway for 43 sites listed as high-priority areas of concern. The transboundary program involves multilateral funding and cross-border legislation to accelerate cleanup and redevelopment of the most contaminated site, mostly harbors, in the downstream region. Upstream, strategies of groundwater infiltration (using permeable surfaces, instead of gutters-and-pipes) and sewage management (using sludge recycling instead of central waste water treatment) are aiming to reduce loads on stormwater systems while contributing to groundwater infiltration. According to the Center for Watershed Protection, costs for decentralized systems for stormwater management are estimated to be three to five times less the cost of conventional buried systems when considered their full life cycle costs.[31,32] Notwithstanding canopy coverage, the abundance of available surface area, in suburban developments makes them particularly excellent candidates for future transformation. In the aggregate, suburban patterns are more flexible and suitable to change then their historic and rigid inner city counterparts. As a result, contemporary practice will necessarily become accountable for watershed-level parameters ranging from surface performance, groundwater dynamics, downstream effects, and subsurface geology.

With the growing rate of urbanization of the Great Lakes Region, the IJC is now confronted with the rapid depletion of freshwater supplies that, according to the World Water Federation, is estimated between six to nine times the rate

29. The International Joint Commission is an independent binational organization established by the 1909 Boundary Waters Treaty to strategically control the amount of water that could be diverted from the Niagara Falls and to prevent further diversion of waters from the Great Lakes Basin.

30. The Sierra Legal Defence Fund estimated in 2006 that 24 billion gallons of municipal sewage were dumped into the Great Lakes. Commonly know as combined sewer overflow, the problem stems from conventional, centralized infrastructure of pipes and gutters that combined sewage and stormwater runoff during peak periods of rainfall. Overloaded systems flow out into open bodies of water spilling sewage towards finally flowing into lakes and rivers. Downstream impacts are evidenced by the closures of beaches, unsightly algae and poor fish habitat (SLDF, 2006).

31. The Center for Watershed Protection in the United States provides the most comprehensive, up-to-date information on measures for water conservation design and stormwater economies (http://www.cwp.org/). Another, equally important study is ECONorthwest's The Economics of Low Impact Development: A Literature Review (2007).

32. The transformation of urban ecologies relies on a sound scientific understanding of topography and vegetal systems with water dynamics – quantitatively and qualitatively - as the underlying superstructure at the regional watershed scale. The tectonic value of landforms and bio-economic characteristics of vegetal systems are best expressed in the writings of Clemens Steenbergen, a landscape architect from the Technical University of Delft who was one of the first and few European practitioner to underscore the relationship between topography and urbanism: "While modern architecture experimented in the middle of the past century with disconnecting topography and form, the landscape became a neutral tableau, reduced to its monumental aspects. The plan was projected onto this as an autonomous intervention.... Today, we find ourselves in an era where we can try to expose once again the landscape origins of the city [...] through a reformulation of its topography by reorganizing the urban fragments in the context of landscape (Arriola and Huet 1994)."

Landscape of Disassembly
The sorting, shredding, bundling and melting operations at Triple M Metal in Brampton, Ontario, one of North America's largest, most modern recyclers of ferrous and non-ferrous metals. The ISO 9001/14001 certified facility handles over 2.5 million tons of scrap every year, reprocessed for mills and foundries on the international commodity exchange markets. Recycled material currently accounts for about 40 percent of the world's steel production. It requires 75 percent less energy than the processing of iron ore and its waste emissions are nearly 90 percent lower. (Photo: Pierre Bélanger, Jacqueline Urbano 2008)

Greenhouse Effect
Aerial view of Leamington, Ontario, the greenhouse capital of North America. Due to highly fertile soils, increasingly warm temperatures and abundance of freshwater, the region has the highest rate of greenhouse start-ups in Canada almost doubling their production annually. Located on the 42nd Parallel, tender fruits, vine-ripened vegetables and specialty flowers are cultivated in controlled hydroponic conditions limiting pesticide inputs and runoff into nearby Lake Erie. Representing $1 billion in farm gate value, Leamington's greenhouse acreage is larger than the entire U.S. greenhouse industry combined. (Photo: GeoEye 2008)

of replenishment. The new adage is that water will be the oil of the 21st century[33]. Attention to the design of urban ecologies is therefore taking on pressing relevance for city-builders at large.

Bio-Industries

With attention focused on regional water resources in the past decade, the Rust Belt region is shifting to a more diverse economic base where some of the fastest growing industries are largely agrarian: viticulture (wine- making and grapevine crops), silviculture (timberlands and dimensional lumber mills), and floriculture (greenhouses and nurseries). Well into a decade of burgeoning expansion, growth rates in the bio-industry have oscillated between 5 and 10 percent, with retail expenditures topping 50 billion dollars a year for cut flowers, cultivated greens, potted flowering plants, bedding plants, sod, ground covers, nursery crops, bulbs, cut Christmas trees, and every other nursery, or greenhouse product imaginable. So competitive has it become to conventional heavy industry, the bio-industries are in fact exploding. Floriculture—plants for bioremediation and bioengineering for example—is currently outpacing all other major commodity sectors in sales growth according to the U.S. Department of Agriculture Economic Research Service since the early 1990s.[34]

Bio-industries can further be distinguished from conventional industries in what they take, what they make, and what they waste.[35] These developments echo a prediction made by the inventor of the assembly line almost a century ago. Henry Ford proclaimed that:

> The fuel of the future is going to come from fruit like that sumach out by the road, or from apples, weeds, sawdust – almost anything. There is fuel in every vegetable matter than can be fermented. There's enough alcohol on one's year yield of an acre of potatoes to drive the machinery necessary to cultivate the field for a hundred years.[36]

Vegetal production[37] is rapidly grabbing hold in the Great Lakes and will keep expanding thanks to global warming, where northern areas of America are opening up to agriculture. There are three types of bio-industries: greenhouse start- ups in the fertile Niagara Region

33. For more information on the imminent conflict of boundary waters, see Peter Annin's The Great Lakes Water Wars (2006).

34. Agricultural Economics Research Institute (AERI). 2007. Floriculture Worldwide: Trade And Consumption Patterns. The Netherlands. www.agrsci.unibo.it/wchr/wc1/degroot.html

35. Hawken, Paul. 1993. The Ecology of Commerce: A Declaration of Sustainability. New York: Harper Collins Publishers.

36. Henry Ford, as quoted in the Christian Science Monitor during a trip to Sudbury (Ontario), reported in the New York Times Ford predicts fuel from vegetation (1925): 24.

37. Vegetal fuel sources such as hemp, soy or corn were widely publicized by Henry T. Ford and Rudolf Diesel before the advent of alcohol prohibition and well before the supremacy of Southern U.S. oil barons (Pahl 2005).

that doubled between 2000 and 2005[38]; the construction of America's first indoor composting facility on the site of a former tire manufacturing facility in the Hamilton Harbor in 2005; and the construction of the Northeast's first bio-fuel plant on the site of a former brewery in Fulton, New York in 2006. The emerging stream of bio-industrial development signals an important shift whereby economies formerly based on the import of non- renewable hydrocarbons (oil, coal, natural gas) are being outgrown by economies of regionally renewable carbohydrates (soils, vegetal materials, biomass, and wind).[39]

Waste Economies

The contemporary challenge of mass-landfilling[40] effectively signals a turning point in the handling of garbage in big cities. Unilateral solutions to garbage collection and disposal born from mid 20th century industrialized forms of planning and engineering can no longer deal with the magnitude and the complexity of urban waste streams.[41] Closing the material loop[42] is the most significant shift in the economies of waste management. It shows that the that the unilateral dependence on landfilling can be counteracted through new, previously unforeseen economic and ecological synergies that exist between public regulatory agencies and private turnkey enterprise where it matters most: at the source of waste, in urban areas.

One of the most recent and informative examples of the potential effectiveness of this urban strategy is a new, state-of-the-art composting facility in the Hamilton Harbor, contaminated with polychlorinated biphenyls (PCBs) and petrohydrocarbons (PHCs). Built by a world-class public-private partnership between the City of Hamilton's Waste Division, Maple Reinders Constructors (a Canadian design-build company) and the Christiaens Group (a Dutch composting and mushroom technology expert), the 40-acre facility can process at full capacity up to 90,000 tons of wet organic garbage every year, big enough for the disposal needs of a city with 1 million people.[43] Built on the side of a former tire manufacturing plant as the first and largest indoor facility of its kind in North America, the operative costs at this central composting facility (CCF) are 25 to 35 percent lower than landfilling costs, simultaneously offsetting the cost of pre-development

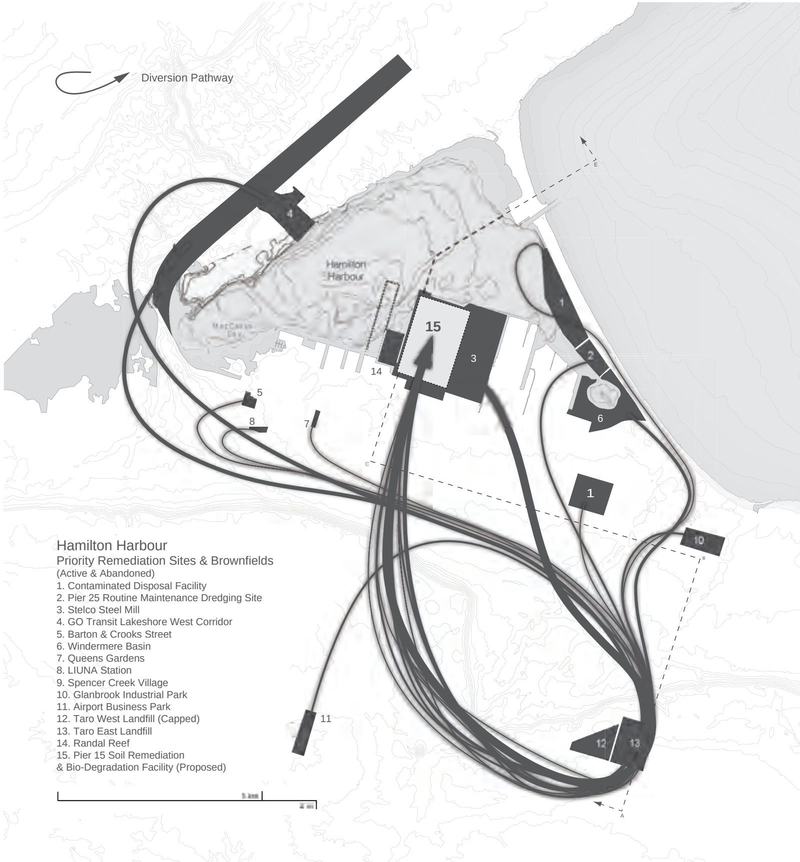
38. According to Ontario Flower Growers Incorporated, "there are more than 250 commercial greenhouses in the Niagara region and 126 hectares (310 acres) protected under glass or plastic. The industry employs about 3,000 people in the Niagara region, generating approximately $250 million in annual sales with agri-tourism that also provides a substantial economic source for the Niagara Region", www.ontarioflowers.com/potted_plants/location.htm).

39. Bio-industries will have a significant impact on the future of energy generation in big cities. Copenhagen, for example, produces 97% of its heating needs by burning its own garbage, and at other times, by burning straw bale; two infinitely renewable fuel sources.

40. Over the past decade, an unprecedented reorganization of the municipal solid waste industry has taken place in the Great Lakes Region as a result of the closure of the world's largest landfill, Fresh Kills Landfill in New York City, and from the tightening of environmental controls by the U.S. Environmental Protection Agency. While the number of small landfills has actually decreased throughout the United States and Canada, the rate of landfilling has dramatically increased during the past 10 years, resulting in the creation of mega size landfills (1 square mile, 200-300 feet in height) whose operations are essentially aimed at achieving greater economies of scale. At the centre of this extraordinary transformation is the State of Michigan, the third largest importer of trash in the U.S. (next to Pennsylvania and Virginia) and home to the largest waste disposal sites in the Great Lakes region. Heightened by cross-border movements of solid waste between Canada and the United States, the shier magnitude of the operations is staggering, receiving approximately a 40-ton truck and trailer every three minutes. For a greater discussion of the transboundary movement of waste in the Great Lakes, see Pierre Bélanger's Airspace: The Operational Ecologies & Geo-Politics of Landfilling in Michigan (2006, 132-155) and Benjamin Miller's Fat of the Land: The Garbage of New York (2000).

41. According to the US EPA's Office of Solid Waste (2007), commercial waste from the construction and demolition industry represent almost twice as much as the municipal sector (400 versus 235 million tons), a figure dwarfed by waste streams in the mining industry that represent five times more every year (2-3 billion tons).

Carbohydrate Matter
Fresh sludge delivered from a wastewater treatment plant in Niagara temporary laid down for storage prior to the de-watering and de-nitrification reprocess. The resulting carbohydrate- and protein-rich matter is reused as organic fertilizer for farm fields and an organic additive for composting facilities. As the single most important contributor to nutrient overloading in the waters of the Great Lakes, over 90 billion litres of combined sewer overflow is discharged from urban, suburban and rural areas into the Great Lakes every year. (Photo: Pierre Bélanger, 2008)



Patterns of Diversion
Flows of contaminated soils from brownfields and organic solids from landfills in Hamilton, Ontario redirected to new soil remediation and composting facilities. Formerly the largest processor of steel and iron in Canada and one of the most heavily polluted inland ports in North America, the 2150 hectare embayment of the Hamilton Harbour is now the site of a major remediation action plan under pressure of its rapidly diversifying economy to clean its polluted waters and contaminated sediments using new discharge management systems and sedimentation decontamination technologies. (Diagram: Pierre Bélanger & Rick Hyppolite, 2008)

42. Material loops refer to the circulation of materials in contemporary manufacturing processes viewed as systems. In production loops (instead of production lines), material inputs (resources) are treated just as equally as material outputs (wastes). For example, with the invention of steel came the invention of slag, with the invention of petroleum came the invention of plastic, with the invention of cement came the invention of sulfuric gas, with the invention of sewage came the invention of sludge. Regionally scalable, the decentralization of urban waste streams are creating circular economies that are usurping conventional linear economies and where assembly lines are making way for landscapes of disassembly (Bélanger 2007).

43. The composting process-an inexpensive endogenous biotechnology that decomposes organic materials from oxygen depletion and thermal convection- will revolutionize the industry of mass-recycling of organic waste in the 21st century, just like the Bessemer process was the first inexpensive method for the mass-production of steel from molten pig iron in the 1940s.

44. The Taro East Landfill that services the Greater Hamilton Area is owned by Philip Services Corporation (PSC), a waste management giant ragging under a one-billion dollar debt load from environmental lawsuits. See Michael Marley's article on its recent solvency Philip, subsidiaries pursue bankruptcy cover in Canada (2003).

45. See Platt, Brenda. 2006. The five most dangerous myths about recycling. The Institute for Local Self-Reliance. www.grn.com/library/5myths.html (accessed June 08, 2006).

46. Chertow, Marian. 2005. The Economics of Recycling, [Keynote] Presented at the Yale Center for Industrial Ecology's By-Products Beneficial Use Summit, Philadelphia Pennsylvania.

47. For a related discussion on the relevance of synergy, see Haken Hermann's The Science of Structure: Synergetics (1981). The concept of synergies was popularized in the 1970s by Buckminster Fuller in two important volumes Synergetics I-II (1975 & 1979).

48. This program establishes policies and best practices for processing and diverting sewage and sludge from feedlots as fertilizer on farm fields to minimize water quality and public health impacts (USDA 2008).

49. This program involves the decontamination and diversion of dredgeate from underwater lakebeds in harbours combination with other industrial products such as ash and biosolids and upland sites and confined disposal facilities (USACE 2008).

bioremediation, including in-situ deep molasses injection. As a result, the neighboring landfill that was once the most active industrial site in the region is ironically straddling bankruptcy and rapidly being squeezed out of the waste handling market altogether.[44]

The statistical effect of recycling can be staggering. For example, if all of the 25.5 million tons of durable goods now discarded into America's landfills each year were reclaimed through reuse, it is estimated that more than 100,000 new jobs could be created in this industry alone.[45] Through employment spinoffs and technological innovation, the multiplier effect of the recycling industry eclipses the conventional industry of waste landfilling.

This concept is, echoed by the Northeast Recycling Council, where recycling now provides the bedrock for large, robust manufacturing industries in the United States that use reusable materials. It provides manufacturing industries with raw materials such as recycled newsprints, recycled cardboards, recycled plastics and recycled metals that are less expensive than virgin sources.[46] In the 21st century, it seems that waste will be the new food.

The synergies and spin-offs[47] from contemporary streams of development demonstrate how new efficiencies and new spaces are created when urban systems are designed to be tightly integrated into with regional land-based resources. When compounded, these streams of development also point towards the effectiveness of landscape-based strategies that can solve multiple challenges at once. Broader scale regional materials management programs testify to that effectiveness. Developed in the mid 1990s from tighter environmental controls and stronger economic synergies, the U.S. Department of Agriculture's Comprehensive Nutrient Management Planning Program[48] and the U.S. Army Corps of Engineers' Beneficial Material Reuse Management Program[49] – respectively involving the diversion and land application of sludges and dredgeates – are two significant examples of land reclamation strategies that are restructuring the historical relationship between downstream and upland sites within regional watersheds.[50]

With more than 70 million tons of sediment dredged from the ports of Great Lakes cities over the past 30 years, there is a considerable potential for landscape practitioners to engage in the design and planning of sites involving the diversion of excavated materials from the mouths of rivers towards inactive or abandoned industrial sites.[51,52] For example, where bioremediation alone cannot solve the challenge of brownfield redevelopment, the cascading effect of new integrated regional economies offers a signify cant model for the reuse of land, where remediation costs may be offset by the overall returns from productive land redevelopment. Achieving greater economies and ecologies of scale, these urban-regional operations can be considered self- generating and self- maintaining. At this precise moment—when these landscape operations are essential—they become infrastructural.[53]

REDEFINING INFRASTRUCTURE

From a distance, the histories and complexities of land transformation and infrastructure deployment in the 18th, 19th and 20th centuries present important evidence of a large collective system of biophysical resources, agents and services that effectively support urban economies in North America.[54] Whereas in the past, industrial economies were forced to contaminate or destroy the environment in service of economy, today that equation has been effectively reversed. Mutually co-dependent, the economy is now inseparable from the environment, and so are modes of production. From a geo-economic perspective, several underlying conditions – pre-conditions[55] – can be deduced from the historic, logistical bond between land transformation and urbanization:

A. *Wasting is natural.*
There is a built-in process to the patterns of urbanization and modes of production that has, and always will generate waste. The creation of circular economies that will handle the by-products of these processes is inevitable.

B. *Globalization is irreversible.*
There exist global economic forces that ex-

50. The sustainability of urban operations is evidenced by reclamation sites such as the Monte Testaccio in Rome (a clay pot dump in the 2nd century AD), the Jardin des Tuileries in Central Paris (a former industrial dump in the 16th and 17th centuries), the Buttes-Chaumont in peripheral Paris (a former quarry and tailings dump in the 18th century), or Flushing Meadows in New York (a former ash dump in the 20th century).

51. Voros, Andrew S.. 2005. "Dredged Materials in Abandoned Mine Reclamation; Applications for the Great Lakes Region. Presented at the Water Environment Federation's Innovative Uses of Biosolids and Animal and Industrial Residuals. West Hatfield, Massachussetts.

52. Great Lakes Commission (GLC). 2006. Dredged Material Management. http://www.glc.org/dredging/dmm/

53. Allen, Stan. Points and Lines: Diagrams and Projects for the City (New York: Princeton Architectural Press, 1999).

54. In relationship to the fields of architecture, landscape and urban design, this finding echoes Kenneth Frampton's observations: "landscaped form as the fundamental material of a fragmentary urbanism is of greater consequence than the freestanding, aestheticized object" in Toward an Urban Landscape (1995, 92).

55. These factors were adapted from McKinley Conway's book Industrial Park Growth (1979) which provides a quantitative analysis of the emergence and expansion of industrial parks that bloomed across America after World War II. The factors are also borrowed from geo-economics, a field that involves the research, planning and development of land and industry to build strong economies and improve quality of life. The field of research was pioneered between the 1950s and 80s by McKinley Conway, an aeronautical engineer from the Southern United States who founded the International Development Research Council and the World Development Federation in the 1980s. See McKinley Conway's Geo-Economics: The Emerging Science (1983).

Landscape of Logistics
CN intermodal shipping terminal showing the shipping yards of retail and automotive giant Canadian Tire, located on the outskirts of the Greater Toronto Area, in Brampton, a major distribution location with access to Highway 401 and 407 for eastbound and westbound, rail-to-truck feeder service between Toronto and Montreal (Photo: Pierre Bélanger, Jacqueline Urbano 2008)

ercise significant and irreversible impact on the economy of urban regions and industrial modes of production. Harnessing those forces with regional conditions is paramount.

C. *Urban systems are regional.*
Over time, the multiplier effect of urban-industrial operations considerably impacts a region over time through job spin-offs, supply chains and distribution networks. Dependent on regional population distribution and world demographics, the magnitude of urbanization is as of yet, undetermined.[56]

D. *Sprawl is inevitable.*
Perpetuated by the proliferation of global distribution networks instead of centers, global mobility gradual leads to the expansion or, the abandonment of urban-industrial regions. The design of horizontal urban systems in relationship with networks of mobility will dominate practice.[57,58]

E. *Ecologies are constructed.*
There exists a complex biophysical system (hydrology, geology, biomass, climate) that preconditions modes of production that is inextricably bound to urban systems (populations, markets). The watershed is its most basic and irreducible structural element.

Once the sole purview of the profession of civil engineering, the management of water, waste, food, transport, and energy, infrastructure is taking on extreme relevance for landscape practice when considering the changing, decentralizing structure of the urban-regional economies. Food production and energy networks can no longer be engineered without considering the cascade of waste streams and the cycling of raw material inputs. Landfills, land farms, laydown areas and sorting facilities can no longer be designed without their wastesheds. Highway networks, sewage systems and subdivisions can no longer be planned without their watersheds. Put simply, the urban-regional landscape is infrastructure.[59]

As an integrative and horizontal discipline that transcends disciplinary boundaries, landscape practice[60] stands to gain momentum widening its sphere of intervention to include the operative and logistical aspects of urbanization. Though they may seem banal, these aspects can bridge the current divide across the economic-ecological gap. The engineering of basic elements such as topography, hydrology and biomass as a system can be instrumental in the amplification of invisible yet fundamental processes that support urban development. Those elements are best expressed through process diagrams and logistical schedules. As a dualized practice, design can be strategically deployed across a range of two different scales: short, immediate periods of time with large geographic effects, over long periods of time. Design, and the research that preconditions it, therefore becomes telescopic, capable of integrating multiple scales of intervention at once.

Enabling this dualized design methodology is a double agency in practice. Long term, visionary outlook (prevalent in large public authorities) must be matched with expeditious project–oriented focus (typical of small-medium enterprises) in order to achieve the triple bottom line of economic, environmental and social imperatives. The gradual deprofessionalization of conventional disciplines towards common ecological objectives and economic objectives will show how flexible public-private practices can cut across sluggish specializations that all too often stunt land redevelopment and economic renewal. These co-operations can usurp stylistic variations or disciplinary differences in project execution. In stark contrast to the 20th century paradigm of speed, the effects of future transformation will be slow and subtle, requiring the active and sustained engagement of long- term, opportunistic partnerships that bridge the private and public sectors.

Design of surface systems, synchronization of material logistics, re-zoning of land across boundaries, sequencing of land transformations over time, synergies between land uses, and reciprocities between different agencies, can therefore augment and accelerate these strategies, placing emphasis on performative effects of practice rather than their end results. The new paradigm of longevity and performance decisively break with the Old World pictorial, bucolic and aesthetic tradition of landscape de-

56. Urbanization designates the propensity to increase, reduce or stabilize the occupational carrying capacity and productivity of land, Urbanization can rely on density and expansion, or on longevity and performance as growth indicators. Conversely, deurbanization can also be understood as an important process of land reorganization and spatial restructuring evidenced by land re-zoning, land abandonment, building mothballing, structural de-engineering, fiscal foreclosure and population redistribution. the Soviet Disurbanists during Russia's Industrial Revolution in the early 20th century provide the earliest examples of the efficacies of deurbanization (Ouroussoff 2007, Starr 1976 & Stites 1989).

57. As an the effect of decentralization, sprawl signals the prevalence of a distinctive pattern of low rise urbanization in North America, which is erroneously dismissed as unsustainable sprawl (Bruegmann 2006). From a global perspective, decentralization is proving to be persistent, pervasive and sustainable thanks to the rise of the middle class throughout the world. What is poorly understood is that urban decentralization and self-actualization stem from the leveling of global socio-economic structures and the increase in world population; a process that has been under way for the past two thousand years. This process is rendered visible by the current shift of conventional, top-down economies of supply are being supplanted by economies of demand. Supply economies find their origins in societal structures where large populations were governed by small circles of power such as royal monarchies, military dictatorships, or industrial monopolies. Extremely hierarchical, vertical and autocratic, these structures account for a large percentage of the world's history. More recently however, we have witnessed the flattening, or leveling of these hierarchical structures, in favor of more horizontal and evenly distributed socio-economic organizations. This structural transformation has been enabled by several major changes in the 20th century: 1) the democratic organization of large populations and large metropolitan regions made possible by urban decentralization; 2) the increase in individual purchasing power, individual housing and individual mobility thanks to New World capitalism; 3) the birth of instant communication made possible by standardized technology systems and, 4) the availability of consumer goods throughout the world made possible by global transportation. As a result, large populations are now better informed and better organized to make decisions, instigate change and place demands upon ruling government bodies. For two different views on this emerging socio-economic shift, see Thomas L. Friedman's The World Is Flat: a Brief History of the Twenty-First Century (2005) and Ayn Rand's Capitalism: the Unknown Ideal (1966).

58. For a brief account of the relationship between mobility, transportation systems and the North American landscape, see Pierre Bélanger's Synthetic Surfaces (2006, 239-265).

59. The infrastructural understanding of urban landscapes exposes the limitations and inadequacies of branded canons of urban growth such as New Urbanism, Smart Growth and Community Planning. By dismissing and excluding lands for production, manufacturing, logistics, distribution and their corollary relationship with regional bio-physical systems, these ideologies fall short of resolving the economy-ecology conundrum facing big cities today. For a greater discussion on the shortcomings of the concept of these ideologies in America, see Richard Florida's article The New Megalopolis: Our Focus on Cities Is Wrong. Growth and Innovation Construct New Urban Corridors (2006) and McKinley Conway's Defining the Supercity (1999).

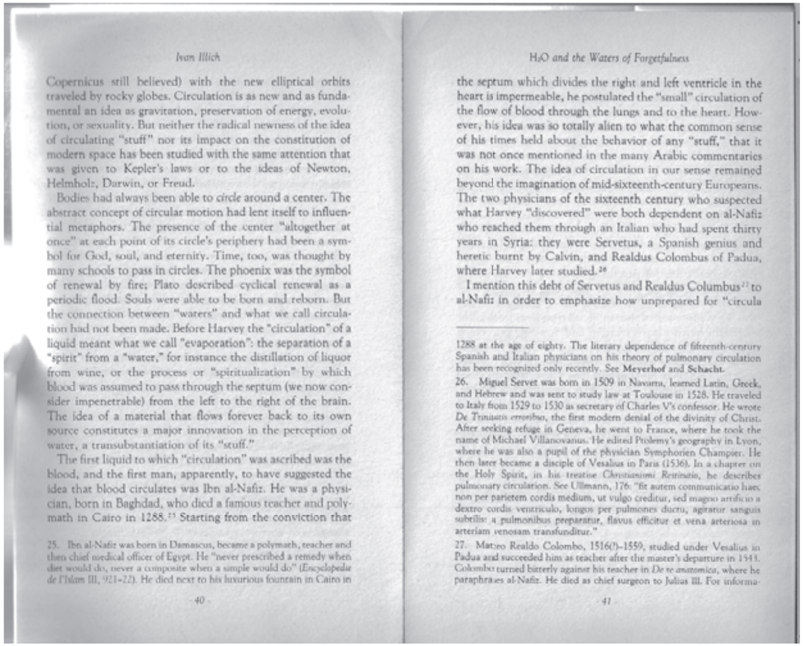
60. Heightened by the forces of global mobility, the decisive transition from centralized industrial states to decentralized urban economies at the turn of the 21st century has spawned a pool of landscape practices that have been focusing on the transformation of brownfields and the remediation of urban ecologies. See "Not unlike life itself: landscape strategy now" by James Corner, in *Harvard Design Magazine* 21 (Fall/Winter 2004): 32–34.

sign. Instead, they propose a logistical and operative agency that landscape intrinsically bears as a practice that deals with complex, multidimensional systems. By design, the synthesis of urban operations-coupled with the reflexive mechanisms that underlie them-can therefore lead towards the development of this contemporary landscape practice; one that is urgently needed for the present and future reclamation of urbanizing and de-urbanizing in the Great Lakes region and North America.

From the case of the 40 million acres of abandoned stump fields of the 19th century Cutover to the industrial wreckage of the 50,000 brownfield sites in the Rust Belt to the management of the 6 quadrillion liters of fresh water in the Great Lakes, a reconsideration of the logistical urban infrastructure is pressing. From the transformation of mono-functional industrial structures to the design of multi-layered urban-ecological systems, greater attention and integration to the landscape of waste, water, transport, food and energy may in fact elucidate the more fundamental processes that underlie and precondition the ongoing and, unfinished urbanization of North America. Seen over time, these nascent processes may appear as incredibly subtle or fleetingly ephemeral, but will prove as an extremely stable and robust infrastructure for the 21st century economy of the New World.

Originally published in Landscape Journal *Volume 28 Issue 1 (Spring/Summer 2009): 79-95.*

Metabolic Landscape.



Ivan Illich

Copernicus still believed) with the new elliptical orbits traveled by rocky globes. Circulation is as new and as fundamental an idea as gravitation, preservation of energy, evolution, or sexuality. But neither the radical newness of the idea of circulating "stuff" nor its impact on the constitution of modern space has been studied with the same attention that was given to Kepler's laws or to the ideas of Newton, Helmholz, Darwin, or Freud.

Bodies had always been able to *circle* around a center. The abstract concept of circular motion had lent itself to influential metaphors. The presence of the center "altogether at once" at each point of its circle's periphery had been a symbol for God, soul, and eternity. Time, too, was thought by many schools to pass in circles. The phoenix was the symbol of renewal by fire; Plato described cyclical renewal as a periodic flood. Souls were able to be born and reborn. But the connection between "waters" and what we call circulation had not been made. Before Harvey the "circulation" of a liquid meant what we call "evaporation": the separation of a "spirit" from a "water," for instance the distillation of liquor from wine, or the process or "spiritualization" by which blood was assumed to pass through the septum (we now consider impenetrable) from the left to the right of the brain. The idea of a material that flows forever back to its own source constitutes a major innovation in the perception of water, a transubstantiation of its "stuff."

The first liquid to which "circulation" was ascribed was the blood, and the first man, apparently, to have suggested the idea that blood circulates was Ibn al-Nafiz. He was a physician, born in Baghdad, who died a famous teacher and polymath in Cairo in 1288.[25] Starting from the conviction that

25. Ibn al-Nafiz was born in Damascus, became a polymath, teacher and then chief medical officer of Egypt. He "never prescribed a remedy when diet would do, never a composite when a simple would do" (*Encyclopedie de l'Islam* III, 921–22). He died next to his luxurious fountain in Cairo in

- 40 -

H_2O and the Waters of Forgetfulness

the septum which divides the right and left ventricle in the heart is impermeable, he postulated the "small" circulation of the flow of blood through the lungs and to the heart. However, his idea was so totally alien to what the common sense of his times held about the behavior of any "stuff," that it was not once mentioned in the many Arabic commentaries on his work. The idea of circulation in our sense remained beyond the imagination of mid-sixteenth-century Europeans. The two physicians of the sixteenth century who suspected what Harvey "discovered" were both dependent on al-Nafiz who reached them through an Italian who had spent thirty years in Syria: they were Servetus, a Spanish genius and heretic burnt by Calvin, and Realdus Colombus of Padua, where Harvey later studied.[26]

I mention this debt of Servetus and Realdus Columbus[27] to al-Nafiz in order to emphasize how unprepared for "circula

1288 at the age of eighty. The literary dependence of fifteenth-century Spanish and Italian physicians on his theory of pulmonary circulation has been recognized only recently. See **Meyerhof** and **Schacht**.

26. Miguel Servet was born in 1509 in Navarra, learned Latin, Greek, and Hebrew and was sent to study law at Toulouse in 1528. He traveled to Italy from 1529 to 1530 as secretary of Charles V's confessor. He wrote *De Trinitatis erroribus*, the first modern denial of the divinity of Christ. After seeking refuge in Geneva, he went to France, where he took the name of Michael Villanovanus. He edited Ptolemy's geography in Lyon, where he was also a pupil of the physician Symphorien Champier. He then later became a disciple of Vesalius in Paris (1536). In a chapter on the Holy Spirit, in his treatise *Christianismi Restitutio*, he describes pulmonary circulation. See Ullmann, 176: "fit autem communicatio haec non per parietem cordis medium, ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longos per pulmones ductu, agitatur sanguis subtilis: a pulmonibus preparatur, flavus efficitur et vena arteriosa in arteriam venosam transfunditur."

27. Matteo Realdo Colombo, 1516(?)–1559, studied under Vesalius in Padua and succeeded him as teacher after the master's departure in 1543. Colombo turned bitterly against his teacher in *De re anatomica*, where he paraphrases al-Nafiz. He died as chief surgeon to Julius III. For informa-

- 41 -

Ivan Illich, H_2O and the Waters of Forgetfulness, 1986

"Circulation is as new and as fundamental an idea as gravitation, preservation of energy, evolution, or sexuality. But neither the radical newness of the idea of circulating 'stuff' nor its impact on the constitution of modern space has been studied with the same attention that was given to Kepler's laws or to the ideas of Newton, Helmholz, Darwin, or Freud."

Ivan Illich, *H2O and the Waters of Forgetfulness*, 1986[1]

"The metabolic requirements of a city can be defined as all the materials and commodities needed to sustain the city's inhabitants at home, at work and at play. Over a period of time these requirements include even the construction materials needed to build and rebuild the city itself. The metabolic cycle is not completed until the wastes and residues of daily life have been removed and disposed with a minimum of nuisance and hazards."

Abel Wolman, *The Metabolism of Cities*, 1965[2]

Atlas of Excreta, 1st Edition, UNDP, 2008.

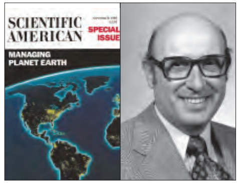
Imagine the planet as a big brownfield. Consider it less as a virgin resource (to protect) or a sensitive system (to shield), but rather as a big ball of oscillating waste (that keeps moving and circulating), where everything - from air of the atmospheres to the water in the oceans - has been used, abused, reused: materials and fluids in different concentrations, whose varying distributions are in constant motion, powered by existing earth processes—arrested, attenuated and accelerated by methods of extraction and evolving technological processes, adjusted, layered, and thickened by urban change. On this planetary surface, waste is the impetus for improved production, enhanced consumption, intelligent exchange. Brown is the new green.

If "the shift from one mode [of production] to another", according to spatial theorist Henri Lefebvre, "must entail the production of a new space",[3] then the transition of industrial systems (closed, linear systems that produce commodities and wastes) towards urban economies (open, circular systems that cultivate commodities from wastes) should also produce new spaces, and open new geographies. If waste is natural and necessary, how then do we design our future?

Looking beyond the residual reclamation of industrial wastes as a catalyst for development, the profiling of emerging waste ecologies and processes of decarbonization trace the contours of contemporary urban geographies beyond cities, outlining a landscape of flows and fluids they engender and influence. Through the characterization of urbanization as a field of flows where materials are like fluids with different concentrations and chemistries, volumes and viscosities, urbanization entails the design the speeds, cycles, synergies and synchronicities of these interconnections. As a revisited strategy, the metabolic representation of urbanization may advance the contemporary ecologic subject, whose premise lays in the perpetual circulation of materials, providing a path towards an endless loop of material resources through interactive spaces of exchange, responsive processes of production, regulatory flexibilities and fluid geographies of cultivation.

The Metabolic Landscape

Or, how a small Nordic nation is conquering the waste-water-energy conundrum.



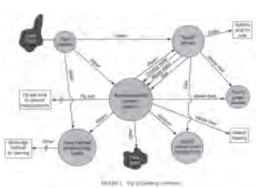
In an 1989 article of Scientific American, Robert Frosch and Nicholas Gallopoulos popularized the term "industrial ecology" from a groundbreaking network of recycling discovered in a small Danish town around the Fjord of Kalundborg.[4] Turning waste into energy, feeding on groundwater, the ecology of industries that emerged over three decades became an icon of post-modern industrialism recognized universally. Largely overlooked however, decentralization underlies Danish policies of waste, water and energy and how urbanism has transformed its economy[5] and ecology.

Decentralizing Denmark

Maersk, LEGO, Novo Nordisk and Arne Jacobsen are national emblems of Denmark's economic fame in 1970 when it had the third largest GDP per capita in the world, second only to Sweden and the United States.[6] From decades of relentless industrial expansion since World War II, Denmark's economy overheated in the mid 1970s. With skyrocketing energy prices, depleting landfill space and contaminated groundwater, a plethora of problems plagued the entire country. From the oil crisis, Denmark developed a national energy policy to decentralize its economy that was largely dependent on oil to for electrical power, heat and mobility.[7] In tandem with the creation of the world's first Ministry of the Environment, the country's urban-industrial landscape was irreversibly transformed through a litany of legislation and a battery of tax strategies.[8] Co-generation plants were set up across the country to turn waste into energy and by the early 1990s, the four largest cities including Copenhagen, Århus, Aalborg and Odense were producing power and heat from burning garbage.[9]

Regional Kommune Structures

Since most Danes live on top of the water they drink, the problem of groundwater depletion and contamination was pressing. With lower underground reserves, the price of water - for urban and industrial consumption - was re-evaluated based on the cost of full recovery instead of market prices. In contrast to centralized systems worldwide, 14 Danish counties, called Kommunes, govern groundwater according to specific underground aquifer regions. Contamination was dealt with a nationwide groundwater survey. Since 1987, all 400,000 wells have been mapped and are monitored electronically 'round the clock. Although the average cost of household water supply in Denmark is considerably ten times more expensive than in the US, Danes consume five times less bottled water than Americans, largely because their tap water is safe and tastes great.[10]



The Kalundborg Prototype

From the energy-waste-water conundrum emerged a network of waste recycling in Kalundborg, west of Copenhagen. In 1976, Novo Nordisk, the world's largest insulin producer, began diverting 10,000 tons of sludge and surplus yeast from the municipality's sewage plant to local farms as organic fertilizer. A decade later, the Asnæs Power Station began converting hot waste-water into high-pressure steam for residential heating, as well as fly ash for cement production and waste-gypsum for plasterboard manufacturing. Combined, the two plants produced massive gains from energy cascading, recovering almost 70% of the typical loss experienced by large power generators while reducing dependency on foreign fuel imports. The small sleepy town of 15,000 people also saves about 15 million dollars annually sponsoring renewed urban investment and infrastructural upgrades. Compounded, 600,000 cubic meters of water are saved annually through the cascading and reuse of waste water effluents.[11]

Urbanizing Infrastructure

Home to a relatively small homogeneous population of 5.5 million people spread across an area the size of Maine, change in Denmark can happen swiftly. Using energy independence as a national objective, the double bind of economy and ecology is being solved through a diverse portfolio that includes garbage, straw, wood, coal, gas and wind. Not surprisingly, Danish manufacturers hold half of the world market in wind turbine manufacturing while the country has become a net exporter of wind energy.[12] Tight controls, precise metering, gradient taxation and accurate pricing are starting to pay off: recycling of waste water and cascading of energy flows is reaching 100% for industries industry and 85% for households. More than an isolated case of waste recycling, the Kalundborg prototype proves durable as a testbed for the limitless capacity of waste and energy synergies when factoring the primacy and longevity of groundwater resources. Recovering a his toric discourse initiated by Abel Wolman's 1965 *The Metabolism of Cities*, this text serves as a rethinking of urban sustainability that integrates urban flows and urban patterns across a borad range of different political dynamics and material geographies. From self-heated cities to cycling industries, the regional decentralization of Denmark's economic system makes the case for renewing the discourse on the landscape of America's infrastructure and the roles that waste, water and energy play in patterns of urbanization.

WATER, WASTE & WARS

On January 21st 1968, at the height of the Cold War, a B-52 Bomber carrying four thermonuclear warheads crashed seven miles off the coast of Greenland in territorial waters of the Baffin Sea belonging to the Kingdom of Denmark. Triggering an era largely opposed to nuclear power, several nuclear accidents– including Three Mile Island in 1979, Chernobyl in 1986 and Barsebäck in 1992 - foreshadowed imminent dangers of radiation fallout at a time of heightened environmental awareness across the globe. An Emergency Preparedness Plan in the Event of Radioactive Fallout was the first national program rolled out across Denmark in 1970 by what is recognized today as the first ever Ministry of the Environment in the world.[13] Reactor-free as a result of the 1981 Nuclear Referendum, Denmark has since experienced ground-breaking transformation of its infrastructure, both economically and ecologically. Underlying this change is the synchronized management of energy, waste and water systems that is largely preconditioned by its size, its resources and its urbanization. Chronicling a series of largely overlooked events and conditions during the past 100 years, this brief article revisits the build-up of Denmark's regional infrastructure and how the persistent decentralization of its landscape underpins this change.

In 1970, as Denmark adopted the Nordic Model Welfare State, the World Bank announced that the smallest country in Europe reached the third largest GDP per capita in the world, second to Sweden and the United States.

Denmark's prominent wealth was made visible internationally by Danish giants such as global shipping broker Maersk, universal toy producer LEGO and modern architectural genius Arne Jacobsen.[14] As the Island of Vikings enjoyed the returns of postwar industrialization, its prosperity was overheating, and soon after challenged when petrol shortages hit the country in 1973 as a result of the Arab Oil embargo.[15]

For several years, fuel supplies were rationed and food prices spiked. From November 25th 1973 to February 10th 1974, Sunday driving was banned altogether. The crisis re-ignited in 1979 with skyrocketing oil prices after the declaration of Iran as an independent Islamic Republic. Almost entirely reliant on oil in the 1970s as the single source for its power for both heating and transportation, the Arab oil embargo affected every sector of Denmark's post-war industrial economy.

Fuels & Materials

Scarcity bred ingenuity. By the late 1970s, Danes were seasoned to energy shortages for more than a century. Decades of scarcity – from fuel to space to water – were marking decisive shifts in the country's ability for wholesale change. During World War II for example, Nazi Occupation of Denmark cut off international supplies. The short 68-kilometer border entirely controlled by the German troops turned peninsular Denmark into an island. For almost five years, the entire population encountered a shortage of almost all imported goods.[16] Fuel and rubber were the hardest hit. Short on any major reserves of fossil fuels, Denmark re-enlisted two materials - lignite and peat – as substitutes for factory and household heating, while coal-fired gasworks provided, albeit intermittent, electric power. Despite their lesser burning temperatures and faster combustion rates, both materials were available regionally and more importantly they were replenishable. Short on fuel, blocks of beechwood were burned to power ad-hoc generators mounted on specially modified transport trucks.

The few private vehicles that could afford to travel were busy negotiating congested streets of bicycles, the only affordable system of personal mobility available during the World War. Everything had value, everything was self-powered. It was even outlawed to dump feces and excrement of any kind in the sea, since precious fertilizer for countryside

HUSK ET HALVT PUND KAFFE OG 50 GULE NORTH STATE

– det var dengang

De behøver sikkert ikke BILLED-BLADET til at fortælle Dem, at vi lever i Surrogaternes Tid. Det bliver vi allesammen mindet om, fra vi om Morgenen skulde have haft vores Morgenkaffe, til vi om Aftenen mindes den hyggelige Aftente med hjemmebagt Brød og Cigaretter eller anden Tobak. Men derfor er disse Sider trods alt ganske fornøjelige — og e n Trøst har vi: Vi deler samme Skæbne, Rige som Fattige.

FOT.: SIMONSEN

Cellulds-Sommerjakken er blevet vasket af en renlighedskærlig Husmoder. Vandet var for varmt, og han minder nu om en forvokset Konfirmand.

Aah, Kaffe — duftende og friskbrændt. Naa, ja, vi kan vænne os til meget, og nu synes vi, at 1/4 Pund Kaffe, blandet med 3/4 Pund Erstatning, smager udmærket.

Cykledæk af Hø kender vi ikke rigtig endnu, men det skal nok snart komme. (Billedet herunder). De kan kun holde højst en Maaned, men saa kan man jo forsøge at ryge Resterne.

Behøver dette Billede en Tekst! Kan De huske, dengang vi sagde: „Vil du ha' en Cigaret — ja, jeg har desværre kun en almindelig North State."

Klip-klap, trip-trap. Den Lyd er vi fortrolig med nu, fra Hornbæks Strand til Strøgets Fortovssten. Træfodtøj sparer kolossalt paa Læderforbruget (herunder).

Source: Billed-Bladet No.36 D.9, September 1941-45.

Ole gnaver med god Appetit i en Humpel Rugbrød; Men det smager ikke helt, som det plejer, for nu er der 20 pCt. Klid blandet med Rugen.

Birthe har en Sparegris, som faar Smaapenge af Mor. Men Grisen grynter lidt arrigt for Tiden. Aluminiumsmønter og Frimærker, er det Mad?

Baby-Ulla morer sig med en morsom raslende Lyd, naar hun sparker med Benene i sin Seng. Hun ligger paa Papirlagener for at spare dyre Lagener og do. Sæbe.

Scarcity breeds Ingenuity

Public propaganda pamphlet distributed by the Department of Labor explaining substitutes and techniques for countering the widespread shortage of materials, fuels and jobs with scrap recycling, regional fuels, water conservation, food rationing and bicycle transportation during wartime. A "Waste is not Waste" campaign is developed by the Danish National Association for Combating Unemployment (LAB, Landsforeningen til Arbejdsløshedens Bekæmpelse) during World War II to create an industry and economy of trash materials.

Brillantine hører ogsaa til svundne Tiders Luksus. Man kan forsøge med andre Ting i Stedet for, f. Eks. Paraffinolie.

Husmødre, der sætter en Ære i smukt ferniserede Gulve, har en Prøvelsens Tid, ogsaa hvad Fernis angaar. Erstatningen forsøges herunder.

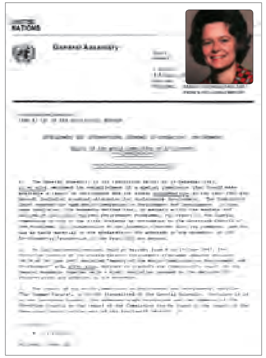
farms was desperately needed for constant food production. The lack of diesel oil equally made it difficult to maintain heat supply during five cold Nordic winters from 1940 to 1945 forcing plant owners to establish back-up heating systems. Instead of individual heating units, resources were pooled and solid fuel boilers were established for district heating systems across the country.[17] To extend existing fuel supplies, the first standardized bottle return systems in the world were put into place between 1904 and 1920 by Carlsberg breweries saving considerable energy and raw materials.[18] With oil reserves eventually running dry, the use of refuse as a fuel became the natural panacea. By the turn of the century, this was nothing new. By 1903, the waste-to-heat conversion process was in fact, already in place. Just outside of Copenhagen, the first combined heat and power plant – early precursor to contemporary cogeneration systems - began receiving its first garbage loads as solid fuel at the Frederiksberg incinerator, the first of its kind in the country.[19]

Dumps & Fires

While oil prices were skyrocketing in the mid-1970s, Denmark was also running out of landfilling space. Greatly reducing overall volumes, burning garbage was as widespread as it was imperative. The increasing shortage of landfill space was further exacerbated from the restructuring of the national waste administration. Compounding a critical situation, alarming concerns were raised over regional groundwater quality and looming threats of environmental hazard from unchecked waste management and agricultural runoff. In a nationwide hydrogeological study in 1987, over 1500 landfills and buried waste repositories were scrutinized by the Danish EPA.[19] Coupled with pesticides from large agricultural operations, plumes of leachate were dangerously spreading underground from unlined landfills. At the Grindsted and Vejen Landfills – the Love Canals of Denmark – drinking water was at considerable risk of contamination from heavy metals and hydrocarbons in leachate. The millennium old practice of landfilling and open pit burning in Denmark reached an impasse.[20]

Surface & Subsurface Waters

Groundwater depletion exacerbated the landfill imbalance. Used for industrial cooling, cleaning and irrigation – groundwater was rapidly dropping. From the post war boom in the 1950s to the 1970s, water extraction from mass industrialization and mass agriculture was occurring at an unchecked pace. Excess abstraction also stemmed from mass urbanization. In the early 1980s, the Danish EPA found that the three largest cities - including Copenhagen, Århus and Odense - were all found to be withdrawing three times more groundwater than could be replenished. By the end of the 1980s, groundwater was under visible threat of leachate contamination originating from centralized landfills, excess extraction and chemical effluents across the entire country.[21]

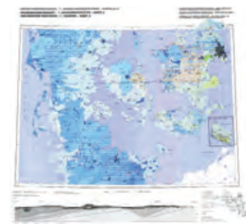


Brundtland's Problématique

From an economic perspective, Denmark's sluggish economy simply compounded the country's infrastructural challenges. Rising unemployment, plummeting exports and rising inflation plagued a country that was facing an emerging trade bloc from the EC. By the early 1980s, Denmark was in deep trouble. Europe's smallest nation was in a double bind: how to ensure the longevity its groundwater resources and solve the growing waste problem while expanding its industrial output to increase global competitiveness? All this, while becoming energy independent?

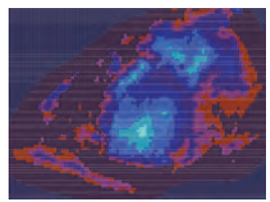
STRATEGIES, SYNERGIES, & SYNCHRONICITIES

During the 1970s and 1980s, a litany of legislation was tabled, irreversibly changing the course of the country's urban-industrial landscape: the creation of the world's first Ministry of Environment in 1971 (ironically at the precise moment that Copenhagen's Christiania district declared itself a Free State within Denmark), a National Energy Policy in 1976, the Chemical Waste Deposit Act in 1983, the Brundtland Report in 1987 dubbed 'Our Common Future',[21] and the Environmental Protection Act 1992.[22] Regional decentralization, not liberalization, of its national infrastructure became de rigueur. Unlike bureaucratic policies, these measures were designed as preemptive strategies and based on three simple, long term principles: the replenishment of groundwater resources, the reduction of waste generation and the development of energy independence. With a small relatively homogeneous population that was rapidly urbanizing, Denmark's culture of compliance was an asset, allowing change to rollout quickly. So, reformulating the energy-waste-water conundrum relied on three basic imperatives: quantifying water reserves, reordering waste streams and, rechanneling energy sources.[23]



Metrics & Minimization

Surveying the entire country's groundwater resources was the first measure. Since Danes live on top of the water they drink, solving the ecology-economy juggernaut was critical and complex. Unlike most countries in the developed world, the 5 ½ million people that inhabit a country the size of Maine or South Carolina, draw 99.7% of their drinking water directly from the ground. The Danish water system is entirely decentralized with more than 3,000 waterworks and 400,000 wells (70,000 of which supply less than 10 households) that draw groundwater aquifers 20-200 meters below the surface. When the Danish EPA - prodigy of the Ministry of the Environment - undertook its nationwide groundwater survey in 1987, it provided real-time electronic information for all 325,000 groundwater wells throughout the country that to this day is publicly accessible online, any time.[24]



Dating back to the world's first Water Supply Act in 1926, this decentralized structure presents several advantages: it contributes to good groundwater and drinking water quality across the country, and it allows consumers to keep an eye on the quality and to identify possible solutions to pollution threats. As a result of the tight controls and precise metering of groundwater supplies, the price of water in Denmark is based on the principle of full cost recovery as opposed to arbitrary market pricing, an unquestioned standard throughout the world. Notoriously high prices and high taxes eventually pay off. Although the average cost of household water supply in Denmark is considerably more than in the US ($3.50 vs. $0.35 per cubic meter) according to the World Water Federation, Danes consume five times less bottled water than the global average (22 liters vs. an average of 65 liters in the US) largely from the pure, great tasting, tap water.[24]

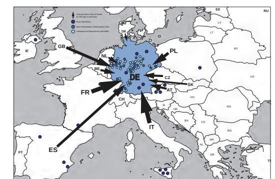
Cycling & Banking

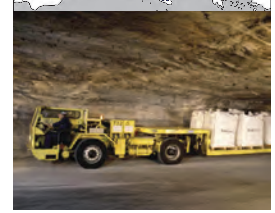
To solve the landfill airspace snag, the second measure involved the reduction of waste through source separation and the optimization of recycling networks. A new, effective order was established. First, reuse what is recyclable. Second, burn what is combustible. Third and last, landfill the rest, as close as possible to the point of origin. But there is little or no centralized curbside recycling to speak of in comparison to the American model. Instead, individuals drop off used goods to material depots or recycling banks. Reducing the volume by more than 90%, landfills could now be reserved for non-toxic non-recyclable residues that could not be burned. With the Waste Deposit Act in 1983, the waste industry was entirely restructured: national legislation was deregulated and municipalities now had to deal with their own waste streams and ensure their own landfill capacity. To divert waste away from valuable and expensive landfills, taxing of waste became necessary to create a market for waste recycling.

The late 1980 and 1990s became an unprecedented era for environmental taxation and ecological tax reform in Denmark. Pricing & taxation became a major strategic instrument. Stemming from the contentious albeit successful introduction of the 180% car tax in the 1970s, new graduated tax system on CFC, waste and packaging were introduced in a decade later. Recycling suddenly became profitable than landfilling, ranking higher in the waste echelon (landfilling costs 5 to 10 times per ton more than in the US).[25] According to Dansk Retursystem, bottle recyclers in Central Copenhagen today, can earn a higher living wage than welfare recipients in North America.[26]

Pooling & Backfilling

Hazardous materials operate on the same principle. Accounting for less than 1% of the total waste generated, hazmats are transported to a central waste facility, the *Kommunekemi* in Nyborg.It is the first and only treatment plant of its kind built in 1971 from an order of the Danish EPA. Organic chemicals, solvents, and oils are separated and burned in high temperature incinerators, waste heat and emissions are recaptured, then reconverted into steam by a district heating plant.[27] Generated steam is then re-distributed to 4500 neighboring homes. Remaining hazardous waste is either exported as neutralizer for highly acidic landfills in Western Norway or as backfill material for underground salt mines in Northern Germany.[28]





Fjord Urbanism
Aerial view of the Kalundborg Fjord and the classic spatial distribution of farm fields, industrial areas and small urban areas Nestled in this small embayment are some of the country largest manufacturers, plants and refineries including Novozymes (biotech), Asnaes (the country's largest power plant) and Statoil (the country's biggest refinery) that set up shop in Kalundborg during the 1960s and 1970's due to the excellent ocean access to the Baltic Sea, short trucking distance to the nation's capital, cheap commercial grade land, abundant of fresh water for manufacturing. Due to stringent air, land and water emission restrictions, adjacent lands to heavy industry and power generation can be used for recreational and agricultural uses.

Source: Google Earth - Digital Globe, 2008.

Condensing & Cascading

Closing the loop on waste production enabled the third measure to achieve energy independence. Energy cycling and diversification was the base. Denmark set the stage in 1992 when it became the first country to adopt explicit CO_2 taxes on both household and business energy consumption. Energy suddenly became much more expensive but also more valuable.[29] Danes are renowned for exorbitant electricity bills. Coming to the rescue, a loophole providing a possibility: since garbage is exempt from taxation when used as a solid fuel (it becomes almost CO_2 neutral), why not burn it to produce steam and power?[30]

REGIONAL ECOLOGIES & ECONOMIC EFFECTS

The century old practice of turning crud into candlepower was legitimized on January 1st, 1997 onwards when Denmark became the first country in the world to ban the landfilling of incinerable waste. Breaking new ground on combined heat and power production, bio-fuels (straw bale, sludge, wood chips) now took precedence over fossil-fuel fuels (coal, oil, natural gas) for combined heat and power production. With its waste-to-energy policy, adopting EU landfill directives in 1999 was straightforward: it already surpassed European standards by avoiding the problem of landfilling altogether. Coupled with sophisticated emissions recovery systems, the waste incineration option posed a much lesser threat to the groundwater.

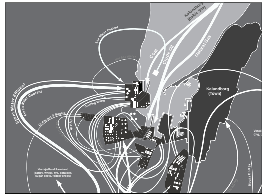
Energy diversification entailed the birth of new power plants. From the 1976 National Energy Policy emerged a plan by the Danish Ministry of Trade and Industry to establish a number of power generating stations throughout the country to ensure a steady supply system, independent from imported oil and its derivatives, while rolling out known optimization techniques of waste recycling and energy cascading.[31]

Fluids & Gases

Supplying one third of the nation's electricity, the Asnaes Power Plant was one of the first coal-fired power plants retrofitted and expanded to address the new waste-water-energy agenda. Located, eighty kilometers west of Copenhagen, the 400 kilovolt facility is also the biggest. Putting out close to 6 terawatt hours of electrical

power for the population of Zealand including inhabitants as far away as Copenhagen, the plant also produces more than 500 mega joules per second of waste heat in the form of steam from the required cooling of the power generators. In the 1960s into the 1970s, it relied on seawater and groundwater in the fjord of Kalundborg, and more recently on surface water from Lake Tissø, some 34 kilometers away as an industrial coolant supply. In response to national groundwater concerns in the mid-1980s, the power plant began using large quantities of waste water from nearby Statoil Refinery in order to cool down its towers.[32]

Less than a decade later, the power plant began converting waste water into high pressure steam and sold back to the refinery for heat-



ing requirements. Capitalizing on an existing pipeline network, excess steam was then piped to nearly 5000 homes in residential neighborhoods spread out across Kalundborg,[32] a small town recognized for being Denmark's deepest harbor. Its intermodal infrastructure (sophisticated bulk cargo shipping, extensive stevedoring, trucking logistics and brokers) provides excellent access to the Baltic Sea for industrial companies and its fast ferry service to Aarhus and Samsø, makes Kalundborg an internationally significant industrial node. Coupled with abundant groundwater and affordable land within the vicinity of Copenhagen, Kalundborg has become a privileged location for the establishment of biotech companies located one hour from Copenhagen.

Solids & Aggregates

Once headquartered in Copenhagen, the Novo Group set up shop there in 1968 for these basic reasons. Due to the large quantity of waste liquids generated in enzyme production by its child company Novozymes, the broth of microorganisms, potato starch and sugar is dewatered and reprocessed into 250,000 m3 of dry and liquid biomass, redistributed annually to 600 local farmers as organic fertilizer on fields. As a result of the triple bottom line, Novo reduces reliance on commercial pesticides and diverts sludge from waste treatment. With transformative legislation, additional waste products from the Asnaes power plant such as waste gypsum is reused for plasterboard

manufacturing at nearby Gyproc, fly ash for concrete production at Unicon and bottom ash for road construction in the region, due to its naturally low aggregate availability. Even the local bmx track is built with dewatered sludge from the local wastewater treatment plant. Organic sludge from the local waste water treatment plant is now diverted to the nearby RGS90 soil remediation facility (one of the world's most sophisticated soil remediation facility) for bio-piling and conversion into sandblasting materials for building restoration. Geo-remediated sludge is also diverted to a local fish farmer as fertilizer, at the base of the Asnæs power plant.

Biologicals & Biofuels

During the past thirty 30 years, this network has effectively resulted in measurable effects and spin-offs: over 50% of industrial waste has been diverted from regional landfills and treatment plants, urban energy demands have been reduced by 25% and regional dependency on foreign material imports has substantially decreased and net reduction of 3 million liters of freshwater use and replenishment of groundwater supplies. In total, 15 million Euros are saved every year, totaling over 80 million over the past few years. With its tight industrial waste recycling network and new land use synergies, Kalundborg is recognized as the first prototype of industrial networks worldwide.

With droves of visiting consultants and academics every year, the small town is ironically better known for the contemporary landscape of industrial synergies emerging than for the twelfth century architecture of the Vor Frue Kirke cathedral it has maintained for 800 years. Today, the industrial systems implemented throughout the country also explain the prominence of Danish manufacturing companies on the world stage today. Denmark's dynamic duo, Novozymes, the world's largest producer of industrial enzymes located in Kalundborg and Vestas, the leading wind turbine producer in the world whose facilities dot almost every medium size town across the entire country from Lem to Nakskov. Pioneers in their respective fields of renewable resources, both companies are currently listed on US stock exchanges.

novo nordisk®
Vestas

Ecology of Scale

The prototypical waste-water-energy strategy has proven to be scalable. The biggest of the power plants in Denmark is the Avedøre power plant that runs on a cocktail of different fuels including coal, natural gas, oil but is largely fueled by renewable biomass including straw bale and waste wood. Combined with heat generated from refuse incineration plants, waste steam now supplies 97% of the city's heating supply needs. Waste steam from the plant is combined with waste heat to keep 1.2 million houses in Greater Copenhagen warm during the winter.[33]

Living on Landfills

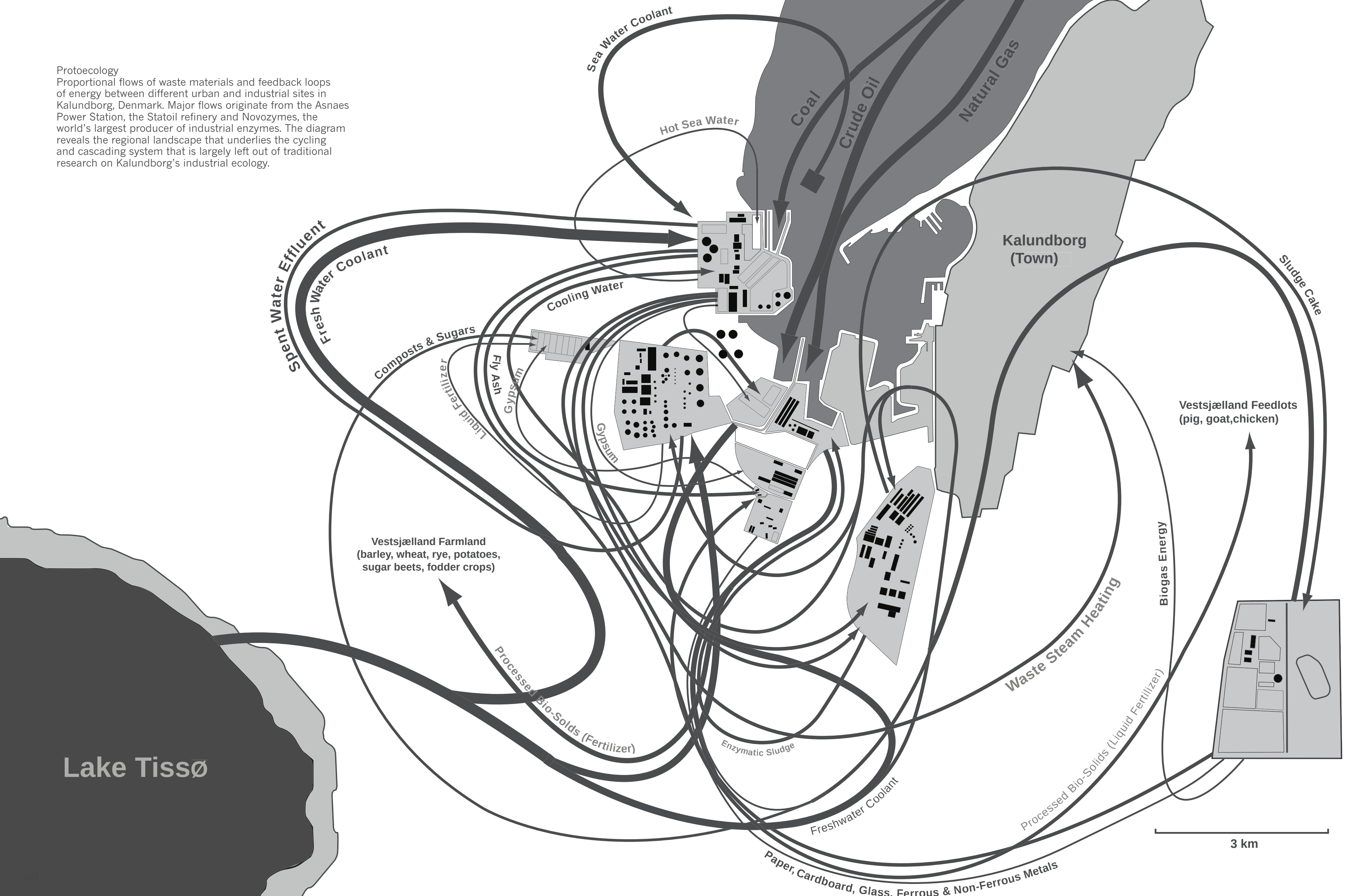
From a landmark agreement between five city mayors dating back to 1984, waste steam from electricity production that was traditionally released in the harbor is now recaptured and channeled back 1300 kilometers through pipelines directly into homes across the city and its surrounding suburbs. In one large pool-operated system, a total of four combined heat-and power plants, four waste incinerators and more than 50 peak load boiler plants with more than 20 distribution companies, total heat generation capacity from waste hovers around 30,000 terrajoules. According to the Danish Energy Authority, the system shaves 1,400 euros off from annual household bills, roughly translating into a bulk savings for the city of 200,000 tons of oil every year. Today, Copenhagen is the only city in the world to be almost entirely heated from the waste it generates.[34]

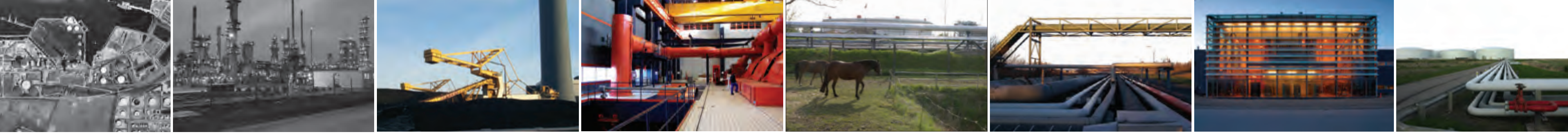
With the projected relocation of the central harbor to the reclaimed lands of Nordhavn, Copenhagen is planning for future growth while synchronizing its development. Two hundred hectares will be reclaimed from the Øresund with 46 million cubic meters of materials excavated from the construction of the new city metro line and topped off with recycled demolition debris. Heralded as the Paris of Scandinavia, Copenhagen in the future will look more today like a carefully crafted landfill than a pristinely preserved city. Decentralization in the future, both as a strategy of urban decongestion and ecological reclamation, therefore seems necessary and inevitable.[35]

Recovery & Recirculation

Current statistics are promising. Today, Denmark recycles 100% of the

Protoecology
Proportional flows of waste materials and feedback loops of energy between different urban and industrial sites in Kalundborg, Denmark. Major flows originate from the Asnaes Power Station, the Statoil refinery and Novozymes, the world's largest producer of industrial enzymes. The diagram reveals the regional landscape that underlies the cycling and cascading system that is largely left out of traditional research on Kalundborg's industrial ecology.

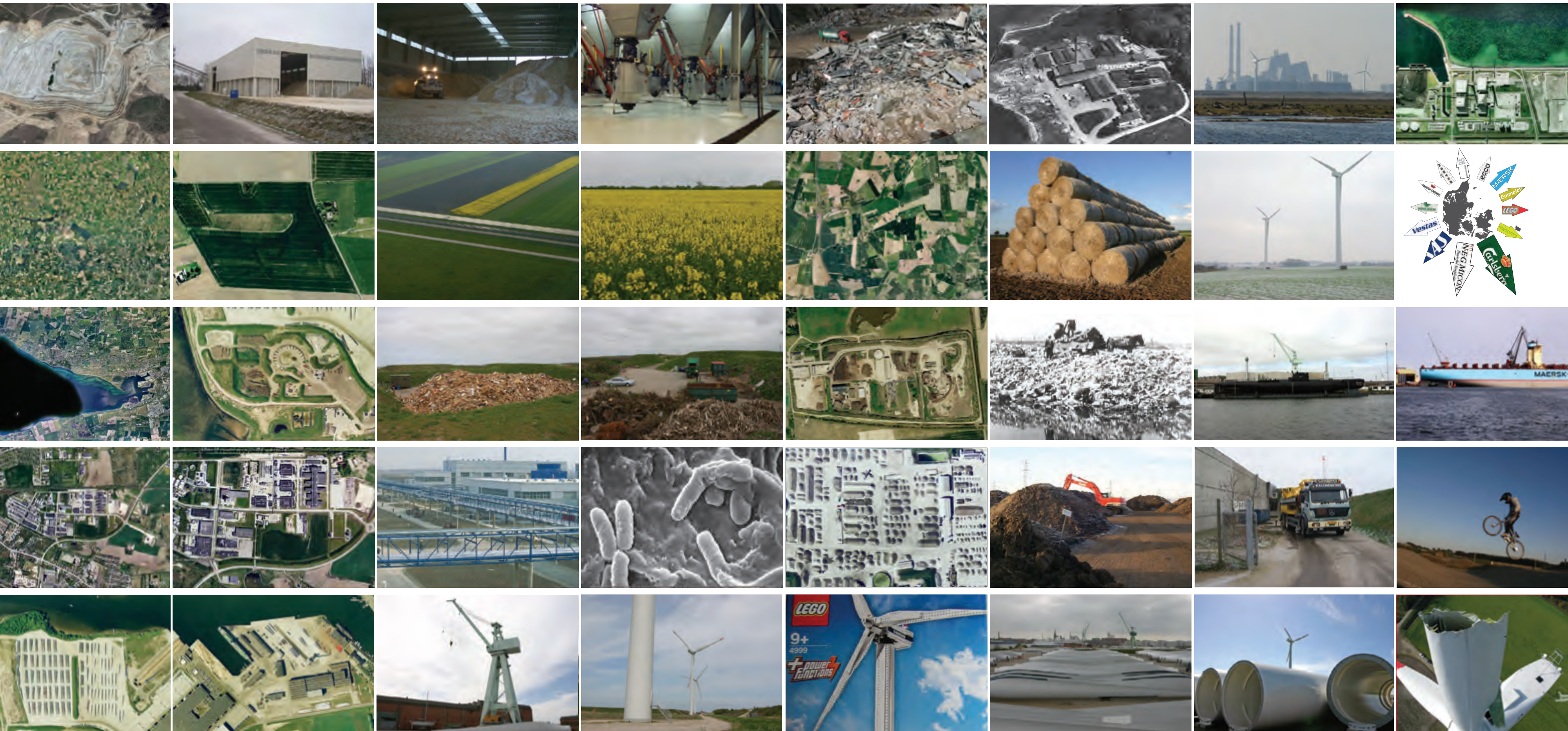


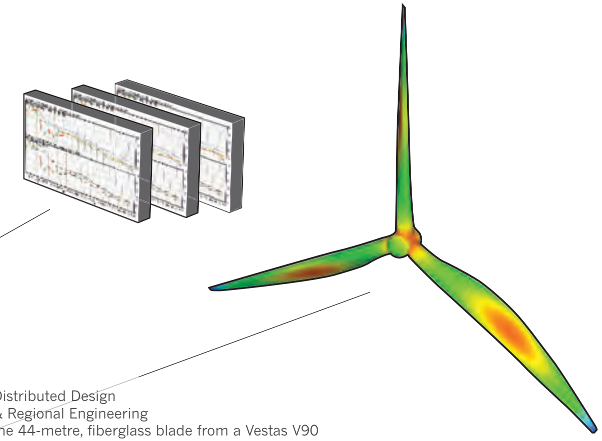


Fluid Urbanism (Field Work)

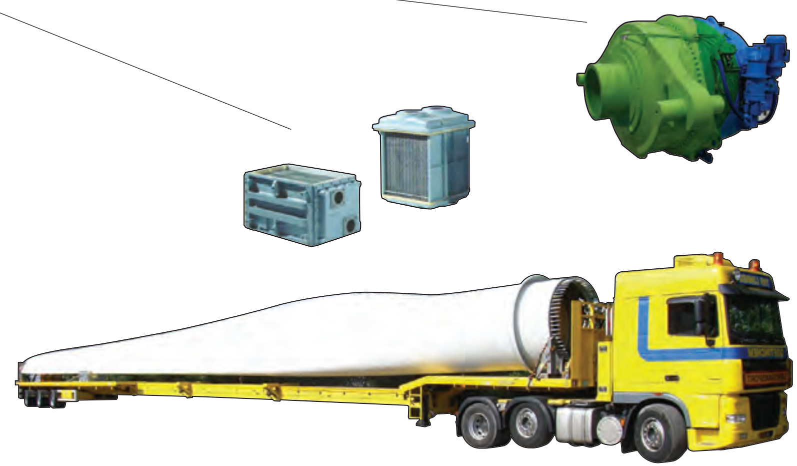
Landscape of pipelines, designated corridors and distribution right-of ways around the Kalundborg Fjord, where waste steam from the main power plant is redistributed to heat local plants and nearby residential homes. Due to stringent air, land and water emissions, adjacent lands to heavy industry and power generation can be used for public and agricultural uses. Conservation of resources is less of a matter of preservation or protection as it is about conversion and continuous flow.

(except where noted, all ground photos by Pierre Bélanger)





Distributed Design
& Regional Engineering
the 44-metre, fiberglass blade from a Vestas V90 3.0 megawatt wind turbine fabricated and stored on the site on a former landfill used for coastal dredge disposal in Nakskov, Denmark. Once the John Deere of Denmark, the small engine manufacturer and agricultural equipment supplier from the small town of Lem in Western Denmark is now the leading manufacturer and erecter of wind turbines in the world thanks to partnerships with energy giant NEG Micons. Once named Vestjysk Stålteknik A/S in 1928, the structure of the Vestas company is entirely decentralized: towers are built in Nyborg, blades are made in Nakskov, Lem, and Skjern. Control systems are built in while R&D is funded at the RISØ Laboratory in Røskilde.



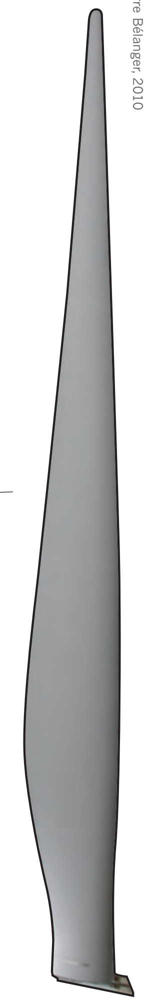
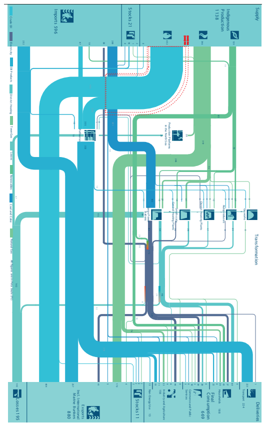


Diagram: Pierre Bélanger, 2010

steel slag, bottom ash, fly ash, asphalt and practically all of its concrete from industrial, construction and demolition processes. Thanks to the non-profit bottle return agency, Dansk Retursystem, it has a 100% return rate on its reusable glass bottles, with an average 33 reuses.[36] As of 2002, the 31 Danish incineration plants now treat almost 3 million tons of waste annually, corresponding to around 600 kg per capita, third only to Switzerland and Japan for being the country in the world that incinerates the most waste per capita. Reciprocally, there has been a sharp drop in the demand for more landfill airspace from the existing 134 landfills across the country.



Decentralizing Denmark

With the national Energy Plan in 1976, the country's energy mix is now the most diverse in the world: it relies on 20% coal fired power plants for electricity, and almost entirely on waste to energy plants through combined power systems for its heat. Renewables, in the form of wind and biomass is the largest power provider. Thanks to least cost zoning, the largest percentage comes from the burning of waste. Unlike most of its EU neighbors, there are no nuclear power plants in Denmark. Wind now supplies 21% of their energy and although there exists circle of energy co-dependency with its neighbors including Norway, Sweden and Germany.[37]

Opportunistically, Denmark sells wind power during peaks, and buys hydro power during lulls. From this, it has become a net exporter of wind energy. Spin-offs from the wind industry alone amount to 20,000 jobs for a country with half the population of the state of Maine. And now the government is putting up $1 billion to develop and integrate solar, tidal and fuel-cell technology.[38]

Not surprisingly, Danish wind turbine companies hold a solid share in half the world market, generating 3 billion euros out of a world total of 6 billion.[39] More than just a series of isolated experiments in urban recycling or industrial ecology, the entire landscape of Denmark – both on land and offshore – is proving durable as a test bed for the limitless capacity of waste synergies and energy synchronicities latent in the recirculation of by-products and rechanneling of heat sources when factoring the longevity of pre-existing groundwater resources. From the construction of the first military forts using waste materials during the Middle Ages to the conversion of sludge into fertilizers in the 20th century to the generation of power from garbage in 2008, the ecology of waste - the irreversible by-product of industrial and urban operations - appears to be one of the most sustainable economies in the history of the Old World. In other words, shit, the excreta of urbanization, is the new fuel.

Originally presented at the Ecological Urbanism Conference *chaired by Mohsen Mostafavi in March 2008 at the Harvard Graduate School of Design.*

Endnotes

1. Ivan Illich, H2O and the Waters of Forgetfulness (London, UK: Marion Boyars, 1986): 40.

2. Abel Wolman, "The Metabolism of Cities", Scientific American 213 Special Issue 'Cities' (September 1965): 179.

3. Henri Lefebvre, The Production of Space, english translation by Donald Nicholson-Smith in 1991 (Paris, FR: Editions Anthropos, 1974/1984): 46.

4. In their 1989 article, Frosch and Gallopoulos clearly proposed that "the traditional model of industrial activity in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed of should be transformed into a more integrated model: an industrial ecosystem. In such a system the consumption of energy and materials is optimized, waste generation is minimized and the effluents of one process whether they are spent catalysts from petroleum refining, fly and bottom ash from electric-power generation or discarded plastic containers from consumer products serve as the raw material for another process." See Robert A. Frosch and Nicholas E. Gallopoulos, "Strategies for Manufacturing", Scientific American Vol. 261 No.3 (September 1989): 94. Although the original title of the article - "Manufacturing: The Industrial Ecosystem View" - did not feature their notion of industrial ecology as they intended, Paul Hawken was one of the first authors to make a direct connection in the early 1990s between the emerging notion of industrial ecology and industrial ecosystem that they presented in their 1989 article, with the Kalundborg network of waste recycling and material symbiosis that was well under development in the 1970s. In it, he states that "for the first time, industry is going beyond life-cycle analysis methodology and applying the concept of an ecosystem, to the whole of an industrial operation, linking the metabolism of one company with that of others. The prototype of industrial ecology and cooperation is Kalundborg, Denmark." See Paul Hawken's chapter "Parking Lots and Potato heads" in The Ecology of Commerce: A Declaration of Sustainability (New York: Harper Collins Publishers, 1993): 73.

5. Jerzy Regulski, Decentralization and Local Government: A Danish-Polish Comparative Study in Political System (Roskilde, DK: Roskilde University Press, 1988). Regulski makes several important distinctions between the socio-political dimensions of regulatory decentralization and the territorial dynamics of spatial deconcentration. See also "Strategies for Decentralization and Local Government Autonomy—An Assessment of a Danish Initiative" by David Etherington, in Public Money & Management Vol. 16 No. 1 (1996): 45-50.

6. Caspar Jorgensen and Morten Pedersen (eds.), Modernism And Rationalization (Aalborg, DK: Museum of Northern Jutland and The Heritage Agency of Denmark, 2006)

7. Henriksen, Ingrid. "An Economic History of Denmark". Economic History Association Encyclopedia, edited by Robert Whaples (October 6, 2006) http://eh.net/encyclopedia/article/henriksen.denmark

8. Ellen Margrethe Basse & Erik Werlauff, Environmental Law in Denmark (New York, NY: Kluwer Law International, 2000).

9. Babcock Heron Kleis, Wilcox Vølund and Rambøll Søren Dalager, 100 Years of Waste Incineration in Denmark : From Refuse Destruction Plants to High-technology Energy Works (Esbjerg, DK: Babcock & Wilcox Vølund ApS, 2004)

10. Berit Hasler et al., "Economic Assessment of the Value of Drinking Water Management in Denmark by Groundwater Protection and Purification of Polluted Groundwater (Discussion paper for the Seminar on Environmental Services and Financing for the Protection and Sustainable Use of Ecosystems, Geneva, 10-11 October, 2005); GEUS - Geological Survey of Denmark and Greenland, Annual Report - 2001. As the major contributor to groundwater pollution, the flow of nitrogen and nitrates from agriculture runoff is under severe restriction and policy, see "Implementation of the Nitrates directive in Denmark" by the Danish Ministry of The Environment - Environmental Protection Agency (2011): http://www.mst.dk/English/Agriculture/nitrates_directive/implementation_in_denmark/

11. For a comprehensive outline of the origins of the Kalundborg network see the complete chapter by Hennig Grann on the Industrial Symbiosis at Kalundborg, in "The Industrial Green Game: Implications for Environmental Design and Management (Washington, DC: National Academy Press, 1997): 117-123.

12. Jens Vestergaard, Lotte Brandstrup & Robert D. Goddard, III, "A Brief History of the Wind Turbine Industries in Denmark and the United States, (Academy of International Business : Academy of International Business/Southeast USA Chapter Conference Proceedings, November 2004): 322-327; Per Dannemand Andersen, "Review of Historical and Modern Utilization of Wind Power" (Roskilde, DK: Risø Laboratory Publication, Denmark Technical University, 1999).

13. Henry Nielsen, Keld Nielsen, Flemming Petersen, Hans Siggaard Jensen, Forty Years of Research in a Changing Society (Roskilde, DK: Risø National Labroatory, 1998). The popular reaction of Danish and Swedish society to nuclear energy in the early 1980s cannot be understated. For example, the Swedish Anti-Nuclear Movement (Folkkampanjen mot Kärnkraft och Kärnvapen) formed in 1979 to organize opposition for the 23 March 1980 Nuclear Referendum in Sweden (folkkampanjen.se), a year before the Danish Referendum. See also Robert S. Norris, William M. Arkin & William Barr, Where They Were (United States Secretly Deployed Nuclear Bombs In 27 Countries and Territories During Cold War)", Companion Page To The Bulletin of Atomic Scientists (November/December 1999): 26; and, Henry Nielsen and Henrik Knudsen, "The Troublesome Life of Peaceful Atoms in Denmark", History and Technology, Vol. 26, No. 2 (June 2010): 91–118.

14. Justin Fox, "Why Denmark Loves Globalization" TIME Magazine (Thursday, Nov. 15, 2007) http://www.time.com/time/magazine/article/0,9171,1684528,00.html

15. Surprisingly, for a country so well respected for its investment in renewable technologies, namely wind power generation, there is very little critical scholarship on the subject of the history or theory of energy from within Danish academic discourse. Most literature on energy in Denmark is somewhat positivistic, originating from mainly two sources: public information pamphlets or technical references from governments sources or laboratory organizations (e.g. the Danish Energy Policy, 1970-2010, published by the Danish Energy Agency, http://www.ens.dk/en-US/Info/news/Factsheet/Documents/DKEpol.pdf%20engelsk%20til%20web.pdf) or techno-promotional reports from energy corporations (e.g. Waste-to-energy in Denmark published in 2010 by Rambøll for industry representative RenoSam, http://www.ramboll.com/news/themes/waste-to-energy) promoting the added value of incinerators through new, novel architecture. Nevertheless, a larger spectrum of perspectives are available internationally: Thomas L. Friedman, "Flush With Energy", New York Times Op-Ed (August 9, 2008): WK11; Bryan Walsh, " Denmark's Wind of Change"

Time Magazine (March 16, 2009). Finally, for greater detail on the effect o the 1973 oil embargo on Energy, see Foreign & Commonwealth Office, “The Year of Europe: America, Europe and the Energy Crisis, 1972-1974”, (London: Documents on British Policy Overseas Series III, 2001).

16. See the National Ration & Employment Program Pamphlet, 1940-45 (Billed-Bladet No.36 D.9, September 1941): Udenrigsministeriet - Ministry of Foreign Affairs of Denmark Digital Archive: www.befrielsen1945.dk/. In contrast to contemporary resource conservation which hinges on virtual behavioral change, wartime material rationing should be critically differentiated and understood as collective, patriotic, government induced behaviors within the political, social and material contexts of real, live material scarcities and existential threats during periods of conflict or occupation such as during World War I and World War II.

17. DBDH, Danish Board of District Heating, “The Development in Denmark & Introduction of Heat Planning” www.dbdh.dk/artikel.asp?id=463&mid=24); Danish Energy Agency, “Heat Supply in Denmark” (http://193.88.185.141/Graphics/Publikationer/Forsyning_UK/Heat_supply_in_Denmark/index.htm)

18. For a discussion on the Danish Bottle Return system, see “Trade and Environment: Some Lessons from Castlemaine Tooheys (Australia) and Danish Bottles (European Community)” by Damien Geradin and Raoul Stewardson, The International and Comparative Law Quarterly, Vol. 44, No. 1 (January 1995): 41- 71; Nina Joshi, “Danish Beer Bottles”, American University TED Case Studies, Vol.1 No. 1 (September, 1992); Matthew Bettelheim, “Americans could learn a lot about recycling from the descendants of the Vikings” http://earthisland.org/journal/index.php/eij/article/the_great_danes/

19. See “It Began in Frederiksberg” in Kleis et al., 2004: p.4; Colin C. Ferguson, “Land Contamination & Reclamation: Assessing Risks from Contaminated Sites: Policy and Practice in 16 European Countries” Vol.7 No.2 (1999): 36.

20. Hasler et al., (2005)

21. Directly referencing the characterization of ‘urbanization’ as the ‘global problématique’ that was internationally popularized by the Club of Rome in 1972 in its “Limits to Growth: A Report for the Club of Rome’s Predicament of Humankind” (), UN Secretary General and Club Member Gro Brundtland distinctively uses the same appellation ‘global problématique’ in the introductory addendum to the UN Assembly presented in 1987 in the form of the final report “Our Common Future”, Report of the World Commission on Environment & Development 18467 - Addendum to the General Report (Geneva, CH: United Nations, 1987). The report makes very little contribution to the issue of urban conditions, dedicating only 15 pages of the total 374 pages to the urban question, further conflating the notions of the ‘urban’ and ‘crisis’, especially in reference to Third World Cities, and their perceived poverty amidst so-called uncontrollable and illegal, slum development.

22. The Environmental Protection Act was first drafted in 1971, then ratified in the 1980s, and consolidated in 1998. See Ellen Margrethe Basse & Erik Werlauff, Environmental law in Denmark (New York, NY: Kluwer Law International, 2000).

23. For an official discussion of these shifts, see the governmental report by Danish Environmental Protection Agency (DEPA), “Economic Instruments In Environmental Protection in Denmark” (Copenhagen, DK: Ministry of Environment and Energy, 1999): 55-57, 93-96, 150. For a more instrumental analysis of energy taxation and regulatory policy, see Louise Dunn, “Energy Taxation-Denmark” Economic Instruments in Environmental Policy Reports http://www.economicinstruments.com/index.php/climate-change/article/120-

24. See The Geological Survey of Denmark & Greenland (GEUS), Groundwater Monitoring, http://www.geus.dk/publications/grundvandsovervaagning/grundvandsovervaagning-uk.htm

For the online system of groundwater monitoring wells, including water quality and levels per Kommune, see the DATA-GEUS-Jupiter system: http://data.geus.dk/JupiterWWW/waterlist.jsp?virksomhedstype=VV&navn=&vandvaerksid=0&adresse=&maengdemin=0&maengdemax=2147483647&kommune2007vandindvind=326&submit=Vis+liste+med+vandforsyningsanl%E6g

25. Dunn, Energy Taxation-Denmark

26. The Danish Deposit & Recycling System (2012)

27. See Kleis et al. , 2004: p.30.

28. See “ Reverse mining—The development of deep geologic isolation of hazardous (chemotoxic) waste in Germany and its international prospects” by Hartmut W.J. Schade, in Reviews in Engineering Geology, Issue 19 (2008): 23-30.

29. See “Taxes & Subsidies” in Kleis et al. , 2004: p.38-39.

30. See “Denmark’s Waste Tax” by M.S. Andersen, in Environment, Vol.40 No.4 (1998): 11-15, 38-41.

31. See “ The Waste Incineration Order” in Rambøll, Waste-to-energy in Denmark (Copenhagen: RenoSam, 2010): 8

32. The historic and factual account of the Kalundborg case presented and recounted here is based on three successive and funded trips to the region in 2000, 2003, and 2008. Personal conversations and interviews were conducted with company managers, business owners, local mayors, farmers and local inhabitants, enabled by the guidance of the Director of the Kalundborg Symbiosis Institute, Noel Brings Jacobsen.* Additional factual information is drawn from company documents, brochures, unpublished reports, updating information from the initial 1997 account of Henning in The Industrial Green Game. In the understanding of the Kalundborg model as a prototype in industrial cooperation, there is an important and deep seeded history of cooperative enterprises across Denmark dating back centuries. As a model of effective decentralization, the cooperative history Danish dairy industry, for which the country is known for internationally, is especially well documented by the self-published, 1939 pamphlet, The Cooperative Primer (Viroqua, WI) by Richard Anderson Power.

33. DBDH, District Heating In Copenhagen (Copenhagen Energy, 2009) & Jan Elleriis, “Metropolitan Copenhagen Heating Transmission Company” (Copenhagen, DK: CDK, 2010).

34. Ibid.

35. See the complete project history and profile of Nordhavn on the development website: www.nordhavnen.dk/OplevNordhavnen/Historie.aspx

36. For a historic profile of the Danish Deposit & Recycling System, see: www.dansk-retursystem.dk/content/us/about_dansk_retursystem

37. See Kleis et al. , 2004: p.42, and Risø Energy Report 4: The Future Energy System– Distributed Production and Use, edited by Hans Larsen and Leif Sønderberg Petersen (Roskilde, DK: Risø National Laboratory, October 2005).

38. See European Commission on Energy Policy, “Denmark – Energy Mix Fact Sheet” (January 2007) http://ec.europa.eu/energy/energy_policy/doc/factsheets/mix/mix_dk_en.pdf. The ongoing development of these intelligent energy systems and processes of decarbonization rely on material flows and landscape infrastructure management produce that are regional planned and designed. See Smart Grid in Denmark, by the Danish Energy Association and Energinet: http://kom.aau.dk/project/edge/repository/02_literature/PowerSystem/Smart_Grid_Denmark.pdf

39. ECUP, “Denmark – Energy Mix Fact Sheet”, p.2.

FIGURES

P.266-267

Scientific American: William C. Clark (ed.), Special Issue ‘Managing Planet Earth’ (September 1989): cover.

Dr. Robert Frosch (frontal): NASA, 1977-1981.

Kalundborg Symbiosis, Diagram: National Academy of Engineering, “The Industrial Green Game: Implications for Environmental Design and Management (Washington, DC: National Academy Press, 1997): 119.

Abel Wolman, “The Metabolism of Cities”, Scientific American 213 Special Issue ‘Cities’ (September 1965): cover, 179, 180.

Abel Wolman (frontal): Lasker Foundation

Thule Air Force Base, Aerial View, 1989: TSGT Lee E. Schading, Defenseimagery.mil, VIRIN DF-ST-90-10597

Stratofortress Thule Mission: Bobby D. Brewer, www.thuleforum.com/broken_arrow.htm

Post-War New World Map (1941), Maurice Gomberg: Library of Congress Geography & Map Division, Washington DC.

German Occupation in Denmark, 1940: Udenrigsministeriet - Ministry of Foreign Affairs of Denmark Digital Archive.

Peat as Wartime Fuel: Befrielsen 1945 - Rationering og erstatningsvarer, Mnr: 25M0201003 CDnr: 1215427.

P. 268-269

National Ration & Employment Program Pamphlet, 1940-45 (Billed-Bladet No.36 D.9, September 1941): Udenrigsministeriet - Ministry of Foreign Affairs of Denmark Digital Archive.

P.270-271

Open Landfill Burning: DDBH, Danish Board of District Heating, 19767-73.

Groundwater Resource Handbook: Kommissionen for de Europæiske Fællesskaber, Grundvansressourcer i Danmark (Bruxelles-Luxembourg: EKSF, EØF, EURATOM, 1982): cover.

Structural Geology Map, Michelsen, 1978: Kommissionen for de Europæiske Fællesskaber, Grundvansressourcer i Danmark (Bruxelles-Luxembourg: EKSF, EØF, EURATOM, 1982): 4.

Our Common Future, Report: Gro Harlem Brundtland - UN Secretary General, Report of the World Commission on Environment & Development 18467 - Addendum to the General Report (Geneva, CH: United Nations, 1987): 1.

Groundwater Map: Geological Survey of Denmark, Aquifer Sheet 6, Commission of the European Communities - Directorate General for the Environment, Consumer Protection and Nuclear Safety. European Soil Portal: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/groundwater/

1-km Grid Cell Groundwater Monitoring: The Geological Survey of Denmark & Greenland, “Water Resources in Denmark”, in GEOLOGI - NYT FRA GEUS (October 1997): 7.

Green Beer Bottle, 1960: Carlsberg Breweries, Copenhagen, Denmark, Original Beer Importing & Distributing Co. (NY), Tavern Trove.

European Hazardous Waste Flows & Germany’s Underground Mines: Map by Pierre Bélanger, 2008.

Deep Underground Waste Repository: Morsleben Endlager, Bundesamt für Strahlenschutz, 2008.

P.272-273

Kalundborg DK, Coastal Aerial View: © 2013 Aerodata International Surveys.

P.274-275

Incinerator, Interior: Forbrændingsegnet affald, kraner på forbrændingsanlægget, Vestforbrænding AV Miljø, 2007.

Asnæs Power Station, Kalundborg Port, DK: Pierre Bélanger, 2003.

Kalundborg Port, Aerial View: © 2013 Aerodata International Surveys.

Kalundborg Waste Flows: Pierre Bélanger, 2008.

Sludge Truck Transport, Kalundborg, DK: Pierre Bélanger, 2005.

Fly Ash Dust into Drywall Gyproc, Kalundborg, DK: Pierre Bélanger, 2005.

Soil Remediation Plant, Kalundborg, Aerial View: © 2011 Aerodata International Surveys.

Kalundborg City Emblem: Kalundborg Kommune, http://www.kalundborg.dk/

Novo Nordisk Logo: Novo Nordisk A/S.

Disctrict Heat Zoning: “Heat Supply in Denmark”, DBDH, Danish Board of District Heating.

Vestfor Incinerator Plant, Copenhagen DK, Aerial View: © 2013 TerraMetrics - Aerodata International Surveys.

Copenhagen Nordhavn & MiddelGrungen Wind Park, Aerial View: © 2013 TerraMetrics - Aerodata International Surveys.

P.276-277

Protoecology, Diagram of Waste Flows and Material Transfers: Pierre Bélanger, 2008.

P.278-279

Fluid Urbanism, Field Work & Site Photographs of Kalundborg Industrial Region: all ground level photos by Pierre Bélanger, 2008, aerial photos: ©2013 TerraMetrics - Aerodata International Surveys, microscopic imaging (soil bacteria micrograph, Pseudomonas aeruginosa): Centers for Disease Control and Prevention - Public Health Image Library ID #232, via SOILREM/Bioteknisk Jordrens.

P.280-281

Distributed Design & Regional Engineering: diagram by Pierre Bélanger, 2010.

P.282-283

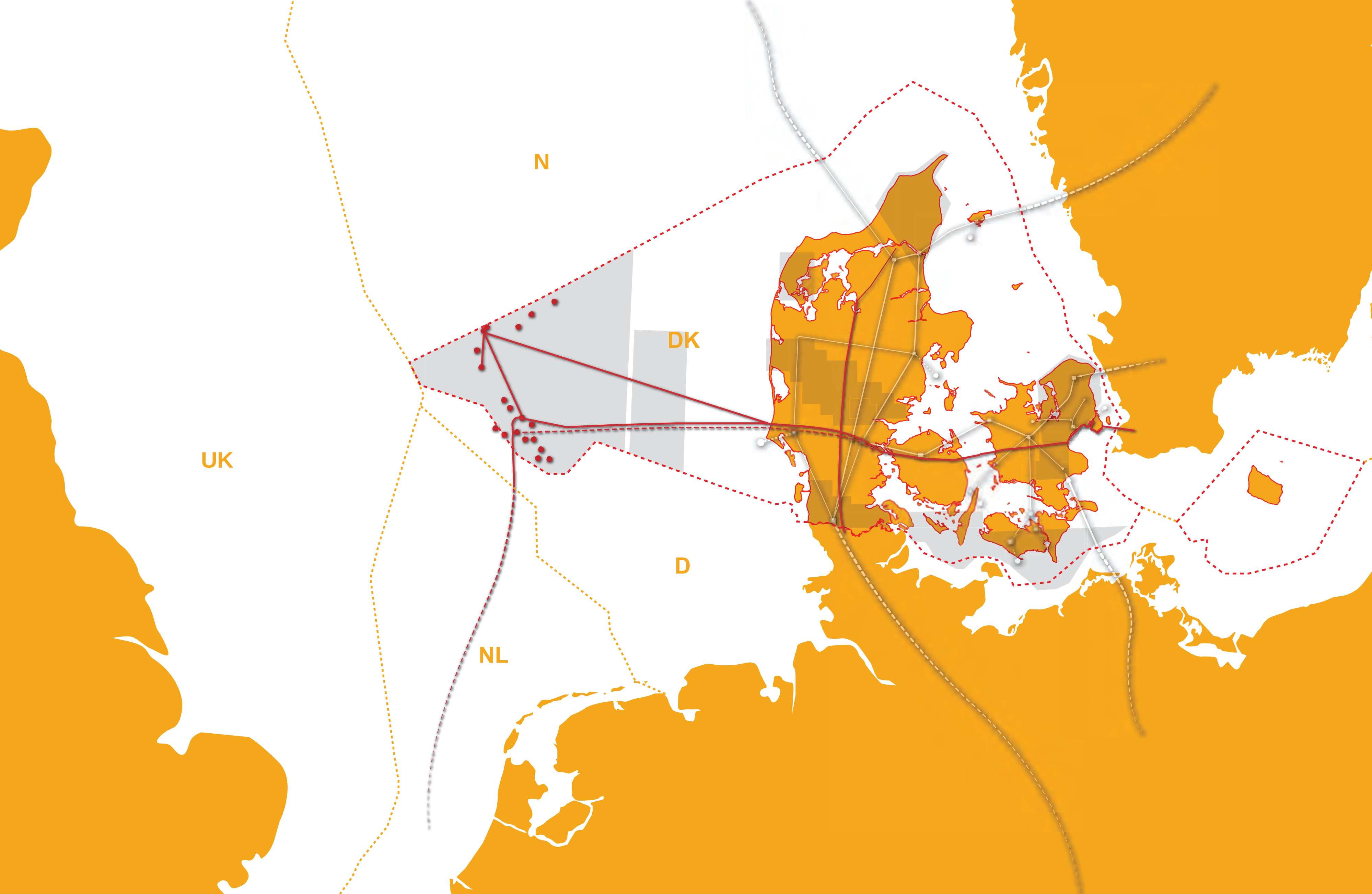
2005 National Energy Flows, Sankey Diagram: Danish Energy Agency (DEA).

Horns Rev 1, Offshore Wind Field: ELSAM A/S - Vattenfall, 2008.

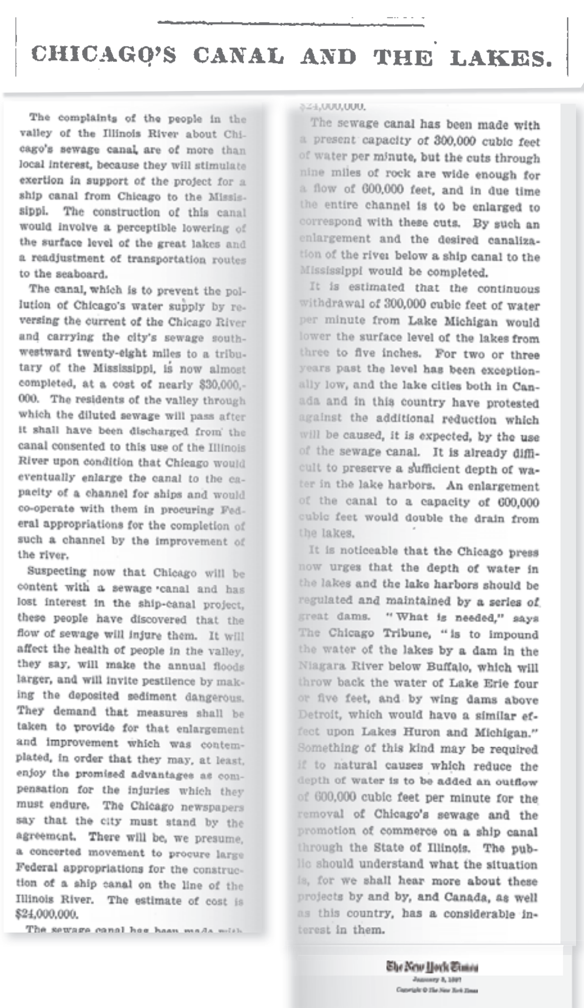
P.284-285

Decentralizing Denmark, Map of different energy systems and distribution networks in Denmark and Nordic Region. Diagram by Pierre Bélanger, 2012, with source information from Danish Energy Agency.

*As of 2010, Ole Morten Noel Brings Jacobsen, Director & Founder of the Kalundborg Symbiosis Institute in Demark, sadly passed away.


N
DK
UK
D
NL

Regionalization.



CHICAGO'S CANAL AND THE LAKES.

The complaints of the people in the valley of the Illinois River about Chicago's sewage canal, are of more than local interest, because they will stimulate exertion in support of the project for a ship canal from Chicago to the Mississippi. The construction of this canal would involve a perceptible lowering of the surface level of the great lakes and a readjustment of transportation routes to the seaboard.

The canal, which is to prevent the pollution of Chicago's water supply by reversing the current of the Chicago River and carrying the city's sewage southwestward twenty-eight miles to a tributary of the Mississippi, is now almost completed, at a cost of nearly $30,000,000. The residents of the valley through which the diluted sewage will pass after it shall have been discharged from the canal consented to this use of the Illinois River upon condition that Chicago would eventually enlarge the canal to the capacity of a channel for ships and would co-operate with them in procuring Federal appropriations for the completion of such a channel by the improvement of the river.

Suspecting now that Chicago will be content with a sewage canal and has lost interest in the ship-canal project, these people have discovered that the flow of sewage will injure them. It will affect the health of people in the valley, they say, will make the annual floods larger, and will invite pestilence by making the deposited sediment dangerous. They demand that measures shall be taken to provide for that enlargement and improvement which was contemplated, in order that they may, at least, enjoy the promised advantages as compensation for the injuries which they must endure. The Chicago newspapers say that the city must stand by the agreement. There will be, we presume, a concerted movement to procure large Federal appropriations for the construction of a ship canal on the line of the Illinois River. The estimate of cost is $24,000,000.

The sewage canal has been made with a present capacity of 300,000 cubic feet of water per minute, but the cuts through nine miles of rock are wide enough for a flow of 600,000 feet, and in due time the entire channel is to be enlarged to correspond with these cuts. By such an enlargement and the desired canalization of the river below a ship canal to the Mississippi would be completed.

It is estimated that the continuous withdrawal of 300,000 cubic feet of water per minute from Lake Michigan would lower the surface level of the lakes from three to five inches. For two or three years past the level has been exceptionally low, and the lake cities both in Canada and in this country have protested against the additional reduction which will be caused, it is expected, by the use of the sewage canal. It is already difficult to preserve a sufficient depth of water in the lake harbors. An enlargement of the canal to a capacity of 600,000 cubic feet would double the drain from the lakes.

It is noticeable that the Chicago press now urges that the depth of water in the lakes and the lake harbors should be regulated and maintained by a series of great dams. "What is needed," says The Chicago Tribune, "is to impound the water of the lakes by a dam in the Niagara River below Buffalo, which will throw back the water of Lake Erie four or five feet, and by wing dams above Detroit, which would have a similar effect upon Lakes Huron and Michigan." Something of this kind may be required if to natural causes which reduce the depth of water is to be added an outflow of 600,000 cubic feet per minute for the removal of Chicago's sewage and the promotion of commerce on a ship canal through the State of Illinois. The public should understand what the situation is, for we shall hear more about these projects by and by, and Canada, as well as this country, has a considerable interest in them.

The New York Times
January 3, 1897

In its recognition of the region as a basic configuration in human life; in its acceptance of natural diversities as well as natural associations and uniformities; in its recognition of the region as a permanent shore of cultural influences and as a center of economic activities, as well as an implicit geographic fact-here lies the vital common element in the regionalist movement. So far from being archaic and reactionary, regionalism belongs to the future.

Lewis Mumford, 1938[1]

The Great Lakes, with the immense resources and communication which make them a Nearctic Mediterranean, have a future, which its exponents claim may became world-metropolitan in its magnitude.

Patrick Geddes, 1915[2]

The Chicago press now urges that the depth of water in the [Great] lakes and the lake harbors should be regulated and maintained by a series of great dams. "What is needed", says the Chicago Tribune, "is to impound the water of the lakes by a dam in the Niagara River below Buffalo, which will throw back the water of Lake Erie four or five feet, and by wing dams above Detroit, which would have a similar effect upon Lakes Huron and Michigan." Something of this kind may be required if to natural causes which reduce the depth of water as to be added an outflow of 600,000 cubic feet per minute for the removal of Chicago's sewage and the promotion of commerce on a ship canal through the State of Illinois. The public should understand what the situation is, for we shall hear more about these projects by and by, and Canada, as well as this country, has a considerable interest in them.

The New York Times, 1897[3]

Over 40 million people live within the watershed region of the Great Lakes in North America, the largest body of fresh water on the planet. During the past two centuries the region has been given a series of idiosyncratic designations such as the Great Cutover, the Manufacturing Belt, the Rust Belt, the Great Lakes Megalopolis and the Megaregion by well-known urbanists from Patrick Geddes to Jean Gottmann. Emblematic of different processes of colonisation, industrialization and urbanization, these historical characterizations reveal a landscape of geo-economic significance beyond the conventional limits of the city while testifying to a deeper ontology of regionalist canons whose focus is the hydrophysical system of the Great Lakes. Referencing a series of overlooked plans, projects and processes, this essay demonstrates how the Great Lakes Region is a macrocosm of change, a case study in the urban transformation of the continent with relevance to other parts of the industrialized world such as France, Germany, Britain, Italy, Russia, Japan and Australia. As a revival of the revolutionary régionalisme of Jean Charles-Brun in late 19th century France and as a challenge to contested globalization identified by Saskia Sassen at the end of the 20th century, this essay proposes that the regionalized of ecological, economic and political conditions is of crucial significance to the global discourse on urbanization.

<<

1. Mumford, The Culture of Cities (New York, NY: Harcourt, Brace and Company, 1938): 306.

2. Patrick Geddes, Cities in Evolution: an introduction to the town planning movement and to the study of civics (London: Williams & Norgate, 1915): 49.

3. The New York Times, "Chicago's Canal and the Lakes" (3 January 1897).

<

The Region & The Globe
Satellite view of the Great Lakes (Superior, Michigan, Huron, Erie, Ontario) and the Atlantic Coast (Boston and New York City in far background) seen from the International Space Station. Source: NASA Visible Earth, 2008

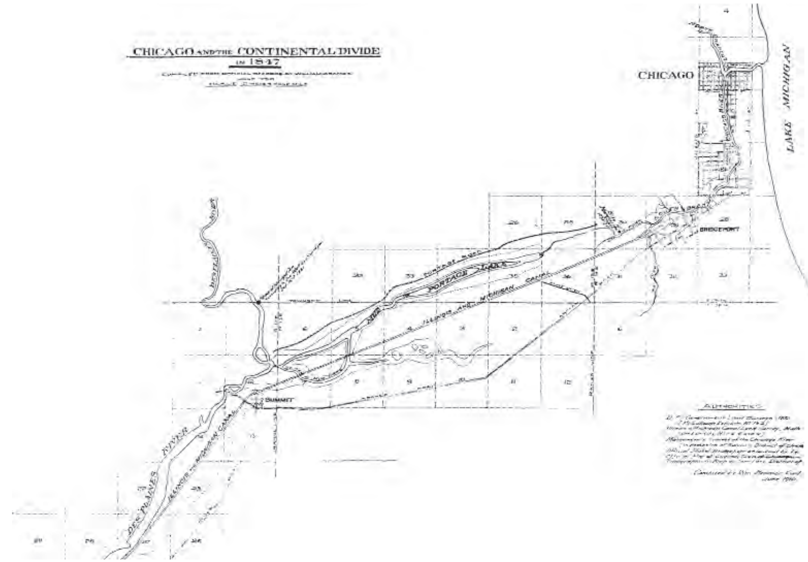
4. As in the case of Chicago, the development of geographic shortcuts between water bodies and across regional divides explains the birth of several cities throughout the Great Lakes. The city of Toronto for example, whose name is derived from the Huron/Iroquois passage or portage, was a shortcut from Lake Ontario to Lake Huron making it a strategic regional outpost for trade and transportation.

5. The annual death rate from diphtheria, cholera and typhoid fever ranged between 500 and 2000 for most of the 19th century. Typhoid fever was virtually eliminated by 1917 with chlorination of the water supply (Chicago Department of Health 1919: 1424).

6. Chicago Department of Health, General and Chronological Summary of Vital Statistics, Annual Report 1911-1918. Reprint Series No.16 (Chicago, IL: The Department of Health, 1919): 1424.

On January 2nd 1900, a dam was unlocked on the southwest shore of Lake Michigan with only a few, anxious trustees to christen water flow from the Chicago River, the first water course ever to be reversed in North America. Planned and built in 10 years, the project was the golden child of two previous parent projects. The Chicago Portage in 1673 and the Illinois & Michigan Canal in 1845 had already set the precedent for geographic shortcuts across the continental divide.[4] The third and final diversion was the Sanitary & Ship Canal, a 28-mile long, 24-foot deep, 160-foot wide trench completed 7 years after Chicago marked the 400th anniversary of the New World during the World Fair. Responding to typhoid and cholera epidemics,[5] the objective of the reversal was to divert sewage away from drinking water intakes located offshore in Lake Michigan for an exploding urban population. Technologically, the Chicago Canal was an engineering marvel in size and scale. Through chlorination of the water supply and a comprehensive sewer separation, typhoid fever was virtually eliminated by 1917.[6] The Canal irreversibly opened the Western Frontier and the Deep South of the United States. Securing Chicago's future as the main portal to westbound-eastbound commerce, the canal linked two coastlines (the Atlantic and the Gulf of Mexico) by connecting two of America's largest trading centers, New York and New Orleans, via Chicago. Using the canal as an infrastructural link, the mid-continental divide was conquered by the year 1900.

Reversal of the Chicago River precipitated another effect. Channeled away from the Lake, sewage poured into the Illinois River on its way to the Mississippi by way of St. Louis. Locally, complaints from downstream residents in Southwest Chicago ignited almost immediately. As the sewage moved further downstream across state lines, so did the backlash. Regionally, St. Louis engaged in a bitter legal battle well before construction started in 1892. While sewage overloading played a role, the major case focused on the over-exertion of shipping traffic from Chicago to the Mississippi originating from a city outside the river basin. Geopolitically, the reversal of the river imposed external effects on residents in the valley of the Illinois River. Although injunctions submitted by the



Divide, Divert & Conquer
1847 Map of the planned Illinois & Michigan Canal running 96 miles (155 km) that opened boat transportation from the Great Lakes to the Mississippi River and the Gulf of Mexico. Source: Chicago Historical Society

Cordon Sanitaire
The 28-mile 200-foot wide 20 feet-deep Sanitary & Ship Canal that effectively reversed the Chicago River, diverting sewage away from Lake Michigan. Source: ©2005 Chicago Historical Society / A. Philip Randolph Pullman Porter Museum Archives

state of Missouri to halt the reversal were rejected by the Supreme Court, limits on water diversions were eventually enacted by 1925.[7] In the decade-long process, the proceedings made visible the downstream effects of upstream urbanization. Geopolitically, it could be deduced that the effects of cities lie well beyond the governing limits of the city itself, and that the source of historical conflicts often flows from the discrepancies, or differentials, between biophysical systems across man-made political boundaries.

Less than a quarter century after its construction, the Chicago diversion had other, major cascading effects: water levels across the Great Lakes dropped at visible rates. International conflict was imminent. Ten thousand cubic feet of water per second were being diverted every second from Lake Michigan triggering alarming concerns from Ontario, the Canadian neighbor to the north who long opposed any freshwater diversions from the Great Lakes. Bordering on four of the five Great Lakes, the Province of Ontario was losing more than 300,000 cubic feet of water per minute from the diversion, a significant loss for the hydroelectric dam at Niagara Falls. Two more diversions and two more reversals would be constructed in less than a quarter century. Chicago was heading into a 100-year long battle of water rights. The State of Missouri joined forces with Wisconsin, Michigan, and New York in a coalition to put an end to the diversions.

The diversion focused a wide and contentious lens on the urban pressures, the physiographic magnitudes, the hydrologic complexities and the jurisdictional constituencies of the region. The conflicts, confrontations and crises that originated with the Sanitary & Ship Canal also laid the groundwork for a history of other water diversions, extractions and abstractions up to the present day. Pre-dated by water works across the Great Lakes such as the Erie Canal and Ohio Canal Systems in the 19th century, followed by other mega-projects like the Niagara Falls hydroelectric dam and the St. Lawrence Seaway in the 20th century, the reversal of the Chicago River can be interpreted as a turning point in North American water management. Technologically, the diversion displayed

7. Missouri's 1905 suit against Illinois to end the diversion was unsuccessful, but the Supreme Court placed limits of water diversion starting in 1925 (Changnon and Harper 1994: 16B38).

8. See APWA, Top Ten Public Works Project of the Century 1900-2000, www.apwa.net/About/Awards/TopTenCentury

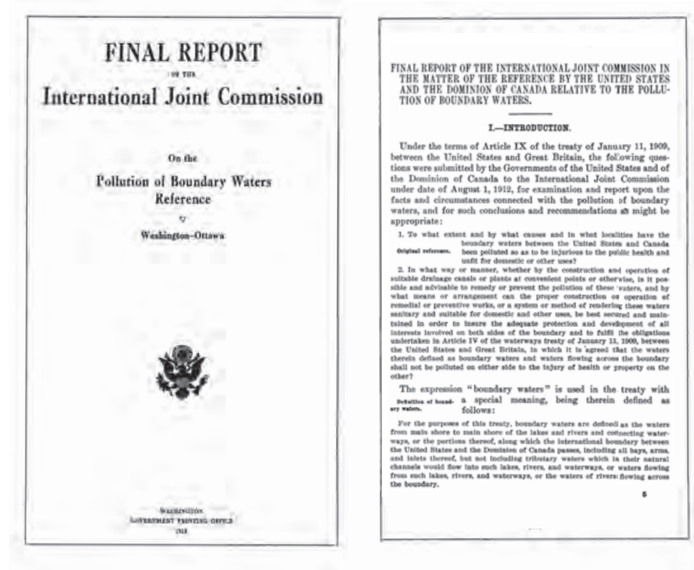
9. Quinn, F. 1988. Interbasin Water Diversions: a Canadian perspective. In Journal of Soil and Water Conservation 42 (6): 389-393.

10. Innis. H. 1950. Empire and Communications. Cambridge, England: Oxford University Press.

the prowess of civil engineering in one of the most important public works projects of the 20th century.[8] Leading to the formation of the Chicago School of Earthmoving, it set the precedent for other construction projects such as the Panama Canal.

The reversal of the Chicago River also marks a major moment in the regionalization – an operative term that designates the geographic, economic and ecological process of characterizing and forming regions according to overlapping geopolitical and biophysical boundaries – of the Great Lakes. Whereas in the past each lake was perceived as one of a series of loosely connected water bodies, a major change occurred in the understanding of their interconnectedness. The politics of the diversion later resulted in the milestone enactment of the Boundary Waters Treaty in 1909,[9] soon followed by the inception of the International Joint Commission (IJC), a cross-border organization exclusively mandated to help resolve disputes and to prevent future ones, primarily those concerning water quantity and water quality along the boundary between Canada and the United States.[10] More than a century later, the IJC has grown in size and influence to become a model of transnational cooperation and watershed governance, recognized worldwide. Paradoxically, the making of a simple water channel revealed the preeminence of the region and how it functions as an essential urban infrastructure that binds cities to their watersheds.

As the largest body of freshwater remaining on the planet, the Great Lakes Region has simultaneously become home to over 40 million people living within its watershed. Testifying to the robustness of water systems underlying urbanization, the current renaissance of turn-of-the-century regionalist tendencies is the contemporary manifestation of a richer, deeper ontology of regional characterizations over the past two hundred years whose fulcrum is the watershed of the Great Lakes. Sourcing the work of public intellectuals, scholars and industrialists, the region has respectively garnered idiomatic designations such as the Great Cutover, the Rust Belt, the Great Lakes Megalopolis and more recently, the Megaregion. Emblematic of different phases of colonization, immigration, industrial-



FINAL REPORT

OF THE

International Joint Commission

On the

Pollution of Boundary Waters Reference

Washington-Ottawa

FINAL REPORT OF THE INTERNATIONAL JOINT COMMISSION IN THE MATTER OF THE REFERENCE BY THE UNITED STATES AND THE DOMINION OF CANADA RELATIVE TO THE POLLUTION OF BOUNDARY WATERS.

I.—INTRODUCTION.

Under the terms of Article IX of the treaty of January 11, 1909, between the United States and Great Britain, the following questions were submitted by the Governments of the United States and of the Dominion of Canada to the International Joint Commission under date of August 1, 1912, for examination and report upon the facts and circumstances connected with the pollution of boundary waters, and for such conclusions and recommendations as might be appropriate:

Original reference.

1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to insure the adequate protection and development of all interests involved on both sides of the boundary and to fulfil the obligations undertaken in Article IV of the waterways treaty of January 11, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other?

Definition of boundary waters.

The expression "boundary waters" is used in the treaty with a special meaning, being therein defined as follows:

For the purposes of this treaty, boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers, and waterways, or the waters of rivers flowing across the boundary.

5

Transboundary Governance
The first major report by the Canada-U.S. International Joint Commission outlining major concerns, causes, and effects of urban pollution for the boundary waters shared between the United States and Canada, specifically focusing on water quality and water levels of the Great Lakes.
Source: IJC, 1918

Landscape of Heat
Logging blocks for timber and fuel in Northern Wisconsin in the region that later became known as the Great Cutover during the late nineteenth century. Photo: Taylor Brothers. Source: © Board of Regents of the University of Wisconsin System

ization, reclamation and urbanization, the characterizations of this landscape has also championed, when considered retroactively, some of the most important regionalist canons in North America. This essay traces a cross-section of overlooked yet influential plans, projects, and practitioners during the past two centuries in an attempt to chart the emergence and transformation of the regional paradigm to reveal its contemporary significance to the global discourse on urbanization.

THE GREAT CUTOVER
& THE CONTOURS OF CONSERVATION

Like the construction of the Calumet-Saganashkee and North Shore Channels a few years later, the reversal of the Chicago River was a response to unforeseen population explosion in the Great Lakes cities as a transit node between the urban markets on the Atlantic Coast and the Grain Belt of the Prairies; lucrative logging and mining industries were attracting Europeans seeking to escape food shortages, oppressive taxes and war to Chicago as the gateway the Western Frontier. Revolutionary farm tools such as the McCormick mechanical reaper, the Baker wind engine and the John Deere steel plough[11] were invented throughout the Midwest in what became a golden age of agricultural innovation. But immigrants soon encountered a reoccurrence of their European plight of density and disease. With the rise of steam navigation, canal construction, rail transport and cross-continental mobility, the birth of the pre-Civil War commercial metropolis and the rise of the 19th-century industrial factory town led to an explosion of urban population followed by a concurrent rural vacuum. Chicago's population for example, jumped from 5000 in 1840 to over 1.5 million in 1900.[12,13] In the absence of an integrated water supply infrastructure, sewage disposal in Lake Michigan polluted fresh water supplies. The diversion of sewage away from the Lake through the Sanitary & Ship Canal was the simplest and most logical solution. With a battery of concurrent farm drainage programs and land reclamation acts in outlying areas, super-urbanization[14] became a trope for profitable, renegade trade generated from the

11. See Collins, D.R. 1990. Pioneer Plowmaker: A Story about John Deere (Minneapolis, MN: Carolrhoda Books, 1990), and McGrath, K.A. 1990. World of Invention: History's Most Significant Inventions and the People Behind Them. Farmington Hills, MI: Gale Research Group.

12. Mohl, R. 1997. The Making of Urban America. Lanham, MD: Rowman & Littlefield Publishing: 93.

13. Ibid, 7.

14. The term super-urbanization was originally used by Benton Mackaye almost a century ago in The New Exploration (Mackaye, 1928).

industries of mass-logging and mass-mining. From mass-industrialization across the region there emerged a series of proto-conservation groups who would shape the future of urbanization.

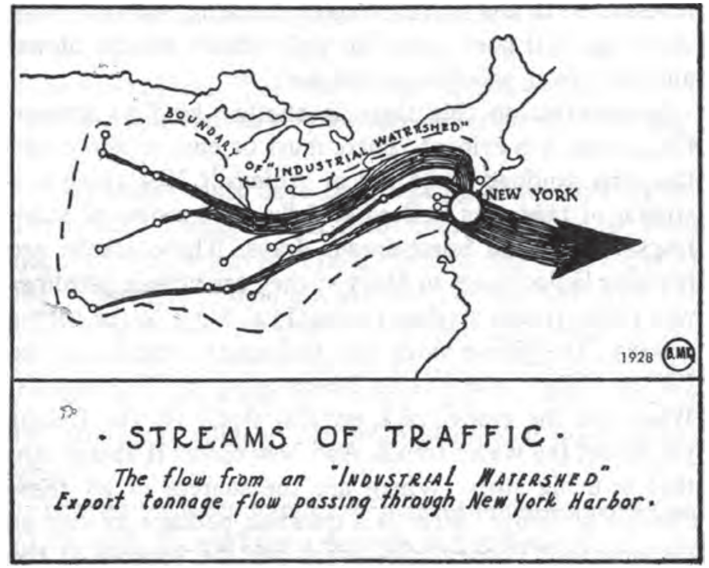
Harvest & Heist

Following the clear-cut logging and slash fires in the virgin forest regions of the Mid-Western United States and central Canada, a massive reclamation project took place. From Northern Michigan to Southwestern Ontario, rampant clear-cutting of the hardwoods (oaks, maples and birches) and the softwoods (like the white pines and spruces) stripped bare over 65% of the 40 million northern acres of choice timber in Michigan, Wisconsin, Ohio, New York, and Minnesota between 1890 and 1920. Historically recognized as the Great Lakes Cutover, the region served as the hinterland of modern commercial centers such as Boston, Philadelphia, New York and Washington. Without any formal plans for reforestation, the devastation of forests resulted in the ongoing westward march in the late 19th century that left in its wake a landscape of stumps, swamps, and scoured fields. With land rendered useless from a logging perspective, a group of conservationists, planners and industrialists emerged to develop strategies for the re-utilization of these razed areas.

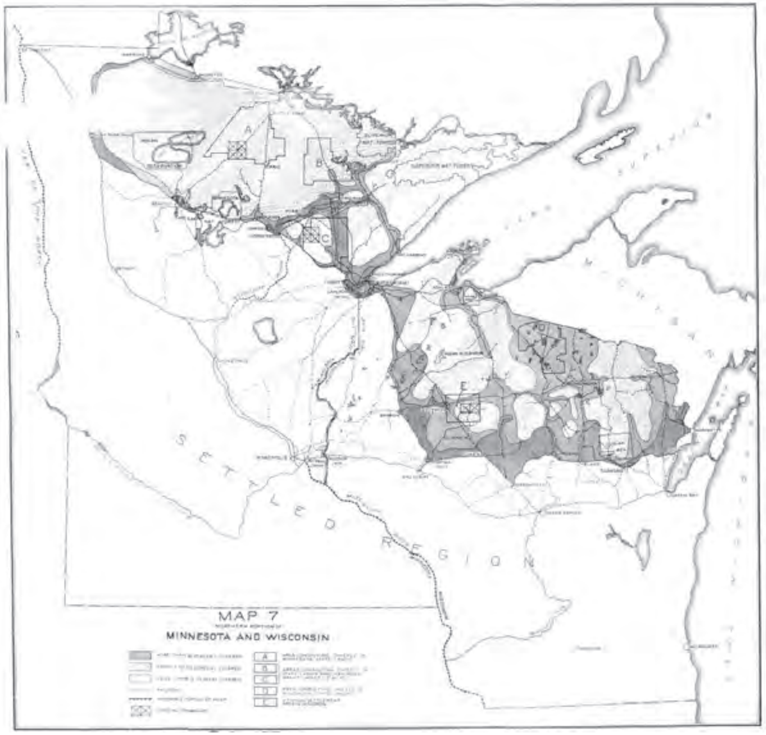
One the most notable proponents of land reclamation and regional planning was Benton Mackaye.[15] Recognized for his conception of the Appalachian Trail on the East Coast, MacKaye drew up reclamation plans for the Department of Labor and the Forest Service in the early decades of the 20th century. He was exploring new regional economic geographies in Minnesota and Wisconsin bordering Lake Superior. Influenced by Gifford Pinchot from the US Forest Service and Michigan conservationist P.S. Lovejoy, MacKaye deplored the idle, nonproductive, waste of the more than ten million acres of cutover lands in Michigan. As observed by Lovejoy in his critical survey of the Cutover *Michigan's Millions of Idle Acres*, the crisis was essentially agricultural.[16] Soils were either too wet or too infertile to turn a profit with crop farming; or too shallow for crop cultivation or rotation swamped by naturally rising water tables after clear cut logging.[17] Once a great

15. Sutter, P. 1999. A Retreat from Profit: Colonization, the Appalachian Trail, and the social roots of Benton MacKaye's wilderness advocacy. In Environmental History 4 (4): 553-577.

16. One of P.S. Lovejoy's most important contributions was a short sweeping survey of the cutover titled "Michigan's Millions of Idle Acres" in A Series of Articles Published in the Detroit News, May 24-June 4 (Detroit, MI: Detroit News, 1920): 3-11.



Regional Flows & Material Sheds
1928 Map produced by Benton Mackaye showing material sheds from the Great Lakes Region to the distribution hubs and centers of power on the East Coast such Boston, New York and Washington, Source: ©1928 The New Exploration



Regional Pre-Planning
1911 Re-settlement diagrams of cutover lands drawn (above) and collected (next page) by Benton Mackaye for the U.S. Forest Service of the Northern Portion of Minnesota and Wisconsin. To different extents and scales, each one is marked by the presence of regional resources, forest configurations, infrastructure networks and water bodies. Source: The Papers of Benton Mackaye, Dartmouth College Library

timber producer, the Great Lakes state became a net importer: home-grown hemlock was out-competed by fir from the West, hickory from the East and oak from the South. Mackaye's strategies reconceived the landscape of the failed agricultural experiments of the Northern Wisconsin region and several other cutover regions in the Northwest United States. Borrowing from the prototypes of woodland settlements published by the Canadian Commission on Conservation, Mackaye and Lovejoy foresaw imminent urbanization by sketching out regional reclamation diagrams that coupled reforestation with repopulation across the landscape of the failed agricultural experiments of the Northern Wisconsin region, and several other cutover regions in the Northwest United States.[18] As a countermeasure to careless, frontier land development in the 19th century, their work pioneered renewable economies of conservation areas, selective logging zones and village settlements.

Once a great timber producer, the Great Lakes state became a net importer of timber:

> "Michigan-grown hemlock, shipped 200 miles, sells at the same price in Detroit as does fir grown on The Pacific Coast, and shipped 2,000 miles. The hickory for the wheels of Michigan automobiles is coming from Arkansas and Mississippi. The oak for Grand Rapids furniture is being cut in Louisiana and Tennessee. Michigan does not even supply itself with enough telephone poles or railroad ties, but imports poles from Idaho and ties from Virginia."[19]

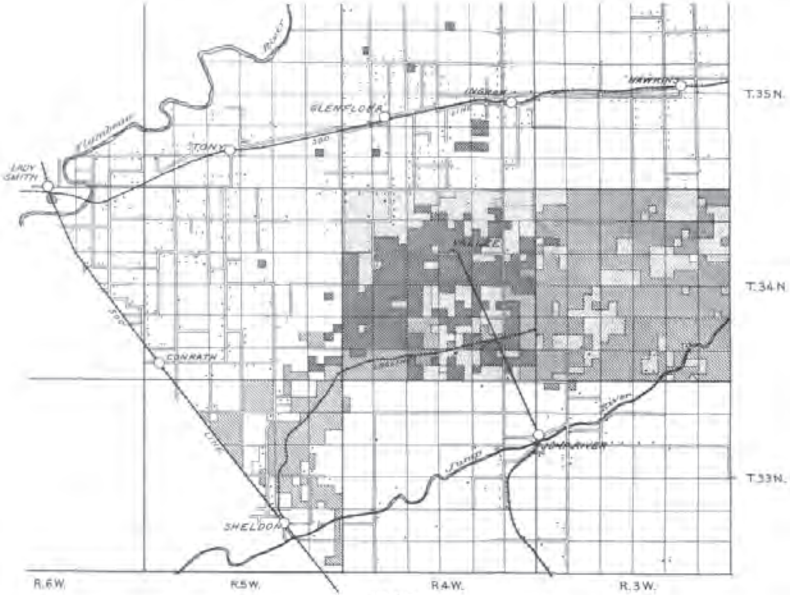
As early century rebuilders, Mackaye and Lovejoy promoted long term, collective land management would upset conventional paradigms of Promethean development that predominated the 19th century:

> "...these are the principles of the highest use of land; of the free soil basis of homesteading, efficient reclamation and State aid to self help; of community cooperation as against Robinson Crusoe independence; of forestry as against timber mining; of permanent employment for the lumberjack; and of the forest

17. Kates, J. 2001. Planning a Wilderness: Regenerating the Great Lakes Cutover Region. Minneapolis: University of Minnesota Press.

18. Early 20th century reclamation strategies echoed 18th century colonization programs like the 'Come to Detroit' campaign employed in the 1750s by the Governor General of New France who provided free incentives such as a spade, axe, sow, plough, seed stock, wagon and a cow to attract newcomers to the swamplands in Michigan; lands that were uncultivable by decades of rampant clear cutting.

19. Benton Mackaye, Colonization of Timberlands – Synopsis (Washington, D.C.: U.S. Forest Service, 1917) (Dartmouth College Library, The Papers of Benton Mackaye, Box 181, Folder 31): 3.



MAP 10

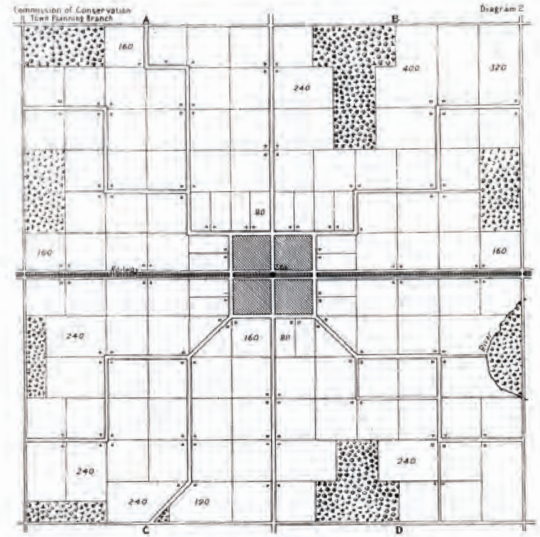
A TYPICAL SETTLEMENT REGION

RUSK CO. WISCONSIN

LEGEND

- LANDS HELD BY ONE OWNER
- LANDS HELD BY A SECOND OWNER
- LANDS HELD BY OTHER OWNERS
- RAILROADS
- ROADS
- FARM BUILDINGS

Page 171a



PLAN FOR

AGRICULTURAL SETTLEMENT

Area, 36 square miles

Scale 0 ½ 1 Mile

Roads ═ *Town Area* *Sites of Farm Buildings* ·

Forest Land

In this diagram it is assumed that the square form of land division for the separate farms must be adhered to as a condition procedent to the planning of the area. Varieties of size of holding from 80 acres (near the town) to 400 acres (remote from the town) are provided for, but all holdings could be made 160 acres if desired. A different plan is shown for each of the quarter sections, adaptable to the imaginary topography of the land, the only feature common to all the quarter sections being the main roads intersecting the township in two directions—one parallel with the railway and the other at right angles thereto. All the farms are grouped so as to give them convenient access to the town, where the same facilities are presumed to exist as are described in respect of Diagram I. The total length of road usually provided in a fully developed township, not including boundary roads, is 60 miles. In this plan there are 36½ miles of principal and 3½ miles of secondary road, making a total of 40 miles. Every farm has sufficient road frontage, and the same length of boundary road is allowed for in both the above cases.

The object of these diagrams is not to suggest stereotyped or rigid forms of land division, but to show the desirability of abandoning such forms. Every township should be inspected and planned before settlement.

20. Ibid, 3.

community as against the hobo logging camp."[20]

Reclamation & Reconstruction

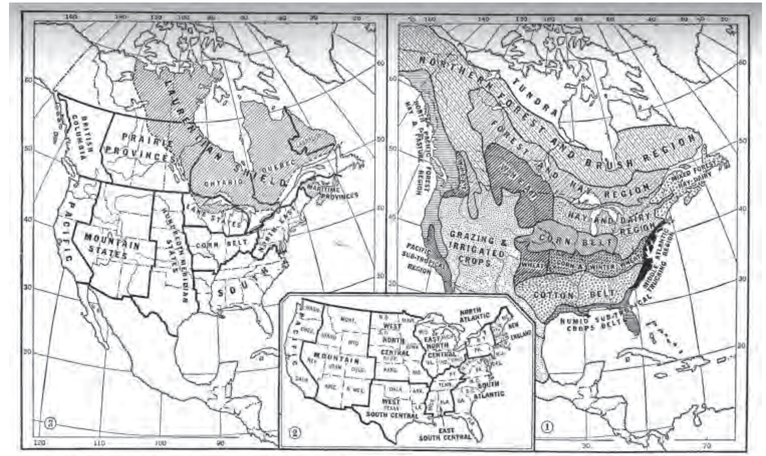
With the groundwork laid by MacKaye and Lovejoy, developments in land planning evolved into the research of Richard T. Ely, a German-trained reform economist from the University of Wisconsin. With his large scale perspective on the challenges of land settlements, Ely proposed and later developed a new field of effective land utilization based on regional forest economics, arguing for a more consolidated understanding of the Cutover Region. Disfavoring the uncoordinated efforts of the greedy land hustler or the uninformed reckless farmer, Ely theorized strategies that synthesized the imperatives of land conditions and urban economies. Those innovations later took shape in 1940 in a book titled *Land Economics*. Leading to the birth of a new field, this publication exhaustively articulated an alternative approach to the development of land. Different from land planning real estate development, land economics was a hybrid discipline drawing on economics, politics, and agriculture. It was based on a regional perspective for the effective reorganization and reuse of land over long periods of time rooted in the pre-existence of resources and the future of urban settlements. Relying on the empirical understanding of biophysical resources as economic structure.

Ely's work was premised on bringing urban longevity to the Cutover Region.[21] Using a regional lens, Ely established the foundations for the reorganisation of land, showing where a new geoeconomic structure could be achieved through collective models of governance that privileged the integration of hydrological systems, regional cooperation and state legislation.

21. Different from land planning or real estate development, land economics is a hybrid discipline crossbred from the fields of economics, politics and agriculture. Land economics is based on a regional perspective for the effective reorganization and reuse of land over long periods of time rooted in the pre-existence of resources and the future of urban settlements.

In his lofty publication, Ely sets out the ground work for instituting a new and contemporary approach to the development of land based on pre-existing systems, regional cooperation and state legislation that, at its base, uniquely hinged on the empirical understanding of hydrological resources:

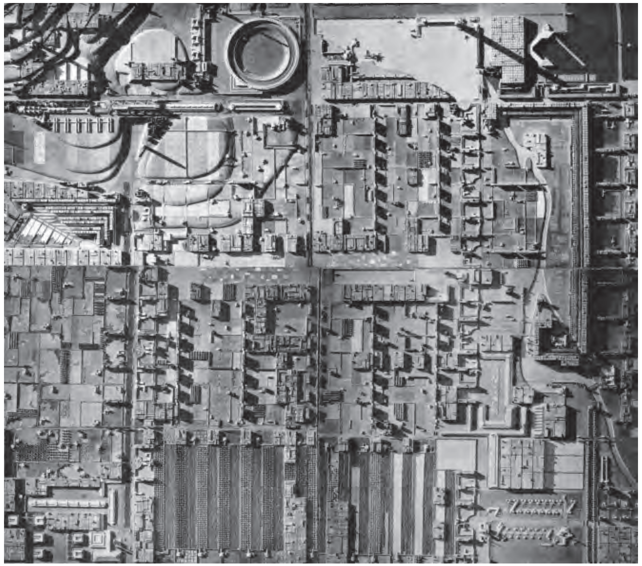
"...percolating water found in the interstices between soil and rock particles



1. *Agricultural Regions* based upon O. E. Baker's maps. See his "Agricultural Regions of North America," *Economic Geography*, Oct., 1926, and U. S. Dept. of Agriculture Miscellaneous Publication 260, *op. cit.*
2. *Geographic Divisions* as used by the United States Census.
3. *Economic Regions* as used throughout the book, based in part on Maps 1 and 2 above.

FIG. 3. REGIONS OF UNITED STATES AND CANADA

Economic Geographies
Map of productive regions of the United States and Canada as a synthesis of agricultural and political divisions in North America. Source: ©1940 Land Economics



Agrarian Urbanization
Layout view of Frank Lloyd Wright's 12' x12' model of Broadacre City representing a decentralized Mid-Western structure of urban land settlement in the 1940s.
Source: ©1958 The Living City

constitutes a vast resource of water. It is estimated that if [groundwater in the United States] were brought to the surface it would form a lake from 500 to 1000 feet deep. [...] The rights to underground water are even more complicated than the rights to surface water because the supply is invisible and the volume and direction of flow are usually unknown."[22]

Landscape Economics

Founder of the American Economic Association and bullish proponent of labor organizations and the public management of resource, Ely premised on the advantage that groundwater resources and surface watersheds offered replenishable capital.[23] In the Cutover region, Ely promoted the de-zoning of the land - rather than the settling of it - taking it out of urban or industrial use for public forestry practices. Ely mapped out land uses as directly generated from soil types, micro-climates and water resources that were primarily agrarian. In his view, collective farsighted reclamation of land had to supplant the nearsighted renegade efforts of private landowners. It was no coincidence that in the 1940s, Frank Lloyd Wright – a Prairie School architect from the Midwest – would unveil almost simultaneously, an intricately detailed scale model representing a hypothetical four square mile community proposal for the denuded landscape of rural Illinois. Aptly titled Broadacre City, the model experimented with a unique Midwestern structure where hydrology and topography pre-figured as primary infrastructures amidst an expansive field of agriculture, housing and civic services.[24] Conceived at his Taliesin studio in Spring Green, Wisconsin, 150 miles west from Chicago, Wright's urban-agrarian proposal was largely an antithesis of the European concept of the centralized industrial city.[25] Almost two decades later, parallel to the land policy objectives of Richard T. Ely and the regional strategies of Benton MacKaye, Wright as an architect/urbanist distilled the essence of the land settlement challenge in the Midwest with his 1958 manifesto *Living City*, proclaiming, "We should have a system of economics that is structure...that is organic tools."[26] Looking beyond the city, they all sought to escape conventional forms of conservation without reverting to pro-rural isolationism or anti-urban

22. Richard T. Ely and George S. Wehrwein, Land Economics (New York: The MacMillan Company, 1940): 382-383.

23. Alan Rabinowitz, Urban Economics and Land Use in America: the Transformation of Cities in the twentieth Century (New York: M.E. Sharpe, 2004): 109.

24. The Broadacre City project was incubated at Taliesin during the 1930s and 1940s. Built in 1911, Taliesin was one of Wright's studios located in Spring Green Wisconsin, more than 150 miles away from Chicago. In the context of the agricultural crisis and increasing industrialization of the Chicago region, Taliesin was a reaction to, and a rejection of the industrial city. For a more detailed analysis of Wright's urban-agrarian counterproposals, see Giorgio Cucci's "The City in Agrarian Ideology and Frank Lloyd Wright" (Cucci, Dal Co, Manieri-Elia and Tafuri 1979).

25. Despite his aversion to the centralized development of the industrial city, Wright maintained faith in its future potential (Wright 1941, Robinson 2005).

26. Frank Lloyd Wright. The Living City (New York: Horizon Press, 1958): 162.

>
Rise and Fall
of a Great American City
Dubbed the "Machine Shop of the World", Milwaukee owed its rise to industries of machinery, meats, and malts that flourished after the Civil War but later declined after the Great Depression. Source: Courtesy of Milwaukee Public Library & Department of City Development, Society for Industrial Archeology, 1901

pastoralism. While their work remained reactive to existing conditions, they opened a broader prospect of the region as a design territory, capable of engaging more diversified processes at larger scales, across longer periods of time. For them, in practice and in theory, the region was becoming the medium.

GLOBALIZATION
& THE CORROSION OF THE MANUFACTURING BELT

Before and during the two World Wars, the Great Lakes states underwent a considerable rate of growth in the areas of weapons production, chemical processing and automotive manufacturing. The abundance of iron ore, coal and electricity along with vast fresh water resources and navigable waterways fed the development of large factory towns in the region of the Great Lakes and industrial metropolises of the Northeastern Seaboard. With an abundance of farm and factory labor the region of the Great Lakes, especially near the Midwest, became a frontier of boomtowns.[27] Large, centralized, heavy industry facilities developed at a rapid pace to secure the region's international reputation as the Manufacturing Belt.

Where timber and transportation had dominated the previous century, the discovery of taconite in Minnesota's Mesabi Range fueled the industrial engine of the Manufacturing Belt.[28] By World War I, Minnesota was meeting two-thirds of US demand for iron ore. Vast supplies of ore could be shipped by rail or by ship from Duluth at the western extremity of Lake Superior and moved eastward to steel mills in the lower Great Lakes located near vast supplies of Appalachian coal. Finally, long and flat steel for product manufacturing or construction projects made its way by rail to growing urban centers on the Atlantic Coast.[29] From this geographic network rose an industrial shed that was underpinned by the geophysical landscape of the Great Lakes. City appellations signified their might: Pittsburg the Steel City, Sudbury the Nickel City, Hamilton the Steel Town, Sar-

27. David R. Meyer discusses this phenomenon with greater depth in "Emergence of the American manufacturing belt: an interpretation" in Journal of Historical Geography, Vol. 9 No.2 (1983): 145-174.

28. By World War I, Minnesota was supplying two thirds of the demand for iron ore in the U.S. (Hall 1997).

29. For events in the region revolving around the discovery of cheap taconite processing, see "Taconite Boom" in Time Magazine (28 April 1952).

Sub-Nation
Map of the manufacturing region of the Great Lakes with the consumer centres of the East Coast, depicted as one of nine 'nations' across North America, by geographer Joel Garreau. Source: ©1981 The Nine Nations of North America

> nia the Chemical Valley, Detroit the Motor City, Cleveland the Bridge City, Toledo the Glass City, Buffalo the City of Light, Milwaukee Supplier to the World.[30]

Deindustrialization & Decentralization
A few decades later, after a relatively short lived peak of production during and immediately following the World Wars, the rate of transformation plummeted. The U.S. steel industry workforce fell from 509,000 workers in 1973 to 240,000 in 1983. Outsourced production, rising energy prices and increasing trade deficits all contributed to manufacturing's demise and the abandonment of heavy industry. From Wisconsin to Upstate New York, the widespread pattern of deindustrialization had incendiary effects including the decentralization of city centers. In his 1981 book, *The Nine Nations of North America*, East Coast journalist Joel Garreau aptly summed up the situation of what he coined as the Foundry:

> "Tough is what defines North America's nation of northeastern gritty cities in a multitude of ways. Gary, South Bend. Detroit. Flint. Toledo. Cleveland. Akron. Canton. Youngstown. Wheeling. Milwaukee. Sudbury. London. Hamilton. Buffalo. Syracuse. Schenectady. Pittsburgh. Bethlehem. Harrisburg. Wilkes Barre. Wilmington. Camden. Trenton. Newark. [...] The litany of names brings clear associations even to the most insulated residents of other regions. These names mean one thing: heavy work with heavy machines. Hard work for those with jobs; hard times with those without. [...] When columnists speak of managing decline, this is the region they mean. When they speak of the seminal battles of trade unionism, they place their markers here. When they write of the disappearing Democratic city political juggernauts, not for nothing do they call them machines, for this is where they hummed, then rusted."[31]

What was once admired worldwide as the US Manufacturing Belt became universally known as the Rust Belt.[32] Burdened by large, overbuilt structures and public works disinvestment, this massive transition simultaneously paralleled

30. For more information on the rise of Milwaukee, see Ralph M. Aderman (ed.), Trading Post to Metropolis: Milwaukee County's First 150 Years (Milwaukee, WI: Milwaukee County Historical Society, 1987).

31. Joel Garreau, The Nine Nations of North America (Boston, MA: Houghton Mifflin Company, 1981): 69.

32. By the late 1950s, decline was prevalent. Jane Jacobs identified early on the transformations occurring in cities across North America in Life and Death of Great American Cities (New York: Vintage Books, 1961), and subsequently in her follow up The Economy of Cities (New York: Random House Books, 1969).

33. Pat Choate & Susan Walter, America in Ruins: The Decaying Infrastructure (Durham, NC: Duke Press, 1983)

the erosion of public infrastructures. America's public facilities were wearing out faster than they were being replaced.[33] From decaying sewers to bridge collapses, incidents across the region were indicative of liberal programs of deregulation that deferred maintenance and cancelled construction that exacerbated urban disaggregation and the hollowing out of inner city cores.

The decline of the Rust Belt in the second half of the 20th century mainly stemmed from six factors: the global mobility of corporations, the attrition of innovation, the inflexible demands of labor associations, the displacement of workers to new sectors of defense, oil, and aerospace in the Sun Belt, and an aging work force. Policies for the globalization of the region and deregulation of national trade began with the General Agreement on Tariff and Trade in 1946, grew with the North American Free Trade Agreement (NAFTA) in 1994 and matured with the formation of the World Trade Organization in 1995. Transnational trading policies opened international borders southward and westward where labor and raw materials were cheaper and environmental laws less stringent. As a result of global outsourcing, plant relocations led to industrial disincorporation, further leading to land un-development, population unemployment and de-urbanization throughout the Great Lakes cities. This structural industrial change may have been inevitable according to regional industrialist Henry Ford:

> "The belief that an industrial country has to concentrate its industries is not, in my opinion, well-founded. That is only a stage in industrial development. [...] Industry will decentralize. There is no city that would be rebuilt as it is, were it destroyed – which fact is in itself a confession of our real estimate of our cities."[34]

34. Henry Ford (in collaboration with Samuel Crowther), My Life and Work (Garden City, New York: Doubleday, Page & Company, 1922): 192.

As a result of industrial deconcentration in the Northeast, boomtowns became ghost towns while abroad, relocating industry found surrogate cities: Bangkok supplanted Detroit, Shanghai supplanted Cleveland, Taipei supplanted Toledo, and Mexico City supplanted Milwaukee.[35]

35. Jones, R. 2004. As Detroit falters, Asian makers pick up speed: Toyota likely to surpass GM as world's top carmaker; China lurks in wings. http://www.msnbc.msn.com/id/10532121/ [accessed July 24, 2008]

Disurbanism & Disassembly

Aquatic Bio-Indicator
Brown bullhead from Wisconsin's Fox River with lip tumors demonstrating the presence of aromatic hydrocarbons used for dyes, pharmaceuticals and agro-chemicals and that are known carcinogens. Source: ©1974 National Geographic

36. Edward L. Glaeser, "Can Buffalo Ever Come Back?" City Journal, Issue 17 No.4 (Autumn 2007): 94-99.

37. Jerry Slaske, "Choosing Milwaukee's next top cop: Roughed-up Milwaukee needs results from its next chief", Milwaukee Journal Sentinel (Aug. 19, 2007).

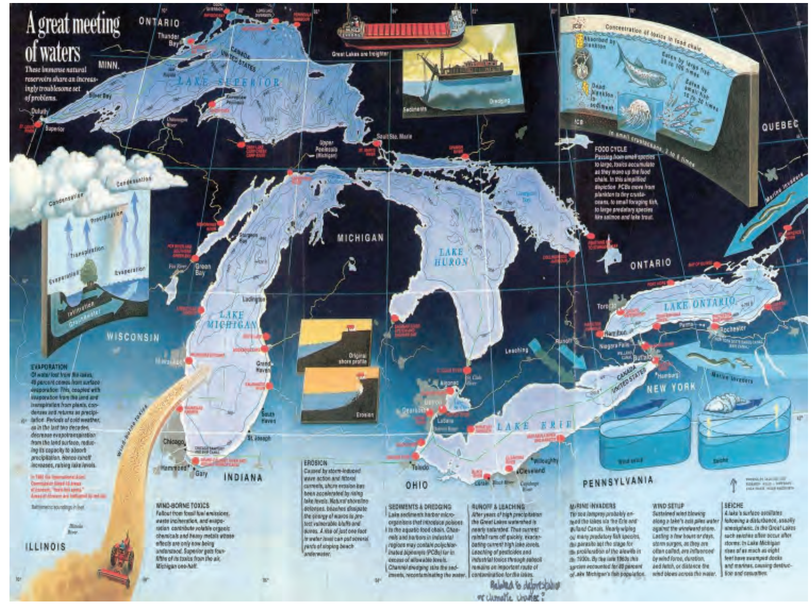
38. For a comprehensive biography of the rise and fall of Flint's industrial legacy, see Dandaneau (1996) and Harvey (1996).

39. LeDuff, C. 2009. To Urban Hunter, Next Meal is Scampering By. In Detroit News (April 2) www.detnews.com/article/20090402/METRO08/904020395.

The economic fallout further precipitated the population vacuums of inner cities and former boomtowns in the Rust Belt from the 1950s onward, largely leaving them victims of decaying oversized infrastructure, contaminated vacant land, heavy tax burdens and social attrition. Despite good intentions, copious amounts of money were poured into urban renewal projects - new stadiums or convention centers - in Detroit, Flint, Milwaukee and Buffalo little has improved economic situations.[36] Milwaukee for example now has twice as many murders that Los Angeles. Buffalo as twice the taxes of New York City, and Flint has the third highest crime rate in the nation.[37] General Motors CEO Roger Smith closed down all the assembly plants in Flint, Michigan leaving over 40,000 people jobless and the entire city virtually bankrupt in the 1980s. Since then, majors have been toying with tourism as a substitute for urban economic regeneration and environmental reconstruction. Downtown Flint has seen its share of big city ideas: the $13-million Hyatt Regency Hotel and a $100-million AutoWorld theme park were rolled out to arrest decline but failed to jumpstart local economies. Reduced to junk bond status, the generic landscape of GM's assembly plant is like the rest of the city, vacant and abandoned on the overgrown banks of the Flint River.[38] As the sun has set on this deurbanizing landscape, decline and neglect seem to have come the progenitors of ecological regeneration, displaying the latency of biophysical dynamics that existed before industry.[39]

URBANIZATION
& THE SYSTEMIC RECLAMATION OF THE GREAT LAKES WATERSHED

Although deindustrialization and decentralization are dominant motifs of the Rust Belt, what is often marginalized is the long term legacy of industrial economies. The depletion of cheap resources, the depopulation of factory towns, the decrease of tax revenues, and the failure of urban infrastructure epitomize that legacy. Most notorious are environmental after-effects across the region including oil fires on urban rivers in Cleveland, Toronto, and Chicago, overfertilization and sewage discharge of Lake On-



Open, Complex Systems
Map depicting the systemic representation of the Great Lakes region following the 1978 Great Lakes Water Quality Agreement that was signed by Canada and the United States to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem". Source: National Geographic, 1983.

Crisis as Catalyst
Aerial view of the Humber River in Woodbridge during Hurricane Hazel in November 1954, subsequently leading to the Conservation Authorities Act. Source: National Library & Archives of Canada.

tario and Lake Michigan, algal blooms from eutrophication in Lake Erie and Lake Ontario,[40] and the mercury contaminations from industrial discharge that closed fisheries on Lake Superior, Lake Michigan and Lake Huron in the 1980s.

The total impact of industrial effluents, chemical dumps and urban floods was largely invisible until a quarter-century after the Manufacturing Belt passed its peak. Three events within 17 years defined the ecological enlightenment about the fallout of mass industrialization: Hurricane Hazel in 1954, the Milwaukee River point source discharges in 1967 and the Love Canal Incident in 1971. With the respective efforts across the region by landscape architect Michael Hough, the *Milwaukee Sentinel* daily newspaper and the Love Canal's Lois Marie Gibbs, a series of milestone legislation ensued: the Conservation Authorities Act in 1946, the Environmental Protection Agency of 1971, the Superfund Bill of 1980 and the Clean Water Act of 1977. Point source separation of industrial effluents, encapsulation of chemical dumps and planning of urban floodplains soon became underlying principles in the re-planning of cities. Non-compliance and lack of enforcement does threaten this ambitious objective,[41] but the Clean Water Act has managed to cast light on a dark industrial age when Americans could no longer swim in major rivers like the Mississippi, the Potomac or the Hudson.[42] Reconsidered historically, a pattern of ground and water contamination could no longer be ignored nor treated separately as it was before. It was now being understood regionally as a new systemic understanding of the effects of industrialization emerged.

De-Engineering & Re-Planning

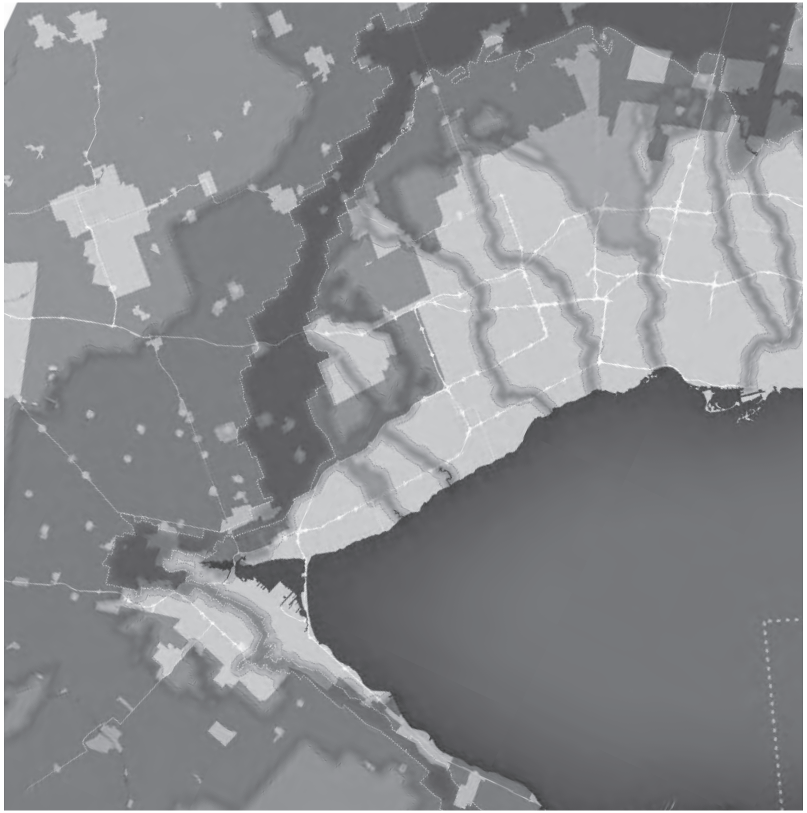
One of the most influential organizations to emerge from Hazel's aftermath is the Toronto & Region Conservation Authority. Founded on the urban ecological tenets of landscape architect Michael Hough in the late 50s,[43] the TRCA has grown over the past fifty years to become an influential think-tank-cum-action-group, whose name is synonymous with watershed management, ecological planning, habitat restoration, business financing and urban development. This non-profit, quasi-governmental organi-

40. During the 1960s and 1970s, several newspaper headlines read that Lake Erie was "dead" when, according to the USEPA, the lake was actually more alive than ever. In fact, it was undergoing cultural eutrophication, an accelerated aging process by a large influx of nutrients (phosphorus) due to agricultural runoff and untreated wastewater effluent, mainly from industrial and household detergents. Evidenced in satellite aerial photographs, blue-green algae (Anabaena, Aphanisomenon, Microcystis, Cladophora) was blooming profusely in the western basin. See Larry Bentley, Environmental Education for Ohio, Biosphere 2000 Project, Environmental Science in Action: Lake Erie. (EPA, August 2006).

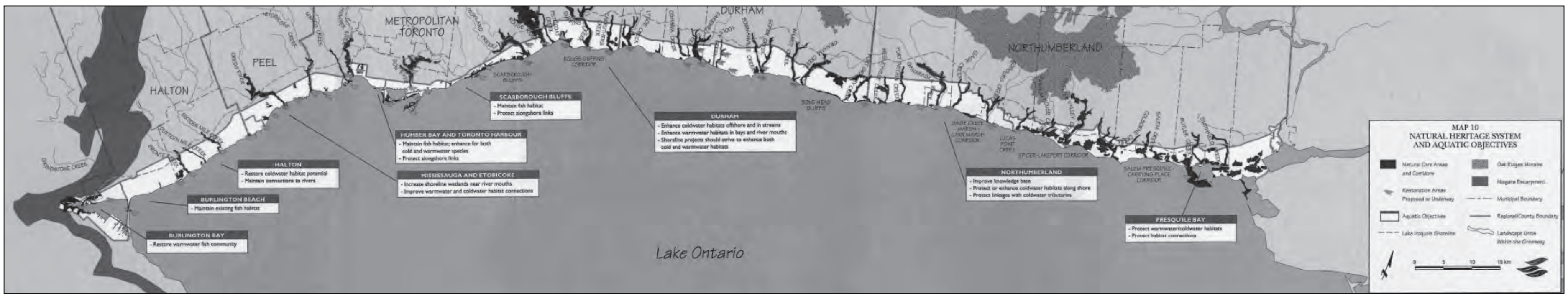
41. For a thorough discussion of water policies in the Great Lakes over the past three decades, see Hoornbeek (2005) and Sandin (2001).

42. Discharges and diversions are now regulated by the 1985 Great Lakes Charter and the subsequent 2005 Amendment.

43. In an article titled "The Urban Landscape - The Hidden Frontier", Michael Hough outlined how urban infrastructure could be conceived regionally and designed ecologically (Hough 1983).



Landscape as Megastructure
Plan and detail of the 300-kilometer long greenway strategy conceived by Michael Hough, for the urbanization of the northern shore of Lake Ontario in relationship to distinctive patterns of ravines, watersheds and glacial groundwater resources. Source: Toronto Waterfront Regeneration Trust, 1981 (below), adapted from Municipal Affairs & Housing, 2008 (left).



44. According to the Center for Watershed Protection, the full life-cycle cost of decentralized systems of urban water management is estimated to be three to five times less than conventional buried systems that are often found in inner cities (Center for Watershed Protection).

zation now mandates five major watersheds draining into Lake Ontario that support the five and an half million population of the Greater Toronto Area (GTA), while innovating strategies of groundwater infiltration (permeable surfaces instead of gutters-and-pipes) and sewage separation (sludge recycling instead of landfilling).[44] With the abundance of available permeable surface area and green leaf coverage in suburban areas, as well as their suitability for change, the ultimate aim is to reduce loads on stormwater systems while contributing to groundwater recharge. From the continuous flood events in Ontario to the ongoing flooding of the Farnsworth house in Illinois, the challenge of urban flooding has yet to be resolved in any comprehensive way and will persists. Larger and larger urban agglomerations, aging sanitary sewers, leaking water supply lines and the increasing frequency of rain storms will need to be addressed using integrated management measures that closely correlated urban patterns with the dynamics of hydrological systems.

Reclamation & Remediation

Addressing the divide between economy and ecology, a massive remediation program in the Great Lakes Region was spearheaded by the International Joint Commission (IJC) in the late 1980s, addressing the impacts of discharges and diversions, floods and droughts and contamination and cleaning. With its mandate to advise on the use and quality of boundary waters in Canada and the United States, the Commission addressed three of the most pressing challenges in the Great Lakes: combined sewer overflow, nutrient overloading, and sediment contamination. Redressing the historical legacy of shoreline industries, the purpose is to reclaim the "chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem".[45] As the principal source of contamination in Great Lakes rivers and harbors, polluted sediment created by decades of industrial and municipal discharges has historically limited remediation and redevelopment efforts by virtue of its geographic magnitude.[46] The IJC has since initiated a massive with remedial action plans for 43 priority sites throughout the region. The binational program uses multilateral funding and cross-border legislation to accelerate cleanup and redevelopment of the most

45. The third most important contributor to lake water pollution is nitrogen and phosphorus overloading from fertilizer and pesticide runoff.

46. See "Natural Capital and Ecological Goods & Services" in Ducks Unlimited Canada, "Natural Values: Linking The Environment To The Economy", www.ducks.ca/conserve/wetland_values/conserve.html

Regional Register
Icon of Modernism, the Farnsworth House designed by Mies van der Rohe and built in 1951, succumbs to record-breaking flood from the Fox River but survives as a geo-physical registration of perennial rain levels in the region. Source: ©2008 Landmarks Illinois, National Trust for Historic Preservation

Infrastructural Coupling
View of stormwater interceptor tank doubling as public space promenade on the edge of Lake Ontario, on Toronto's waterfront. Source: West 8/Adriaan Geuze, 2010.

contaminated site, mostly harbors, in the downstream region.[47] Since bioremediation alone cannot solve the challenge of brownfield redevelopment, the effect of new integrated regional economies offers a significant model for the reuse of land. At this scale, remediation costs can be offset by overall returns from productive land redevelopment across multiple sites. For the first time in the history of the Great Lakes, the collective objective of an economy based on clean fresh water has become a public regional imperative. There is a contemporary urbanization of waterfronts in the Great Lakes at the turn of the 21st century and cities such as Chicago, Toronto, Hamilton, Sudbury and Detroit are in the vanguard. Public works projects by Kathryn Gustafson and Piet Oudolf in Chicago or by Field Operations, West 8 and MVVA in Toronto can be seen as the inception of a systemic, regional reclamation project in its infancy. [48] Its economy is its ecology.

SUB-URBANIZATION
& SUPER-URBANIZATION

Horizontal spread and peripheral expansion remain the predominant forces that restructure towns and cities across the Great Lakes, but citing depopulation and outmigration from city centers as the only causes of economic decline during the second half of the 20th century is flawed. Nationally, population statistics show that while the population of the US was increasing, the Great Lakes region remained nearly constant with just 1 percent growth.[49] What really occurred was regional population dispersal through inner city exodus.

Culturally and economically diverse, metropolitan areas such as Chicago and Toronto kept growing, but mostly on their peripheries. Access to a multitude of urban, public and high-quality services - education, mass transit and medical health care - supported by essential infrastructures of waste, water, food, transport and energy made them particularly attractive to a younger knowledge-oriented generation. The transition from an industrial economy to an urban economy also involved a shift from mass-production and heavy equipment to light

47. Environment Canada, 1999. The State of Municipal Wastewater Effluents in Canada. Ottawa, ON: Queen's Printer.

48. This systems-based strategy has more recently been harnessed by Alan Berger in the more substantive, complex, and proactive engagement of the natural and built systems, which is leading to the formulation of more intelligent design scenarios at larger scales (Berger, 2009).

49. See Great Lakes Information Network., "Demographics in the Great Lakes Region" http://www.great-lakes.net/econ/refs/demog.html

manufacturing and to just-in-time logistics.[50] Large centralized industries of macro-production made way for a decentralized regional pattern of micro-production requiring new land uses and public services.

The only Logical course of action was for nearby factory towns was to downsize. Regionalizing their services, distributing densities, and tapping larger urban economies became possible.

Youngstown mayor Jay Williams has been testing the potential outcome of downsizing in Youngstown, Ohio. With plant shutdowns by Republic Steel and Youngstown Sheet & Tube Company over the past twenty years, the city is facing major fiscal deficits inherited from oversized infrastructure, abandoned properties, and countless miles of asphalt roads to maintain. Derelict buildings are being razed, underground utilities cutoff, lands banked, and industrial districts rezoned, back taxes are exchanged for land stewardship and roads are ripped up or blocked out. Remaining lands are amalgamated for urban agrarian use, parkland, or water uses.[51] Former industrial land uses are overlaid with new productive functions, bypassing the traditional rezoning process. Counter strategies are modest be effective. The Mahoning River was once the sewer of Youngstown's steel mills; now it serves as the backbone of an emerging corridor of light and medium sized manufacturing enterprises.[52]

Echoing Ely's approach to land economics, Williams' decommissioning strategy suggests a general process of de-urbanization, where industrial un-development and land un-incorporation will ultimately reduce the tax burden on citizens and maintenance burden on public works department. "Instead of capturing its industrial past, Youngstown hopes to capitalize on its high vacancy rates and underused public spaces to become a thriving bedroom community serving Cleveland and Pittsburg both of which are 70 miles away."[53] Suburbanization may be Youngstown's imperative.

Beyond the City
Paramount to the understanding of this geographic phenomenon is the reconsideration of the Old World notion of the city as the locust

50. Waldheim, C. & Berger, A. 2009. Logistics Landscape. In Landscape Journal Vol. 27(2): 219-246.

51. See "Youngstown Planners turn Shrinking Population into Positive" Associated Press (19 June 2007) www.youngstown2010.com/news_information/national/ap%20story.pdf

52. City of Youngstown and Youngstown State University, The Youngstown 2010 Citywide Plan (2005) www.youngstown2010.com/plan/plan.htm

53. For more information on Williams' groundbreaking work, see Belinda Lanks, "The Incredible Shrinking City - Facing steep population decline, Youngstown, Ohio, is repositioning itself" in Metropolis Magazine (May 2006).

Post-Fordist Landscape
Demolition of 'Buick City' in Flint MI, one of the the largest automotive manufacturing complexes in the world, originally built in 1904, bought by General Motors, and shut down in 1999. Source: Leonard Thygesen, 1993 & 2002

New World
Jean Gottmann's map of Northeastern megalopolis representing a throughly new and unprecedented pattern of urbanization, in complete contrast to the centric, compact configuration of the European city. Source: Megaolopolis, 1961

of urban activity. Whereas the categorically European notion of the city relies on theories of smallness, compactness, proximity and density, the North American logic of urbanization relies upon the exigencies of scale, distance, logistics, openness and horizontality. This counter-intuitive view was explore in greater depth by French geographer Jean Gottmann in the late 1950s.

Studying the logic of a rapidly spreading pattern of urbanization across the Northeastern region, Gottmann later collected his findings in a book originally titled *Megalopolis: The Urbanized Northeastern Seaboard of the United States* in which he called for the rethinking of the Old World notion of the city altogether:

> "we must abandon the idea of the city as a tightly settled and organized unit in which people, activities, and riches are crowded into a very small area clearly separated from its non urban surroundings. Every city in this region spreads out far and wide around its original nucleus; it grows amidst an irregularly colloidal mixture of rural and suburban landscapes; it melts on broad fronts with other mixtures, of somewhat similar though different texture, belonging to the suburban neighborhoods of other cities."[54]

Grounded in geography and economics, Gottmann's observations characterized the Northeastern Seaboard of America from Boston to Washington as an urban landscape with a decisively distributed, horizontal structure. Anticipating Gottmann's future work, Geddes observed in 1915:

> "That the expectation is not absurd that the not very distant future will see practically one vast city-line along the Atlantic Coast for five hundred miles, [...] the great lakes, with the immense resources and communication which make then a Nearctic Mediterranean, have a future, which its exponents claim may became world-metropolitan in its magnitude."[55]

These findings proved useful a decade later when the Greek architect and planner Constantine Doxiadis attempted to map out the future

54. Jean Gottmann, Megalopolis: The urbanized Northeastern seaboard of the United States (New York: Twentieth Century Fund, 1957): 5.

55. Patrick Geddes, Cities in Evolution: an introduction to the town planning movement and to the study of civics (London: Williams & Norgate, 1915): 49.

of the Great Lakes Region. Prefiguring centrally in his diagrams, the basin of the Great Lakes could be understood as an urban megastructure.[56] Commissioned by the private regional electrical utility Detroit Edison Company, the project involved a three year study on the pattern of urbanization of Great Lakes cities. Despite Doxiadis' firm commitment to ekistics, the study of human settlements, his exclusive focus on the Urban Detroit Area overlooked the fate of the region.

Based on double digit growth from postwar projections, the study assumed a steady and excessive growth for Detroit, the region and the continent.[57] Exacerbated by a world view that characterized urbanization as a universal crisis, the results of Doxiadis's three-volume study were skewed: downward economic trends were overlooked, socio-political events such as labor disputes and union riots were ignored and the Canadian side of the Great Lakes was sometimes left blank. His plans overstated the importance of inner cities in the face of the extensive decentralization that was already occurring. For example, the 1965 plans projected populations of 15 million for Detroit, 75 million for the Great Lakes area, and 400 million for North America by the year 2000.[58] Overestimates would have boded well for the electricity authority since they fed the illusion of increasing demand for electrical energy and distribution infrastructure.

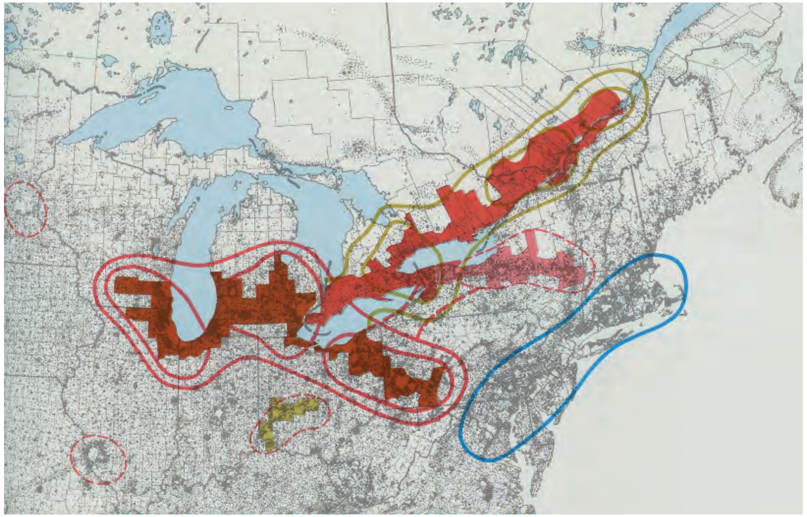
Reliant upon conventional measures of city census and data inventories, Doxiadis' plan turned out to be a false positive, overstating the importance of inner cities in the wake of extensive decentralization, both regionally and nationally. Revisiting his precedent setting analysis of the Northeast megalopolis, Gottmann updated his findings with startling results:

> "Twenty years ago, the patterns of urbanization along the Great Lakes did not seem to be truly comparable in density and function with the Northeastern Seaboard megalopolis. A vast chain of metropolitan regions was forming there, especially on the American side of the lakes.., but with a looser structure and specialization in manufacturing production rather than in quarternary activities.

56. See Doxiadis, C.A.. 1967(a). Emergence and Growth of an Urban Region: The Developing Urban Detroit Area - Vol. 1: Analysis. Detroit, MI: Detroit Edison Company, Doxiadis, C.A. 1967(b). Emergence and Growth of an Urban Region: The Developing Urban Detroit Area Vol. 2: Future Alternatives. Detroit, MI: Detroit Edison Company, Doxiadis, C.A.. 1970. Emergence and Growth of an Urban Region: The Developing Urban Detroit Area - Vol. 3: A Concept for Future Development. Detroit, MI: Detroit Edison Company: 3-5.

57. Constantine A. Doxiadis, "Great Lakes Megalopolis in Emergence and Growth of an Urban Region: The Developing Urban Detroit Area - Vol. 1: Analysis (Detroit, MI: Detroit Edison Company, 1967): 75-81.

58. Constantine A. Doxiadis, Emergence and Growth of an Urban Region: The Developing Urban Detroit Area Vol. 2: Future Alternatives (Detroit, MI: Detroit Edison Company, 1967): 91.



Doxiadis' Dream
The speculative boundaries of the growing Great Lakes Megalopolis from the hand of ekistics guru-cum-world planner Constantinos A. Doxiadis. Source: Emergence & Growth of an Urban Region (Volume II), 1970

63. Classic definitions of cities rely too heavily on political boundaries to implement blanket economic policies. The discourse on regional characterization was the subject of a heated debate during a symposium in 1976 held at the City Hall of Toronto in Ontario. See Leman Group (ed.), Great Lakes Megalopolis: From Civilization to Ecumenization [Symposium Proceedings] (Ottawa, ON: Canada Ministry of State - Urban Affairs, 1976). Other noteworthy studies on the characaterizations of the region include "The Rise of the Mega Region" by Richard Florida, Tim Gulden, Charlotta Mellander (Toronto, ON: The Martin Prosperity Institute, 2007) and "Ecology of Regions" by Richard T. T. Forman in Land Mosaics: The Ecology of Landscapes and Regions (Cambridge, UK: Cambridge University Press, 1995): 22-28.

> Now a rapid evolution has taken place modifying the picture, and I am much inclined, even in my strict interpretation of the megapolitan concept, to recognize its rise here. The Canadian sector of the Great Lakes Megalopolis is probably, in the present circumstances, the most megapolitan indeed by its rapid development of transactional activities, and by its national and international role as a hinge and as an incubator.[…] The Great Lakes Megalopolis is probably the largest in area of the present megapolitan systems, […] envisaged as extending from the city of Quebec, in the East to the metropolitan area of Milwaukee in the West, including along that axis such great agglomerations as Montreal, Ottawa, Toronto, Detroit, Buffalo, Cleveland, and Chicago. […] comparable to other systems in the world including megalopolis of northwestern Europe (Amsterdam to the Ruhr), the Rio de Janeiro-São Paulo complex in Brazil and the urban constellation in Mainland China centered on Shanghai."[59]

But he cautioned against facile, simplistic generalizations about urban regions:[60,61]

> "The megaregion, as it is becoming today is not a larger, or bigger city. Nor is it merely an amalgamation of cities and metropolises growing together […] [this emerging pattern] is not simply urban growth on a bigger scale; it is rather a new order in the organization of space and in the division of labor within society, a more diversified and complex order, allowing for more variety and freedom."[62]

GEOGRAPHIC URBANIZATION

Numerous gains can be made by the made in their collective characterization of cities as urban regions.[63] Although the urbanized region of the Great Lakes might appear today as a collection of large, unplanned, generic cities sprawling haphazardly out of control, there is a prevailing logic to its morphology and development. Conditioned by a complex ecology, it is a landscape of urbanization that is best under-

59. Jean Gottmann & Robert A. Harper (ed.), "Megapolitan systems around the world" in Since Megalopolis: The Urban Writings of Jean Gottmann (Baltimore: The Johns Hopkins University Press, 1990): 162-171.

60. The Greek term megalopolis is misleading. By definition, it connotes a very large city or the simple outpour of a small city. This conceptual definition relies on the core-periphery model of urbanization, an Old World perspective that implies centralization, containment and compactness; tenets of the Athenian Oath. For a comparison on the use of the term, see Elizabeth Baigent, "Patrick Geddes, Lewis Mumford and Jean Gottmann: divisions over 'megalopolis'" in Progress in Human Geography 28, 6 (2004): 687–700.

61. The exclusive economic or statistical characterization of the Great Lakes Region is limiting and reductive. Saskia Sassen discusses the limitations of national level indicators, data sets and policies as well as the conventional categories of metropolitan centres such as housing, transportation, population to discuss the broad range of goods and services afforded and, provided by the size of the megaregion: "a megaregion may well turn out to be a sufficiently large scale to optimize the benefits of containing multiple and interacting local economies". Implied in Sassen's statement are economic as well as ecological advantages. See "Megaregions: Benefits beyond Sharing Trains and Parking Lots?" in The Economic Geography of Megaregions edited by Keith S. Goldfield (Princeton, NJ: Policy Research Institute for the Region, 2007). The limitations of quantitative analysis of such large scale urbanization can be seen in the conventional planning tools used by the University of Michigan in Methods for Planning the Great Lakes MegaRegion (Urban and Regional Planning Program University of Michigan, Ann Arbor April 2006) by Elizabeth Delgado, David Epstein, Yoohyung Joo, Raju Mann, Sarah Moon, Cheryl Raleigh, Erin Rhodes, Daniel Rutzick.

62. Jean Gottmann, "Megapolitan systems around the world", Ekistics, 243 (Feb 1973): 113.

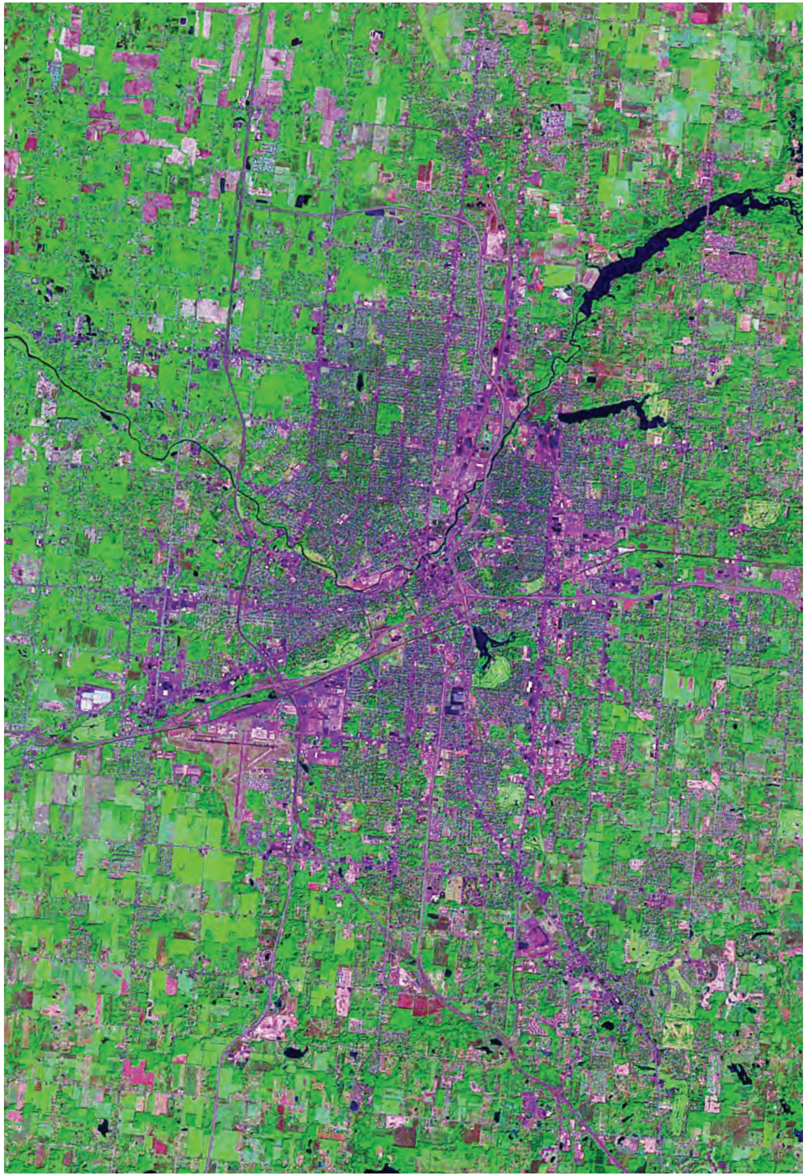
stood as an unfinished region.[64]

Indicative of this nascent process are three notable structural transformations that provide evidence of ongoing spatial change: land banking, energy harvesting and greenhouse growing.

Banking Land

There are between 30,000 and 50,000 brownfield sites across the Great Lakes states that pose obstacles to urban redevelopment and threats to groundwater resources. So far, local governments have been unable to manage brownfield sites or prevent blight due to the accumulated effects of subsurface contamination, outdated fiscal legislation, inflexible zoning policy and financial accountability. Michigan is an exception and an experiment. The state has recently enacted new legislation with revisions to the 2004 Brownfield Redevelopment Financing Act and created the Genesee County Land Bank Authority to address the erosion of property values throughout the Saginaw Bay watershed in Northern Michigan. Land banking involves the acquisition of abandoned and foreclosed properties through a series of unique measures: vacant lot aggregations, surface maintenance regimes, land management strategies, demolitions, reconstructions, sales, property transfers, foreclosure prevention and alternative zoning mechanisms. Land banking along the Flint River in Northern Michigan is achieving several objectives. First, it effectively reclaims isolated watershed lands and forms a hydrological network. Second, it reduces loads on existing systems and builds up the capacity for self-sustenance. Third, it elicits contemporary forms of development, stimulating emerging light industries such as mini-mills, mini-smelters, mini-farms or micro-breweries.[65] In turn, fiscal benefits are passed down from county, to municipality, to taxpayer. Today, the Land Bank Authority manages over 4,000 properties and its flagship is the City of Flint, ironically the graveyard of General Motors and United Auto Workers.[66] As the envy of real estate property management, Flint is becoming a prototypical model for land banking and of regional land reclamation across the U.S.[67]

Farming Energy



>
Banking on Land
Satellite image of Flint in Michigan, home to the once and former 'Vehicle City' and now the seat of the first land bank authority in the State reorganizing abandoned, contaminated land with new fiscal and ecological measures associated with the Flint River watershed (running through center of the image, through the city) and Genesee County. Source: Landsat GeoCover 2008, data courtesy of USGS

64. Economist Paul Krugman confirms that the rhetoric on globalization may have been overstated in "We are not the World" in New York Times (13 February 1997). This global revisionism parallels Walden Bello's Deglobalization: Ideas for a New World Economy (London, UK: Zed Books, 2005).

65. Bryan Taylor, "On the rise: signs of a healthier manufacturing sector are being seen in increased demand and pricing for ferrous scrap" Recycling Today (May 1, 2002).

66. Nassauer, J. & VanWieren, R. 2008. Vacant Property Now & Tomorrow; Building enduring Values with Natural Assets. Ann Arbor, MI: Sea Grant, Michigan, Genesee Institute, Genesee County Land Bank, School of Natural Resources and the Environment, University of Michigan.

67. See Joan Nassauer & Rebekah VanWieren, Vacant Property Now & Tomorrow; Building enduring Values with Natural Assets (Ann Arbor, MI: Sea Grant, Michigan, Genesee Institute, Genesee County Land Bank, School of Natural Resources and the Environment, University of Michigan, 2008) http://www.recyclingtoday.com/articles/article.asp?MagID=1&ID=4369&IssueID=144

Cash Crop
The Harvest Wind Farm in Bad Axe built by John Deere Renewables on land leased from cooperative sugar beet farmers, the first commercial scale public utility wind field in Michigan. Source: ©2008 Don Coles, Great Lakes Aerial Photography

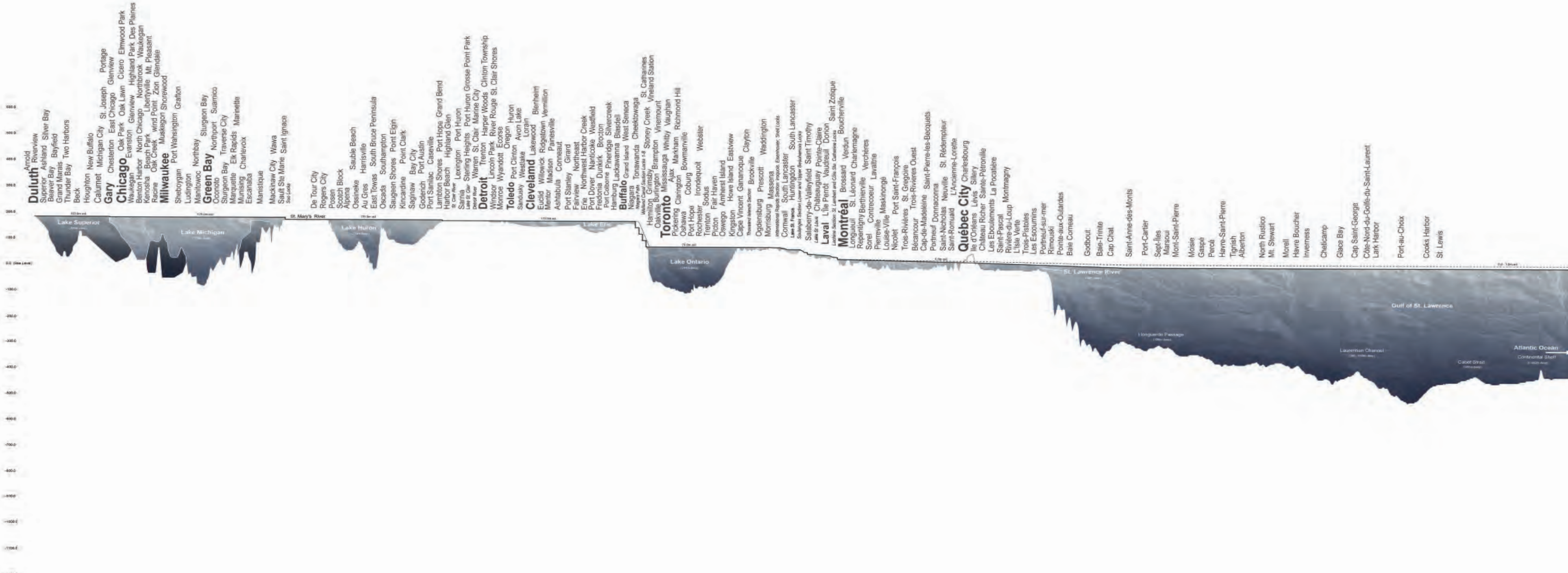
Deregulation during the agricultural bubble in the 1980s led to an unusually high concentration of large agri-businesses in the region. Vertically integrated corporations took over the entire foodshed within 15 years, ploughing half a million small independent farmers and ranchers under and emptying rural communities. Destroying regional economies, the predatory incorporation of the industry took over every aspect from seedlings to supermarkets. Corporate dominance, which relies on economies of scale, is now being put to the real test. The peaking of oil and gas prices in the 1970s, the aging of nuclear power plants and coal-fired power plants in the 1980s and the rising of commodity prices in the 1990s are now calling into question the reliance on the importation of what used to be cheap oil resources from the Middle East or polluting coal from the Appalachian Range. From this shift, hybrid agrarian patterns of development are capitalizing on idle farmland to combine energy generation with crop cultivation. Sprouting from Michigan's farmland are crops of wind turbines in rural areas on the southern shoreline of Lake Huron with its high winds and low densities.[68] Using a loophole in fiscal policy for implementation, John Deere Energy Renewables – the company that revolutionized farming in the late 19th century – is now building the first utility-scale wind farm in Bad Axe, Michigan.[69] The 32-turbine, 52.8-megawatt commercial wind project spreads across five square miles of agricultural fields and produces enough power to supply 15,000 homes. The project is the result of a unique public-private partnership between John Deere, the Detroit Edison Company and the County, but the beauty of the project lies in the co-operation across this new agro-energy shed: farmers lease land to the power utility for the erection of towers, leaving the crop land of beets, beans, cereals and grains undisturbed. In turn, counties collect revenues from building permits and turbine construction, and townships receive annual taxes. The anticipated long-term benefit is that the value of farmland will increase steadily. Another 280 wind turbines are now planned across the county over the next two decades and, according to the National Oceanic & Atmospheric Agency, the estimated potential of 100,000 wind turbines on

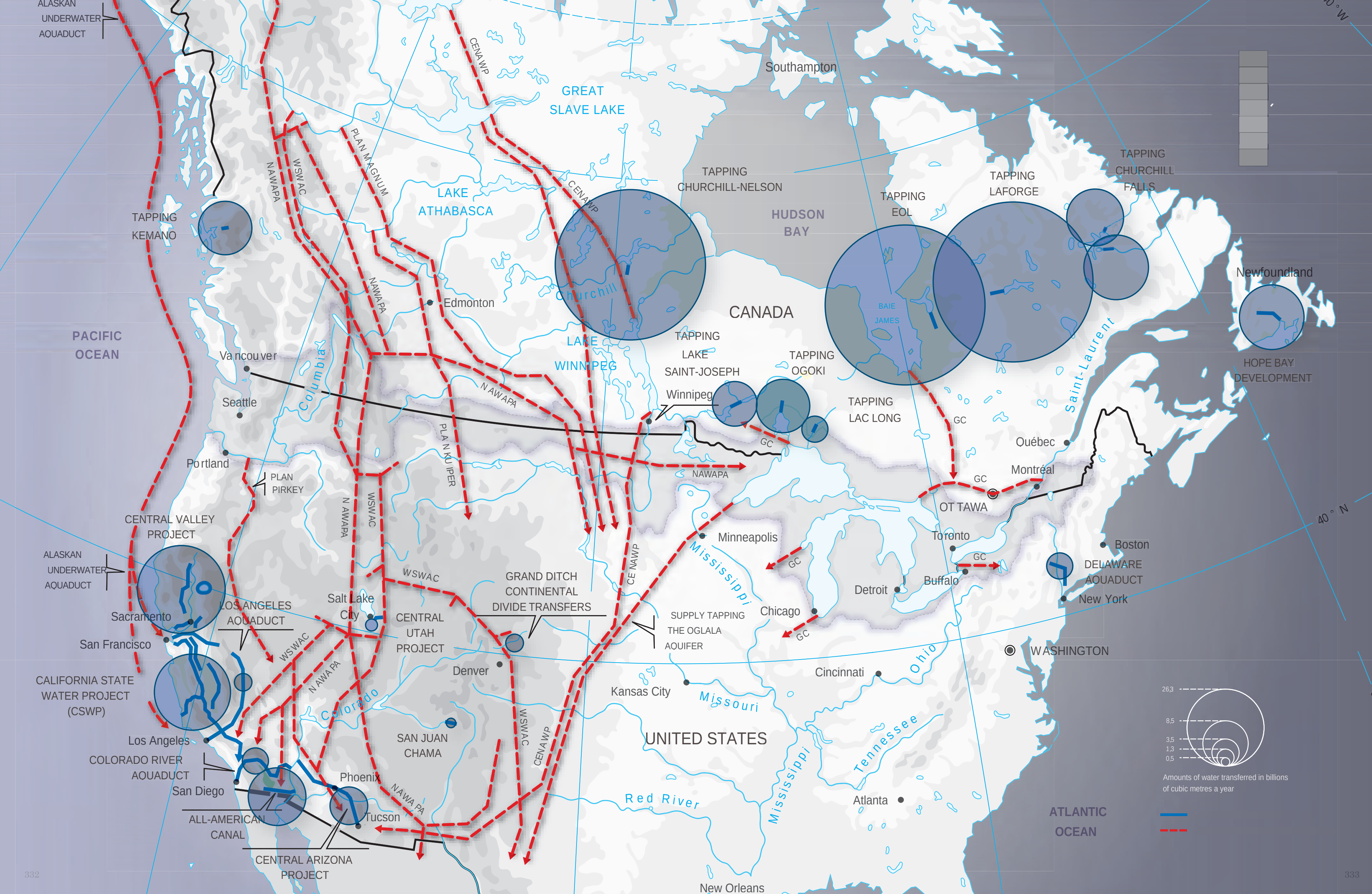
68. Soji Adelaja and Charles McKeown, Michigan's Offshore Wind Potential (Lansing, MI: MSU Land Policy Institute, 2008).

69. Several other aeolian developments are cropping up throughout the region. See Peter S. Goodman, "A Splash of Green for the Rust Belt" in The New York Times (November 1, 2008).

70. Texas is the lead wind energy producing state, and California is second (Adelaja & McKeown 2008).

>
Estuarine Urbanism
A cross-sectional view of the Great Lakes displaying an urban agglomeration of cities from Duluth to Glace Bay, home to approximately 40 million people dependent on the 20 quadrillion liters of water flowing from Lake Superior to Lake Ontario to the Gulf of St. Lawrence. Source: Adapted with data from NASA - NOAA - United States Geological Survey - Statistics Canada – Geode – St. Lawrence Seaway System, 2009


Duluth
Gary
Chicago
Milwaukee
Green Bay
Lake Superior
Lake Michigan
St. Mary's River
Lake Huron
Detroit
Toledo
Cleveland
Lake Erie
Buffalo
Toronto
Lake Ontario
Laval
Montréal
Québec City
St. Lawrence River
Gulf of St. Lawrence
Atlantic Ocean


ALASKAN UNDERWATER AQUADUCT
GREAT SLAVE LAKE
Southampton
CENA WP
PLAN MAGNUM
NAWAPA
WSWAC
TAPPING KEMANO
LAKE ATHABASCA
CENAWP
TAPPING CHURCHILL-NELSON
HUDSON BAY
TAPPING EOL
TAPPING LAFORGE
TAPPING CHURCHILL FALLS
Churchill
Edmonton
CANADA
BAIE JAMES
Newfoundland
HOPE BAY DEVELOPMENT
PACIFIC OCEAN
Vancouver
Columbia
LAKE WINNIPEG
TAPPING LAKE SAINT-JOSEPH
TAPPING OGOKI
Winnipeg
TAPPING LAC LONG
Saint-Laurent
Seattle
N AWAPA
PLAN KUIPER
GC
Québec
Portland
PLAN PIRKEY
NAWAPA
Montréal
OTTAWA
CENTRAL VALLEY PROJECT
N AWAPA
WSWAC
Minneapolis
Toronto
Boston
ALASKAN UNDERWATER AQUADUCT
WSWAC
CE NAWP
Mississippi
GRAND DITCH CONTINENTAL DIVIDE TRANSFERS
Buffalo
DELAWARE AQUADUCT
Detroit
New York
Sacramento
LOS ANGELES AQUADUCT
Salt Lake City
CENTRAL UTAH PROJECT
Chicago
SUPPLY TAPPING THE OGLALA AQUIFER
San Francisco
WSWAC
WASHINGTON
N AWA PA
Denver
Cincinnati
Ohio
CALIFORNIA STATE WATER PROJECT (CSWP)
Colorado
Kansas City
Missouri
WSWAC
CENAWP
Los Angeles
SAN JUAN CHAMA
UNITED STATES
Tennessee
COLORADO RIVER AQUADUCT
Phoenix
San Diego
NAWA PA
Red River
Mississippi
Atlanta
ALL-AMERICAN CANAL
Tucson
ATLANTIC OCEAN
CENTRAL ARIZONA PROJECT
New Orleans
40° N
26,3
8,5
3,5
1,3
0,5
Amounts of water transferred in billions of cubic metres a year

<
Pipe Dreams
Great Lakes water diversions in the context of current and future inter-basin projects across North America, the source of looming cross-regional politics along the longest, most undisputed border in the world. Source: ©2005 Frédéric Lasserre, Major Water Transfers: Tools of Development or Instruments of Power (University of Québec, 2005)

the shorelines of the Great Lakes state could meet one third of America's power needs.[70]

Greenhouse Effects

The single largest consumer of fresh water in the Great Lakes is agricultural irrigation.[71] Followed by public water supply and industrial use, water usage is increasing by 3 to 5 percent year-on-year due to global warming. From an agricultural perspective however, the region is a winner in the climate change game and the Leamington-Kingsville area is at the forefront. Located in Ontario, on the north shore of Lake Erie along the 42nd Parallel, the 'Tomato Capital of Canada' is now the leading greenhouse region in North America with the highest rate of startups in Canada, doubling between 2000 and 2005 in the Niagara region alone. Growers of the principal crops of tomatoes, cucumbers and peppers are diversifying into tender fruits, vine-ripened vegetables and specialty flowers cultivated in controlled hydroponic conditions which in turn limit pesticide inputs and runoff into nearby Lake Erie.[72] Arable lands, increasingly warm weather, abundance of fresh water and sunlight are further contributing to the diversification of its cultures. With $1 billion in farm gate value, Leamington's greenhouse acreage exceeds that of the entire U.S. greenhouse industry. This emergent agro-economy follows the blossoming of other bio-industries across the Great Lakes including viticulture (winemaking and grapevine crops), silviculture (timberlands and dimensional lumber) and floriculture (greenhouses and nurseries). In the past decade annual growth rates in these industries have varied between 5 and 10 percent, with retail turnover across North America topping $50 billion a year for products like cut roses, cultivated greens, potted flowering plants, bedding plants, turf, ground covers, nursery crops, springtime bulbs and Christmas trees. Bio-industries are extremely competitive in comparison to conventional heavy industry. According to the U.S. Department of Agriculture, floriculture – including plants for bioremediation and bioengineering – has been outpacing all other major commodity sectors in sales growth since the early 1990s.[73]

Region as Infrastructure

The concurrent development of land banks,

71. GLWI - Great Lakes Water Institute. 2009. Great Lakes Water Balance. www.glwi.uwm.edu/ourwaters/documents/GreatLakesWaterBalanceBWeb.pdf [accessed 26 March 2009]

72. Green house start-ups in the Niagara Region doubled between 2000 and 2005.

73. Agricultural Economics Research Institute (AERI). 2007. Floriculture Worldwide: Trade And Consumption Patterns. The Netherlands. www.agrsci.unibo.it/wchr/wc1/degroot.html

Commons, Partitions, Bodies
Geopolitical map of the international territorial waters layered with state-provincial-county jurisdictions across the transnational watershed boundary of the Great Lakes Region. Source: Adapted from International Joint Commission - United States Geological Survey - Environment Canada

wind farms and greenhouses demonstrate the potential of new strategies that engage the systemic integration of urban infrastructure with biophysical resources. As countermeasures to the predominant challenges of the Great Lakes Region including water pollution, land abandonment and the farming slump, these strategies usher in an era of regional economic regeneration where large centralized mass production industries are being supplanted by a distributed, networked patterns of production, cultivation and management.[74] Although the long-term effects of this shift have yet to be understood, what remains clear is that the transition from a globally based carbon economy to a regionally based carbohydrate ecology is underway.[75] Opening new territories for renewal and new surfaces for occupation across the region, these developments demonstrate the capability of regional landscape strategies to address several challenges of various complexities simultaneously. This is where design becomes instrumental, moving across varying scales of intervention from planning to engineering, transcending conventional boundaries of private and public interests. From this vantage point, the new design imperatives are found in the basic processes and essential services that support urbanization including the integrated ecologies of water, energy, food, mobility and waste, which have traditionally been treated as separate components or separate districts in municipal planning. Through the bundling of multiple ecological services, strategies can achieve greater economies and ecologies of scale.[76,77] Forming a geographic field, these urban-regional strategies can be considered synergistic, self-perpetuating and self-maintaining. It is at this precise moment that the region becomes infrastructural.[78]

Region as Landscape

Emerging from a long, dark history as the sewer of North America, the Great Lakes region may be understood as a macrocosm of change, a case study in the historical transformation of the continent. Land transformation during the 18th, 19th, and 20th centuries present compelling evidence that, as a large, complex, collective system of biophysical and hydrodynamic processes, the Great Lakes effectively preconditions industrial operations and sustain urban

<
Super-Regional Urbanization
Geospatial context of the Great Lakes with the concentrations and extents of urban patterns across the Americas. Source: Adapted with data from NASA - United States Geological Survey, 2008

74. Slow and subtle shifts are implied in this systemic convergence, re-questioning of the undisputed hegemony of speed in modern industrial production. From mining to agriculture to construction, the acceleration of industrial processes essentially underpinned Modernity in the 20th century. The history of this invisible presence is being countered today by the combined paradigms of pace, synergy and synchronicity that privilege co-operations and inter-relationships, whose developments requiring the active and sustained engagement of long term, opportunistic partnerships between private and public sectors. See Teresa Brennan, Exhausting Modernity: Grounds for a New Economy (London: Routledge, 2000).

75. The development of the carbohydrate economy and the rise of renewable resource industries has its antecedents. Dating back to the turn of the 19th century, before the advent of alcohol prohibition and well before the supremacy of Southern U.S. oil barons, vegetal fuel sources such as hemp, soy or corn were widely publicized by Henry T. Ford and Rudolf Diesel. See Greg Pahl, Biodiesel: Growing a New Energy Economy (White River Junction, VT: Chelsea Green, 2006).

76. Schneider, D.C. 2001. The Rise of the Concept of Scale in Ecology. In BioScience 51 (7): 545-553.

77. Schlich, E. and Fleissner, U. 2005. The Ecology of Scale; Assessment of Regional Turnover and Comparison with Global Food. In The International Journal of Life Cycle Assessment 10 (3): 219-223.

78. Bélanger, P. 2009. Landscape as Infrastructure. In Landscape Journal 28 (1): 79-95.

economies.

Retroactively, the multiple characterizations of the Great Lakes as a region reveal an underlying landscape of persistent geo-economic and biophysical significance that warrants more depth and greater consideration for the future. Economically, the region ranks second in the world with a $4.6-trillion gross regional product. It represents two-thirds of North America's purchasing power, rivaled only by the United States as a whole and larger than the economies of Japan, China, Germany and the U.K.[79] Demographically, the 45 million people that live and work in the region represent 30 percent of the combined Canadian-American population. Geographically, the population is urban and decentralized, bordering a coastline of over 15,000 kilometers. Politically, the region spans eight states and one province, including 447 counties located in two different countries sharing the longest, least disputed border in the world. Hydrologically, the population draws on a nearly 500,000-km2 watershed – ten times the size of the Netherlands or Belgium – as its sole source of fresh water. The urban economy of the Great Lakes is thus inseparable from its Nearctic ecology.

Notwithstanding the demand for staple resources of lumber, taconite and aggregates, the projected 3 to 5 percent population increase is an indicator that the region will continue to attract considerable domestic and foreign interest in the form of immigration and investment. However, due to the scale of processes and range of operations that the region can support its ecology will be, as it always has been, an ongoing setting for conflict and contradiction.[80] Its structure is paradoxical: horizontal yet deep, dynamic yet resilient, integrative yet synergistic. With increased diversions and excess abstractions, reserves of fresh water will be under strain as consumption continues to exceed replenishment by a factor of 6 to 9;[81] water politics will be at the epicenter of these challenges.

Nevertheless, ideological debates will have to yield to a more factual and sophisticated discourse.[82] Historical oppositions between basic concepts such as city vs. country, low-density

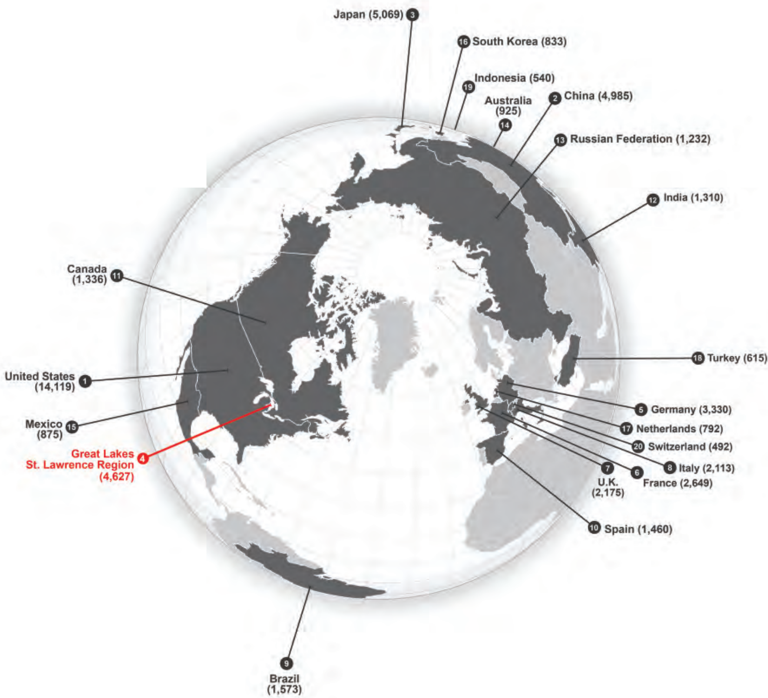
79. These figures were reported by the Austin & Affolter-Caine (2006 & 2008) from the Brookings Institution, originally compiled by World Business Chicago (2009: 2,11) whose comparative data is based on national GDP figures issued by the World Bank.

80. Annin, P. 2006. The Great Lakes Water Wars. Washington, D.C.: Island Press.

81. Great Lakes Water Institute, "Great Lakes Water Balance" http://www.glwi.uwm.edu/ourwaters/documents/GreatLakesWaterBalanceBWeb.pdf

82. Schmidt, S. & Buehler, R. 2007. The Planning Process in the US and Germany: A Comparative Analysis. In International Planning Studies 12 (1): 55–75.

Brave New Ecology
A 92.5-pound bighead carp caught in the upper reaches of the Mississippi River. Introduced to fish farms in America during the 1830s and migrating north to the Great Lakes, this vigorous species thrives in heavily polluted waters and can jump up to 10 feet out of the water. The species shown here, a Bighead Carp, weighed at 92.5 lbs, 62" long and had a 30" girth to establish a new world record. Source: Darin Opel, Illinois Bowfishers Club, 2008



Extra-National Economy
Comparative view of the GDP (Gross Domestic Product, USD billions) of the Great Lakes-St. Lawrence Region in comparison to the top 20 economies across the world. Source: Adapted from World Bank – World Business Chicago – World Economic Forum, 2011

vs. high-density, local vs. global, industry vs. agriculture, native vs. exotic - are quickly becoming obsolete in favor of new complexities, new formulations, and new synergies.[83] Whether we refer to the spread of sea lampreys in the early 19th century or the annual restocking of 4 million fish in Lake Ontario or the more than 100 introduced species found across the Great Lakes today, the transmutation of the ecology of the Great Lakes also requires us to move beyond the conventions of conservation and preservation to focus on the expansion and prolongation of living systems as prime objectives.[84] Whether by planning, policy or engineering, this is the contemporary regional design imperative. The formation of environmental protection agencies, watershed conservation authorities and remedial action plans at the close of the 20th century are some of the initial drivers of this greater paradigm shift, but considerable efforts are required to fully exploit this paradigm shift in the present century.

The refocusing on regions relies on the robustness of their biophysical systems and is equivalent to their economic longevity. As dynamic configurations and operative morphologies, the boundary of surface waters, the network of biotopes, the bathymetry of lake bottoms, the contours of cities and the flow of resources around Great Lakes are fundamental to this shift. As measures of intelligence, the mapping of inter-regional flows and reciprocities provides a base to register and effect change over time. Instead of a single, bounded, closed, homogeneous environment, the regionalization of the Great Lakes can open a wider and richer horizon on a systemic network of endogenous and exogenous processes at work. When viewed telescopically at different resolutions and scales, the region can then be understood as a system of systems.[85]

In this expanded field, the regionalization of design practice can transcend conventional spatial boundaries, disciplinary territories and political ideologies. Design can be liberated from the straitjacket of shortsighted bureaucratic time scales and the confinement of jurisdictional site boundaries. Capitalizing on geopolitical cleavages, design can unearth and propose mutual, cooperative, interdependent and synergistic

83. The failure of colonial-style eradication to subdue more than 100 species of exotic plants, fish and algae in the Great Lakes testify to the persistence and sustainability of global trans-regional ecological flows. Counter-classical views of this growing ecological condition are expressed in Smith (1996), Schaper 2006) or Del Tredici (2006).

84. Regionalism should not, and cannot be solely based on environmental determinism, nor on conventional conservatism. The comparison of three historical views on resource conservation is informative. On one level, there is a view sponsored by Garrett Hardin in Tragedy of the Commons that calls for the public coordination and management of resources as a commonwealth (Hardin 1968). On another more controversial level, conservation and management of resources was put into question by Henry Ford who claimed that "conserving our natural resources by withdrawing them from use is not a service to the community. That is holding to the old theory that a thing is more important than a man. Our natural resources are ample for all our present needs. We do not have to bother about them as resources. What we have to bother about is the waste of human labour." (Ford 1926: 90). On another more extreme level, Ayn Rand argued: "contrary to the "argument from scarcity," if you want to make a "limited" resource available to the whole people, make it private property and throw it on a free, open market" (Rand 1967: 134).

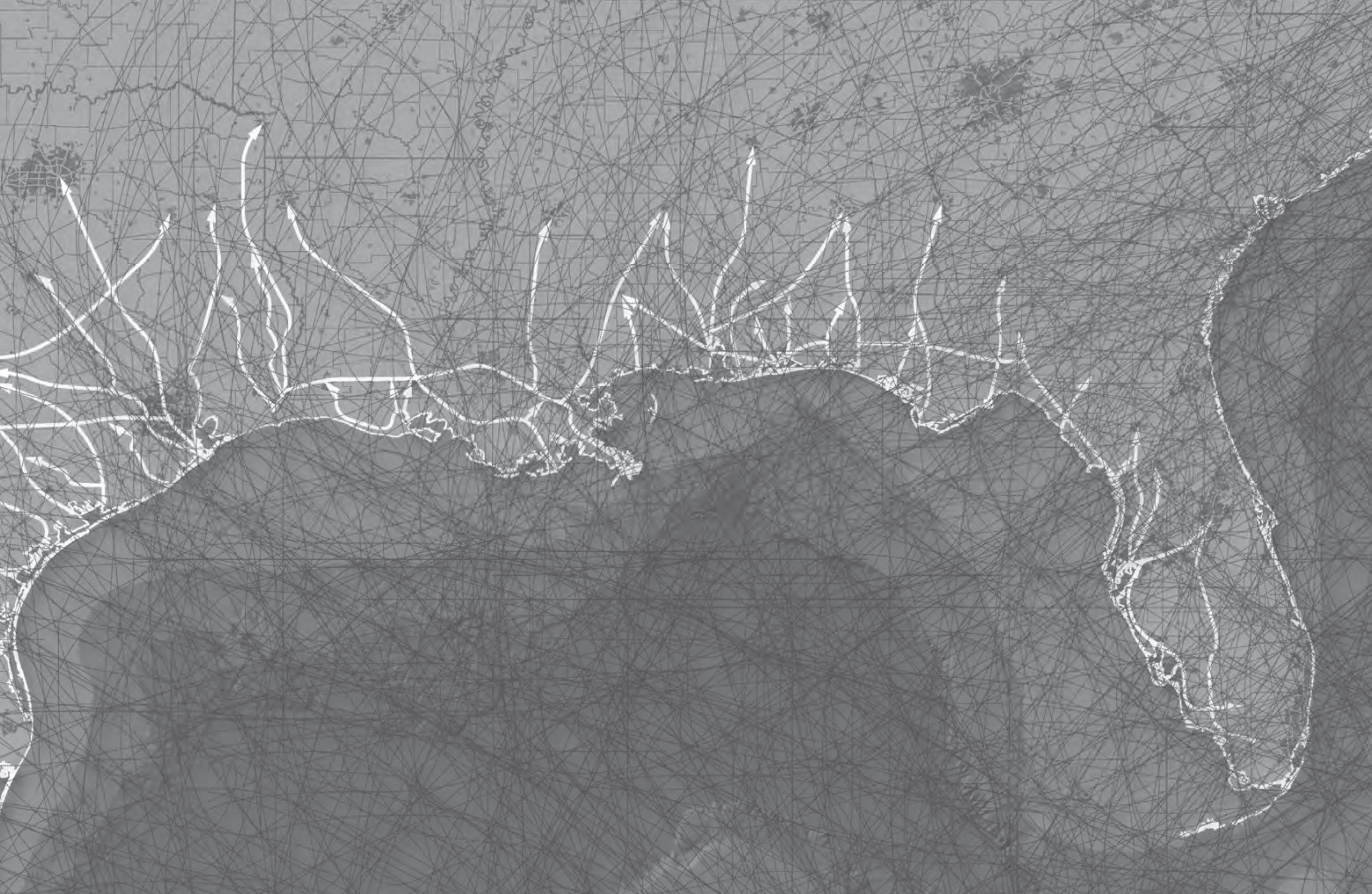
85. This statement is owed to Howard W. Odum, one of the pioneers of 20th century regionalism in America: "The significance of regionalism as the key to equilibrium is reflected in an extraordinary range of situations, such as the conflict between nationalism and internationalism, between sectionalism and federalism, and the imbalance between agrarian and urban life, between agriculture and industry, between individuation and socialization in governmental trends, between a quantity of civilization of standardizing forces and a quality world, between machines and men." Howard W. Odum & Harry Estill Moore, American Regionalism (New York, NY: Henry Holt and Company, 1938): 5.

strategies at large scales that spin off inter-regionally. Consequently, design can be informed by continental geography and global ecologies while being elevated to the superintendence of time. The physiographic and political regionalization of urban areas thus moves beyond that of mere background for planning or mere unit of development. As planning tactic and design strategy, regionalization becomes instrumental and infrastructural, setting the precedent for landscape reclamation and landscape urbanization across the continent and other industrialized regions of the world, from the Americas to Asia to Africa.

From the 40 million acres of Cutover land to the management of over 20 quadrillion liters of fresh water in watershed, the engagement of the Great Lakes as a complex regional landscape is therefore pressing. If freshwater is the oil of 21^{st} century, than the agency of urban regions is of critical and contemporary significance, globally.

Originally published in JOLA - Journal of Landscape Architecture *(Fall 2010): 6-23*

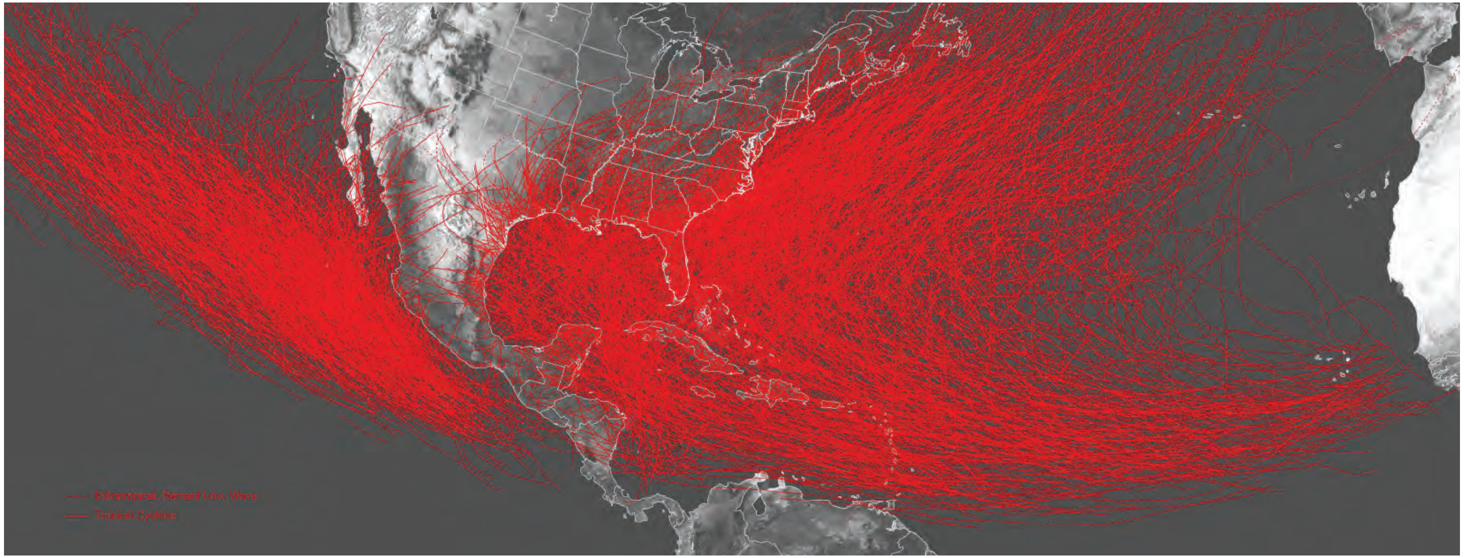
>
Coastal Contraflow
Historic paths of hurricane and subtropical storms from 1857-2011, juxtaposed with stratregic patterns of evacuation from landfall regions along the coast of the Gulf of Mexico towards designated twin cities further inland. Diagram: OPSYS, 2012.



Infrastructural Ecologies.

Increasingly, the agency of ecology is coming into focus as a strategy and system in the design of urban infrastructures and performance of urban economies.[1] This contemporary change is largely attributable to the massive transition from industrialization to urbanization worldwide in the past century made visible by three cumulative shifts: the rise of environmental concerns since the 1970s, the crisis of public works planning in the 1980s, and the erosion of postwar engineered structures from the 1990s onwards, whose legacy total more than 2.2 trillion dollars in urgently needed reinvestment.[2,3] Contributing to the rising influence of the field of landscape, this transition is further amplified by the effects of population pressures such as regional dispersal, transnational migration, geopolitical borders and capital flows, as well as from environmental pressures such as carbon consumption, atmospheric emissions, chemical effluents, groundwater quality, floods, droughts, sea level rise, soaring energy costs and rising food prices. Although tremendous attention has been given to the magnitude of these challenges, the scale and frequency of infrastructural disasters and technological accidents continues to rise at an alarming rate. The upward sloping timeline of events in the past three decades is the most blatant indicator: sudden power outages in the Northeast, rolling blackouts in the Southwest, bridge collapses in the Midwest, as well as oil spills, hurricanes and levee breaks along the Gulf Coast.[4]

<
Urban Hazards
The devastating effects of Hurricane Ike on the shoreline of the Gulf Coast in 2008 near Houston-Galveston, Texas, the third costliest storm event in the history of the US. Source: ©2008 NOAA



Hurricane Alley
Historic paths of major storm events since 1851 forming across the Atlantic Ocean, a climatic pattern responsible for an average of 13 hurricanes occur each year (including Katrina, Ike, Andrew). Map: Pierre Belanger, with source data from NOAA, 2008

These growing incidences are exacerbated by outmoded patterns of land development upheld by the spread of standardized, end-of-pipe engineering, Euclidean land use zoning, and uncoordinated, reactionary planning. The industrial structure of cities today - vertical, centralized and inflexible - further explains the unchecked and unseen dependence on centralized systems of water abstraction, waste landfilling, oil import, food processing, soil depletion, and uniform transportation at the expense of pre-urban, pre-industrial endowments of biophysical resources.[5]

Consequently, we have recently begun to better understand how Fordist modes of production and Taylorist principles of efficiency, have over-simplified the ecology of urban economies and under-played the social role of urban infrastructures, by way of marginalizing and suppressing the living, biophysical systems. At the center of this ecological divide are the historic practices of engineering and planning that operated well into the 20th century, under the tenets of efficiency and control through centralization. Often considered in isolation, the disparate and disastrous events that mark the end of the 20th century index the inherent effects of ecological complexity of urbanization associated with contemporary technologies, biophysical systems, climate change, regulatory frameworks, public works management and population dynamics. Yet, despite infrastructural overload and chronic underfunding, demand for mass-housing, mass-mobility and mass-communications persists. Ironically, the horizontal spread of low-rise urban populations continues.[6]

Stemming from the overexertion of civil engineering[7] and inertia of urban planning[8] vis-à-vis the pace of urban change,[9] and coupled with the exhaustion of the environmental lobby,[10] there is an urgent need for the rethinking of current models of city building towards contemporary patterns of spatial distribution that meet new and existing demands with current resources. Putting into question the conventional capacities of any single discipline to address the magnitude of urban challenges and ecological complexities today, this essay proposes the compound, collaborative formulation of landscape infrastructure as a contemporary field of practice that addresses the flows urban economies and dynamics of global ecologies. To accomplish this objective, this essay firsts outlines prevailing paradigms in the scientific disciplines of engineering and planning, and how they conditioned cities as a socio-technological problem through measures of control and efficiency. A brief survey of shifts that occurred during the proto-urbanization of North America in the 20th century are brought forth to redefine the conventional notion of urban infrastructure and expand it as a landscape of systems, services, scales, resources, flows, processes, and dynamics, that support and cultivate urban economies. In light of the massive infrastructural transformation occurring worldwide, the essay concludes with a series of strategies and projections that reclaim the landscape of urban infrastructure along with pragmatic and immediate advantages for contemporary practice.[11]

MEASURES & METRICS

Infrastructure has grown in complexity vis-à-vis the current urbanization of the world. It is both a response to, and generator of horizontal forms of development, in part due to the transnational distribution of technologies and techniques of urban engineering. Although it is often relegated to mere background or unseen substructure of urban development, infrastructure is the interface by which we interact with the biological and technological world. However banal they are, taps, pipes, wires, sewers, sidewalks, curbs, roads, verges, ditches,

Horizontal Urbanization
View of the expanding urban region of the Greater Toronto Area (GTA) showing the logistics zone f the Pearson International Airport lining Highway 40, with fog rising from the forest ravines of the Etobicoke-Mimico Creek watershed. Photo: ©2007 Pierre Bélanger

sidewalks, medians, spans, pylons, highways, landings, landfills, tunnels, power plants, treatment plants, airports, are the technological spaces - the hardware - that composes the urban world. Simultaneously, urban infrastructure is both site and system. It is designed, constructed and continuously reconstructed. While we may argue on how it actually works, or sometimes how it works even too well, its influence has exerted itself most often to the point of invisibility, often obscuring the connection with the software of social environments and biophysical resources. Rarely do we actually see the entire watershed that supplies the water that we drink or bathe in, nor do we see the subsurface soils that we walk on that underlies roads or regions, nor do we see the power of a coal mine from a power plant that generates the electricity when we turn the lights on.

Central to the reconsideration of urban infrastructure are the historic roles that civil engineering and urban planning have played as the most prominent city building professions of the 19th and 20th century. As twin disciplines, they have both exercised tremendous influence in the shape of cities and urban regions during the past two centuries.[12] To begin, a summary of baseline principles of urban planning and civil engineering is instructive:

A. Standardization:
the singularity of infrastructure as a linear and closed system, designed exclusively on efficiency and economy. The normalization of dynamic systems and externalization of other dynamics or wastes and organic systems are effectively reduced to use-value functions, utility efficiencies or mechanical operations.[13] Standards are therefore developed for purposes of maintenance and self-preservation as opposed to management and modernization.

B. Mono-Functionality:
the singularity of land uses leads to economic, ecological and sometimes social segregation. Dynamic systems become parceled and closed off, externalizing the larger set of biophysical and socio-economic services that intrinsically depend upon their interconnectivity to function. Excessive regulation of land use has further stifled economic development and, despite their original intention, contributed to patterns of low density urban development.[14]

C. Permanence:
as well as they appear to work, standardized infrastructures and mono functional land uses are inflexible to change and they demonstrate a considerable level of fragility towards unexpected hazards, accidents and disasters. Through the illusion of safety and certainty created by specialization and standardization, centralized infrastructure and dense aggregations, such as the reliance on one specific type of energy source or a centralized water distribution system, for example, often exposes large populations to high risks.[15]

Notwithstanding the scale of their influence, civil engineering and urban planning have respectively formed the functional architecture and regulatory framework that underlie the legislative governance and physical construction of cities today. Yet, over time, the implementation of legal controls and standards of efficiency has gradually contributed to the rigid, inflexible and detached nature of cities from greater landscape ecologies and regional climates. As Gene Moriarty discusses in The Engineering Project, “the modern engineering enterprise is primarily a colonizing project”, both self-aggrandizing and totalizing.[16]

Infrastructural Squatting
A 5-kilometre long, extra-legal settlement along the public right-of-way of Quezon City's Republic Avenue, within metropolitan Manila in the Philippines, where road development was formerly planned. Source: ©2011 DigitalGlobe

From Engineering to Design

Through the hegemony of efficiency and scientific positivism,[17] civil engineering has become central to the design of urban environments as the premier design service discipline.[18] How it attained this unwavering status is remarkable, given how very little attention the profession or its parent associations have given to social conditions, political ideologies, or theoretical discourses. Its relative absence of manifestoes alone is both surprising and suspect. Compared to other fields of design such as architecture and urban design or the social sciences and regional planning that are arguably over-theorized,[19] civil engineering has made leaps and bounds by literally operating without theory. In the absence of critical discourse,[20] quantitative logic and numerical precision have become the foundations for achieving accuracy, efficiency and safety. Since the cost-benefits of civil engineering services represent less than 1% of the life-cycle cost of a project, it is rather difficult to contest the economic value of these services where they are viewed as an investment.[21] However central this logic may be, its foundation also relies on the isolation of variables and the exclusion of less quantifiable and more complex information through reductionism and externalization of dynamic forces.

Post-Taylorism

The decontextualization of urban infrastructure is important and critical to recognize as an overlooked side effect of engineering techniques, and to a certain extent, planning policies. Underlying this condition are linear notions of utility and efficiency stemming from technological determinism and technocratic control. Hierarchical methods of management and vertically-oriented administration, borne from the industrial era of Taylorist principles, were premised on the improvement of production through rationality, numerical logic and standardization of the production process and work flows. Central to industrial economies were notions of planning, predictability, centralization and control; principles that influenced the development of factories, production processes, and even military strategies, during the rise of mechanization, automation and Fordist methods of mass production at the turn of the 20th century. While scientific, centralized approaches to management and manufacturing resulted in a series of short-term and direct economic gains, in the long term, it excluded other environmental processes that predated, and preconditioned industrial economies: the pre-industrial ecology of resources, the immediate impacts of large infrastructural networks, culture of labor organizations, social innovations, post-production wastes, regional deindustrialization and international outsourcing.

This practice has more recently been challenged with the disastrous effects of maintenance deferrals, deregulatory frameworks and growing risks made visible by bridge collapses, or major chemical spills. Recent events such as the sudden collapse of I35W Bridge in 2007 on the Mississippi River or the fly ash slurry spill in 2008 at the Kingston Coal Plant have demonstrated the limits of engineered controls, and the shortcomings of rational efficiency. Its overexertion has now made apparent the impermanence and limited lifespan of infrastructure.

In response to these externalities, a post-Taylorist discourse has emerged in the past decades both as a critique of the tenets of efficiency and control, as well as catalyst for decentralized ecological strategies that move beyond engineering and planning. In an attempt to bridge the gap between economy and ecology, the potential for more networked patterns of spatial distribution and more decentralized methods of decision-making is radically changing the landscape of urban economies and production. More diverse and more flexible modes of production, higher quality services, featuring just-in-time production, business process re-engineering, call centers, simultaneous engineering and asynchronous teamwork, across different networks.[22,23]

Infrastructural Apartheid

Further to the re-reading of urban infrastructure and professional disciplines, common assumptions about sustainability need to be challenged. Principles of city building such as density and compactness,[24] growth and permanence,[25] stability and security[26], have been so far unchecked and should be rethought. Often carrying moralistic or ideological overtones, these notions are questionable in terms of their value as governing principles in design. At their core, these principles are rooted in traditions of military engineering and wartime planning.[27] For example, it is crucial to understand that the discipline of civil engineering emerged from the glut of military engineers from West Point during a prolonged period of peace at the end of the 19th century.[28] In traditions of military engineering, defense imperatives led to the delineation of biophysical environments along clears divisions between dry and wet land or, high and low ground. Traditions in water management, topographic earthworks, centralized fortifications and flood control are some of the most important contributions that French military engineering has passed down to techniques of civil engineering, underpinning the work of the U.S. Army Corps of Engineers.[29] Although engineering practices may command a sense of military-like authority, the unwavering adherence to quantitative calculation and hierarchical control has its limitations. It overlooks the social and ecological dimensions that often lie outside the bounds, edges, scopes and peripheries of its facilities. For all of its accuracy and precision, civil engineering is actually handicapped by an exclusive reliance on efficiency at the expense of other, equally important social, spatial, ecological factors. The natural smoothness and seamlessness of Western infrastructure - whether the expansion of a highway or the diversion of a river - questions the neutrality of civil engineering. In several parts of the world, infrastructures ranging from roads and bridges to airports and power plants, have been often implemented and strategically located to serve a small, powerful elite at the expense of a larger, often poorer majority.[30] Effects of the All-American Canal along the US-Mexico border, Highway 443 in Palestine or Republic Avenue slums in Manila are samples of the physical divides created by urban infrastructures. Their unintended consequences have resulted in forms of spatial apartheid, social marginalization, and in some cases, civil strife.

SHIFTS & PROCESSES

The historic lack of engagement of infrastructure as a territory of design stems from its dystopic and banal nature. Traditionally, urban design has concentrated on the design of buildings, blocks and streets as the locust of urban development while overlooking the potential of infrastructure as great enabler, the glue of urbanization.[31]

Decentralization

In the past century, increasing demands for urban services of transportation and mobility have originated from the expansion of cities on their periphery, where more than 60% of the European and more than 80% of the American population live today.[32] Ever since the exhaustion of the City Beautiful Movement at the end of the 19th century Industrial Revolution,[33] the population explosion that soon followed - the urban bomb - radically transformed the making of cities. Planning in America emerged from an infrastructural boom during a period when cities like Chicago, Los Angeles, Boston, and New York were doubling and tripling in population.[34] Gangs were rampant, motorization was just on the horizon, but more importantly, the dramatic rise in urban populations during the 1920s marked a turning point. For the first time in America's history, U.S. demographers recorded the official transition from rural to industrial to urban economies in less than a century.[35] More than fifty per cent of its population lived in urban areas. Notwithstanding crime and congestion, the multiple, con-

De-Zoning
Demolition of GM's Fisher automotive body plant in Euclid, Ohio to make way for new expanding institutional campuses and business parks in the suburbs of Cleveland in the vicinity of Lake Erie. (Photo: ©2008 Pierre Bélanger)

current demands for drinking water, waste management, energy generation, food distribution, and transportation corridors placed significant pressures upon the services of growing, congested cities. Control of these conditions seemed imperative, leading to the separation of urban services into distinct more manageable categories, divisible through the inception of public works departments.

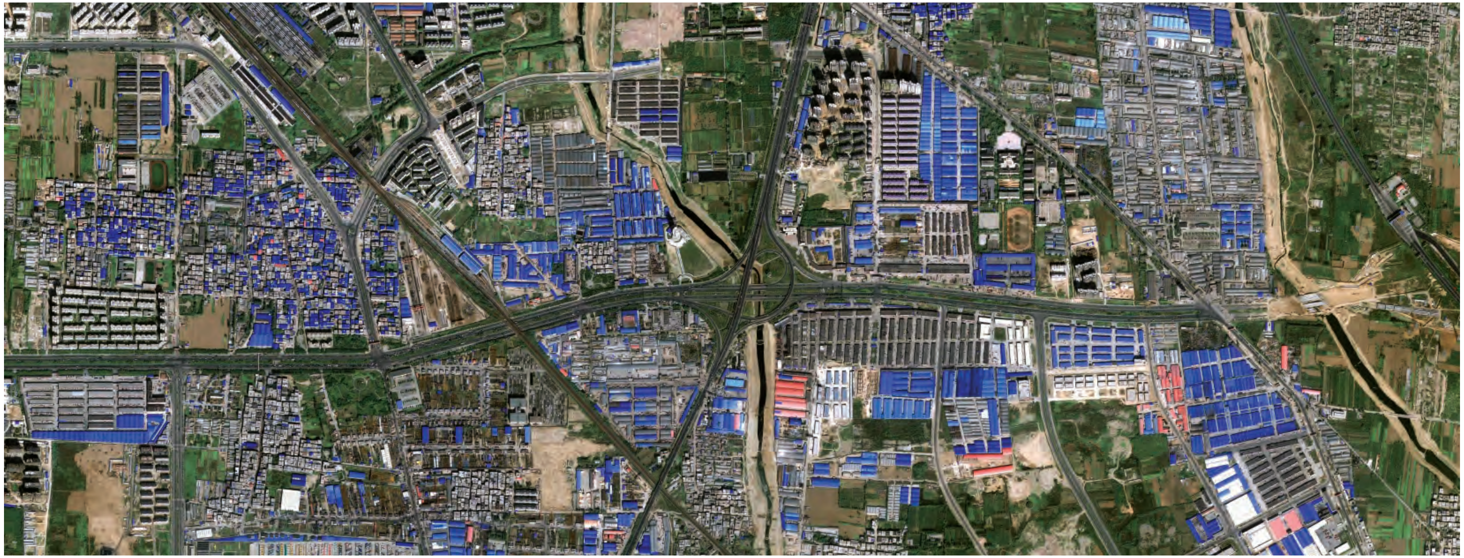
Upward sloping and double digit growth from famine-era migration[36] necessarily resulted in planning policies and zoning regulations premised on the control, containment and constraint of urban growth. Height restrictions, density limits, and land use compatibilities were naturally formalized as part of the specialization of a professional planning discipline. Steeped in a core-periphery understanding of cities, urban planning drew from its inheritance of Old World principles of centralized city development, as well as the legacy of prisons and hospitals (the earliest forms of public planning through architecture) as models of socio-spatial control.[37] Master planning would consequently be predisposed as a social science.

Usurping the goals of the American Civic Association and the grandeur of the City Beautiful Movement, the new planning institution saw the substitution of ground level development with hierarchical control. It capitalized on the separation of government powers that form the backbone of the US Constitution, to place authority in the hands of city governments. Although local governments were the largest stakeholders and beneficiaries of master planning, their objectives were soon subverted. The compound effect of squalid inner city conditions, individual mobility, cheap low-rise housing and deindustrialization fueled processes of outbound horizontal growth of urban populations along transportation corridors and new lines of access. This sprawl leaped over so-called growth boundaries, flowing beyond city limits and threatening the imposed political boundaries that no longer contained horizontal urbanization. Seen as uncontrollable, growth became the new urban problem.[38] The incapacities and inflexibilities of master planning were further demonstrated by the contradictory rise of population checks, excess condemnation and police power.

Unplanning: Zoning, after Euclid

In the urban decentralization of cities, the task of planning relied on the neat separation of services with individual land use classifications. Faith in scientific planning and administrative control led to the establishment of basic single-use categories according to Euclidean planning principles: residential, commercial and industrial. Cities took on new dimensions raising more questions about the use of master plans as instruments of control and management reliant on use-values at the precise moment when, as John Kenneth Galbraith captured in The New Industrial State (1967), "capital [and power] became more important than land."[39] Dependent on jurisprudence, the planning discipline has irreversibly become entrenched in legislation, land use economics and social sciences.[40] Consequently, geography and ecology were divorced from the basis of planning for the future altogether.[41] With rising preservation interests and constant indictments of suburban land development, this divide is growing wider. Planning methods have more recently failed to gain traction vis-à-vis the speed of urban expansion, housing and infrastructural developments or the environmental pressures taking place.

From this divide, between the large scale legislative vacuum of planning and the smaller scale technocratization of engineering, is a vacuum of unaddressed urban challenges. From groundwater abstraction in the Midwest States to river pollution of the Rio Grande to sewage flows in the Great Lakes, demonstrate the regional pressures from urbanization beyond the ever-present divide of political jurisdictions, public works departments and property bound-



Farms, Factories, Workshops
The pattern of subsistence farms in the contemporary logistics and manufacturing hub of Zhengzhou, China, where over 30 percent of land within existing ring roads is under agricultural use due to food security policy. Source: ©2011 GeoEye

aries.[42] Twentieth century planning has been, for the most part, relegated to a generation of lawyers and economists reliant on an over-arching legal or economic world view. Not unlike engineers, planners too have failed to see the greater synergies made possible by a more ecological, more integrative lens that couples and synthesizes different spatial, biophysical conditions with social and economic concerns.

From Plans to Processes
As a landscape, the fragmented, diffuse, and often transboundary pattern of urbanization has further demonstrated the weakness of nation states in facing massive urban change, as well as the fading power of the postwar welfare state to exercise influence or direct patterns of urban growth. Gradually, from the fading of federal power, the boundaries between public jurisdictions and private forces of development are dissolving when dealing with large scale infrastructural projects. Physical boundaries of territories are often limited by state jurisdictions or federal agencies whose boundaries were established by wars or conflicts more than a century ago. Historically, resources such as rivers, coastlines and water bodies served as military or geopolitical boundaries, or were marginalized as backwaters. This political preconditioning explains why water courses and water bodies have historically been reduced to singular functions of sewage or navigation, contributing to the relative invisibility of biophysical resources, habitats and ecotopes; systems that depend on systemic interconnectivity. As a result of these exclusions, biophysical systems are partitioned and parceled into defined areas, often categorized or restricted to bounded sites of conservation or recreation. The static boundaries of political jurisdictions now stand in sharp contrast to the fluid, dynamic patterns of urban growth whereby the flows of water, waste, energy and food transcend geopolitical borders.

From Sub-Urbanization to Super-Urbanization
In parallel with the loosening of engineering's grip on the complexity of urban conditions, the planning of cities is now falling short due to an outgrowth of regulatory boundaries, an inflexibility to adapt to rapid change, and an incapacity to maintain existing infrastructures. Most pronounced in 'older' economies of the New World and 'newer' economies of the Developing World, the inertia of the planning profession is putting into question the regulatory regimes of cities, as the rise of ecological intelligence and systems thinking make connections across the economic and legislative borders.[43] What has been overlooked in the discourse on decentralization and urban dispersal, one that has been skewed by blanket dismissals of sprawl, is the general advantage afforded by the regionalization of urban conditions. In support of urban agglomerations earlier last century, regional urbanist Howard W. Odum documented the characterization of overlapping ecological, economic or social regions "as a technique of decentralization and redistribution of population, industry, wealth, capital, culture, and of bigness, complexity, and technology."[44]

Often poorly understood, the global phenomenon of decentralization and the "flattening of the density gradient" stems from the leveling of socio-economic structures in the 20th century. It is a process occurring across "a more dispersed landscape [that] has afforded many people greater levels of mobility, privacy, choice."[45] The increase in individual purchasing power thanks to consumer credit and the birth of instant communication made possible by network technology systems,[46] have thus contributed to a horizontal pattern of urbanization that functions largely as an alternative to the "densely settled cities that were the norm at the end of the nineteenth century."[47]

>
Urban Footprints, Zones & Regions
The networks f energy, waste, water. food and mobility that service the New York–New Jersey region. Diagram courtesy of Jonathan Scelsa, 2011.

From this larger lens, the process of urbanization change is best understood as a transitional from former industrial economies of supply towards urban economies of demand that has occurred in the past century. From this shift, we can propose that the current rise of urban economies is a reaction to the Fordist modes of production and Taylorist modes of management that have dominated the past century. As a natural response to these models of control and containment, the decentralization of cities and the expansion of urban economies at the regional scale provides major benefits, where super-urbanization opens new territories for occupation, renewal and redistribution.

From Control to Contingency

The rethinking of efficiency, the basis of engineering, and of control, the historic focus of planning, is yielding more strategic and more contingent formats of design.48 Legal and regulatory frameworks are being counterbalanced by pressing concerns about the carbon footprint of cities and the limited lifespan of infrastructure. The view of cities as closed systems, composed of a few controllable variables, is succumbing to a growing body of knowledge and expertise on dynamic, distributed, ecological systems.

With the inability of planning to counteract or control the spread of urban form and capital through growth or shrinkage at the onset of the 21st century,[49] it is clear that planning tasks will merge with more influential parent discipline of landscape architecture, further augmented by softer forms of civil engineering. From this position, zoning as well as dezoning may take on unprecedented roles in the design of regions at super-urban scales. They will transition from being tools of prevention to instruments of projection through forces that may eventually yield a richer, more productive set of ecologies.

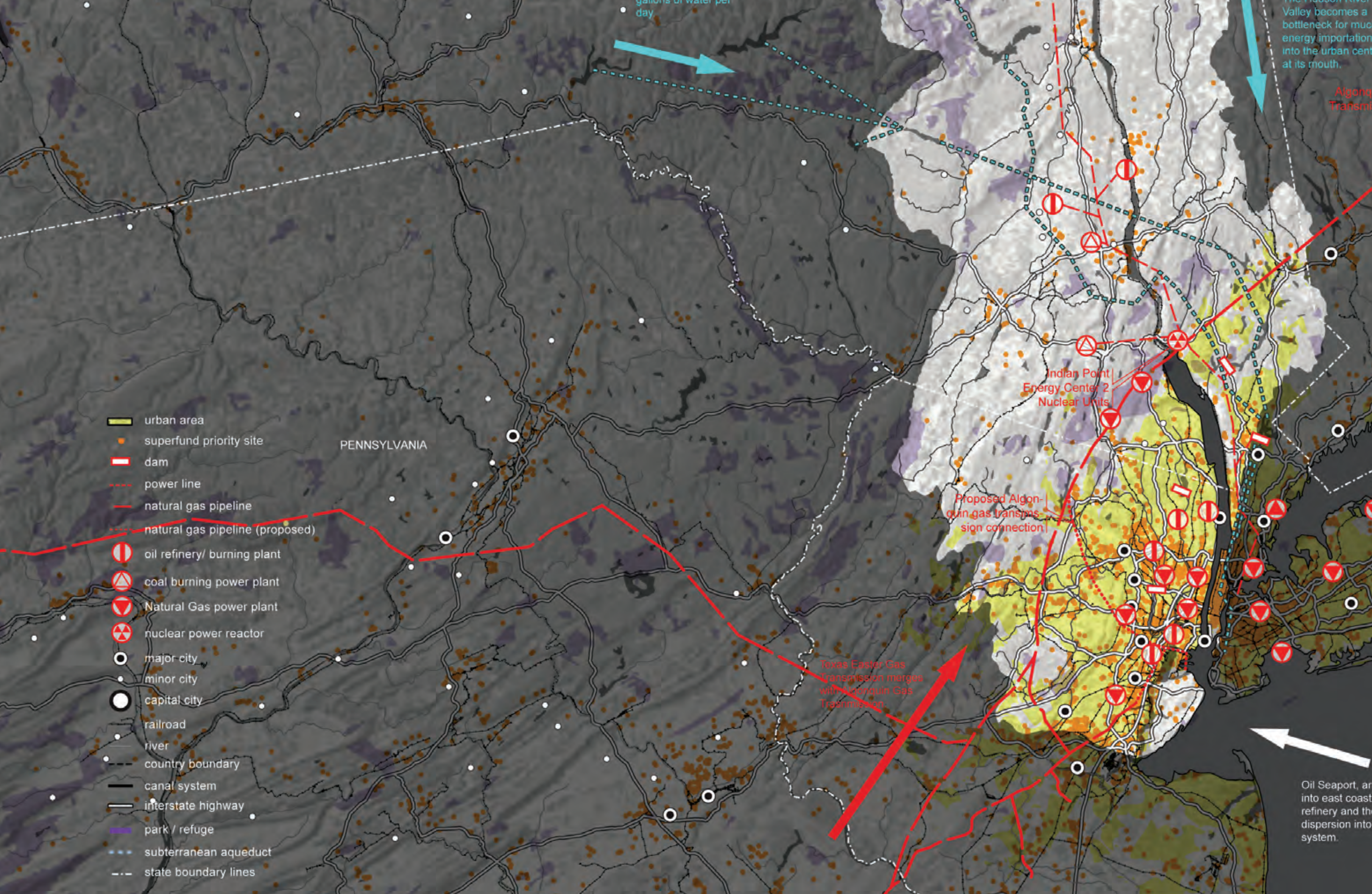
FIELDS & FLOWS

As a result of the diversification urban economies and decentralization of its service infrastructure, we have been witnessing in the past three decades the decoupling of centralized planning from state authorities. Naturally, we are also witnessing the waning of national identities associated with great public works, such as the highway systems and great engineering feats,[50] followed by the decoupling of infrastructure as an exclusive domain of practice of civil engineers. From this flattening of urban administration and engineered hierarchy, a set of new regionalized identities are emerging that privilege diversity and differentiation, most evident in a more visible landscape of resources, cultures, territories and innovations.[51]

In order to initiate a more ecologically-responsive, socially-expedient, culturally-relevant, and fiscally-effective reorganization of urban lands, how then can we rebundle and redesign essential urban services - from water resources and waste cycling, energy generation and food cultivation, mass mobility and network communications – as living landscapes that span the divide between economy and ecology facing contemporary cities?

Regionalization

From this re-questioning and re-reading of the dominant principles of the past two centuries, and the disciplinary cleavage created by the complexity of current urban conditions rises the field of landscape, a multi-disciplinary and cross-scalar horizon where forces converge: resulting from three convergences at the turn of the 21st century: the ecological with the economic, the social with the political, the organic with the technological. Here, the horizontal nature of the field of landscape avoids disciplinary cul-de-sacs, rendering irrelevant the historic oppositions between concepts such as city and country, rural and urban, natural and


day
Valley becomes a
bottleneck for muc
energy importation
into the urban cent
at its mouth.
Algonq
Transmi
PENNSYLVANIA
Indian Point
Energy Center 2
Nuclear Units
Proposed Algon-
quin gas transms-
sion connection
Texas Easter Gas
Transmission merges
with Algonquin Gas
Trasnmission.
Oil Seaport, ar
into east coast
refinery and th
dispersion into
system.
urban area
superfund priority site
dam
power line
natural gas pipeline
natural gas pipeline (proposed)
oil refinery/ burning plant
coal burning power plant
Natural Gas power plant
nuclear power reactor
major city
minor city
capital city
railroad
river
country boundary
canal system
interstate highway
park / refuge
subterranean aqueduct
state boundary lines

Ecologic Zoning
Aerial view of Donau-Auen wetlands bordering the Danube, a riparian system that protects Wien's City Centre, the Vienna International Airport, the Schwechat vineyards from the perennial risk of 1 to 7-metre flood levels. Image: ©2011 DigitalGlobe, ©2011 GeoEye

human, modern and historic. By employing a wider view, we can expose how the landscape of urbanism lies beyond the grey matter of cities, operating dynamically across several overlapping regions. This vantage opens a wider and deeper view of urban economies and urban footprints. Resource flows from across watersheds, energy demands and food provision from continental sources index the greater extents of urbanization.

When viewed over time, this super-urban vantage sheds light on the interconnections of infrastructure, spatially and temporally. Largely perceived as smooth, seamless and permanent, infrastructure networks are, in fact, extremely fragile and short-lived. Spatial conventions that are borne from the techno-bureaucratic factions of public works departments (waste, water, energy, food and transport agencies) and inherited from classical, Old World notions of civil engineering or from the sociopolitical mechanisms of legislative zoning and master-planning inherited from military ideologies and wartime strategies are deliberately put into question.

So far, in the discourse of urban reform, considerable attention has been given to the hard systems of urban support such as roads, sewers and bridges, evident in national investment policies[52] and private investment in waste treatment and water delivery systems. A parallel discourse has emerged in design, planning and engineering on the value of softer, leaner infrastructures premised on ecology as the catalyst of infrastructural reform and the driver of urban morphology.[53] In the wake of ongoing restructuring of city centers towards more decentralized and dispersed spatial patterns, cultural thinker and theorist Sanford Kwinter projects that "we have no choice today but to deal with the new "soft" infrastructures: of knowledge infrastructure, program infrastructure, cultural infrastructure, virtual infrastructure."[54]

Risk & Complexity

Often operating on extraordinary scales, and precipitated by the onslaught of global urbanization, the basic attributes of urban infrastructure and large scale public works (roads, canal, bridges, dams for example) conjure a sense of plain and simple awe.[55] By virtue of its bigness alone as urbanist Rem Koolhaas observes, infrastructure "instigates a regime of complexity" that mobilizes the full intelligence of design, less dependent on "meticulous definition, the imposition of limits, but about expanding notions, denying boundaries."[56] Pragmatically, the field of landscape - both cross-collaborative and trans-scalar - provides the instrumental equipment to best handle the complexity precipitated by contemporary urbanization.

In the high-risk technological landscape of the 21st century however, it is ironically the unassuming attribute of dumbness - the relative ease of understanding and interpreting a strategy - which serves as design's greatest asset in its accouplement with infrastructure.[57] If civil engineering has worked in the past, it has achieved its status by simplicity and straightforwardness.. In the current reallocation of public sector work to the private sector market and more collaborative forms of project delivery, the advantage that infrastructure affords, both as a construction and as a concept, is that it further transcends the conventional boundaries associated with public works and private properties by referring to underlying conditions and challenges that are specific and common to both.

This is the greatest service that infrastructure promises as an emergent design territory. Yet, in order to do so, design must be more opportunistic in its borrowings from predominant disciplines, and leverage disciplinary knowledge outside the formal limits of its own capacities while engaging more synergistic collaborations.[58] Identified over a decade ago by Gray L. Strang in a special edition of *Places Magazine*, the advantage of appropriating infrastructure

Farmland & Power
The first commercial scale public utility wind field in Michigan built by John Deere Renewables on land leased from cooperative sugar beet farmers near Bad Axe.
Source: Don Coles, Great Lakes Aerial Photography, 2008.

as landscape is heightened since:

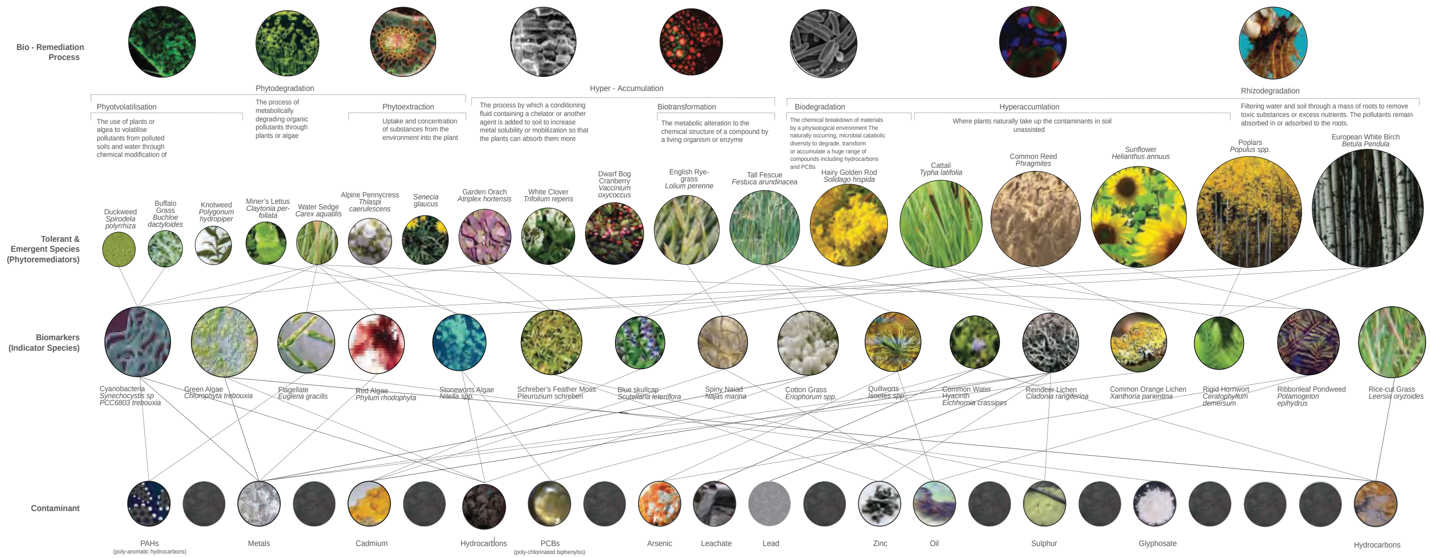
The amount of funding for renovating public infrastructure is likely to far exceed the amount that will be available for buildings, parks and open space. Large budgets can be used to produce urban design that simultaneously solve utilitarian problems, and help repair cities and regional landscapes at a scale not dreamed of since the days of the great dams.[59]

Circular Economies & Resource Flows
Underlying this latent potential is the horizontal nature of landscape both as scale and system. The synthetic capacities of landscape conflates both infrastructure and ecological process, anabling the reclamation of formerly abandoned sites with the intensification of new ones. As a scale, the field moves from the bio-molecular to the global geographic, by way of urban, ecological regions. It operates across the disciplines of engineering at the smallest level to policy planning at the highest level. As a system,[60] the scale of landscape is operationalized though ecological intelligence. In contrast to closed, industrial systems of production from economies of mass production, it is as an open system of exogenous and indogenous flows. Like an operation system, its software and hardware come in the form of points, patches or planes of interventions or as networks and zones of influence, sometimes fluid, temporal, or sometimes fragmented. Surfaces of intervention are often unconstrained, climate works as a conditioner rather than a constraint. At its extreme, the field of landscape can potentially be subversive, where aesthetics are embedded through patterns and processes of latent biodynamics. Through connections, expansions, contractions and projections, urban conditions become synonymous with constructed ecologies. Wastes and excesses, the surpluses of urbanization, become absorbed into a re-circulating economy of secondary and tertiary materials, through downcycling and upcycling.

From this horizon, we can begin to see how the processes of urban agglomeration and decentralization work as strategies of distribution and dispersal in response to the legacy of Old World models of urban centrality that failed to adapt to the rising demands of contemporary population pressures, modes of production, communication networks, and biophysical systems. The vertical growth that characterized much of the 19th and 20th centuries is being eroded by the horizontal nature of income and population distribution across larger areas, and the inefficiencies and inequalities often associated with compact, exclusive, or unaffordable city centers. Here, the processes of decentralization - whether by strategies of distribution or dispersal[61] - provide capabilities and opportunities to open a new territory of morphologies where patterns and processes drive new morphologies in the future.[62]

Landscape as Infrastructure
Emerging from these ecological imperatives and economic exigencies, the project of landscape infrastructure proposes an expanded operating system for contemporary cities where the full complexity of biodynamic processes and resources are visualized and deployed across the full footprint of urbanism and the lifecycles of infrastructure. As a theoretical evolution of the reformist discipline of landscape architecture at the beginning of the 20th century, landscape infrastructure engages the full capacity of post-Euclidean planning and global contextualism of capital flow while exploiting the techno-spatial capacity of 21st century civil engineering in order to deploy ecology as the agent of urban renewal and expansion. Departing from conventional bureaucratic and centralized forms of civic administration, this contemporary formulation foreshadows a more flexible, cooperative and process-driven agency for the design disciplines with a co-commitment to the metrics of design, research

Bioindication
Relational diagram of contaminant-sensitive plant species as vegetal indices of bioavailability and hyperaccumulation.
Source: OPSYS, 2011



and implementation. From this position, design strategies can be launched between two extremes: short, immediate interventions that are graduated and sequenced over long periods of time with large, durable geopolitical and ecological effects. Design - including the research that precedes it - becomes strategic, capable of integrating multiple scales of intervention at once.

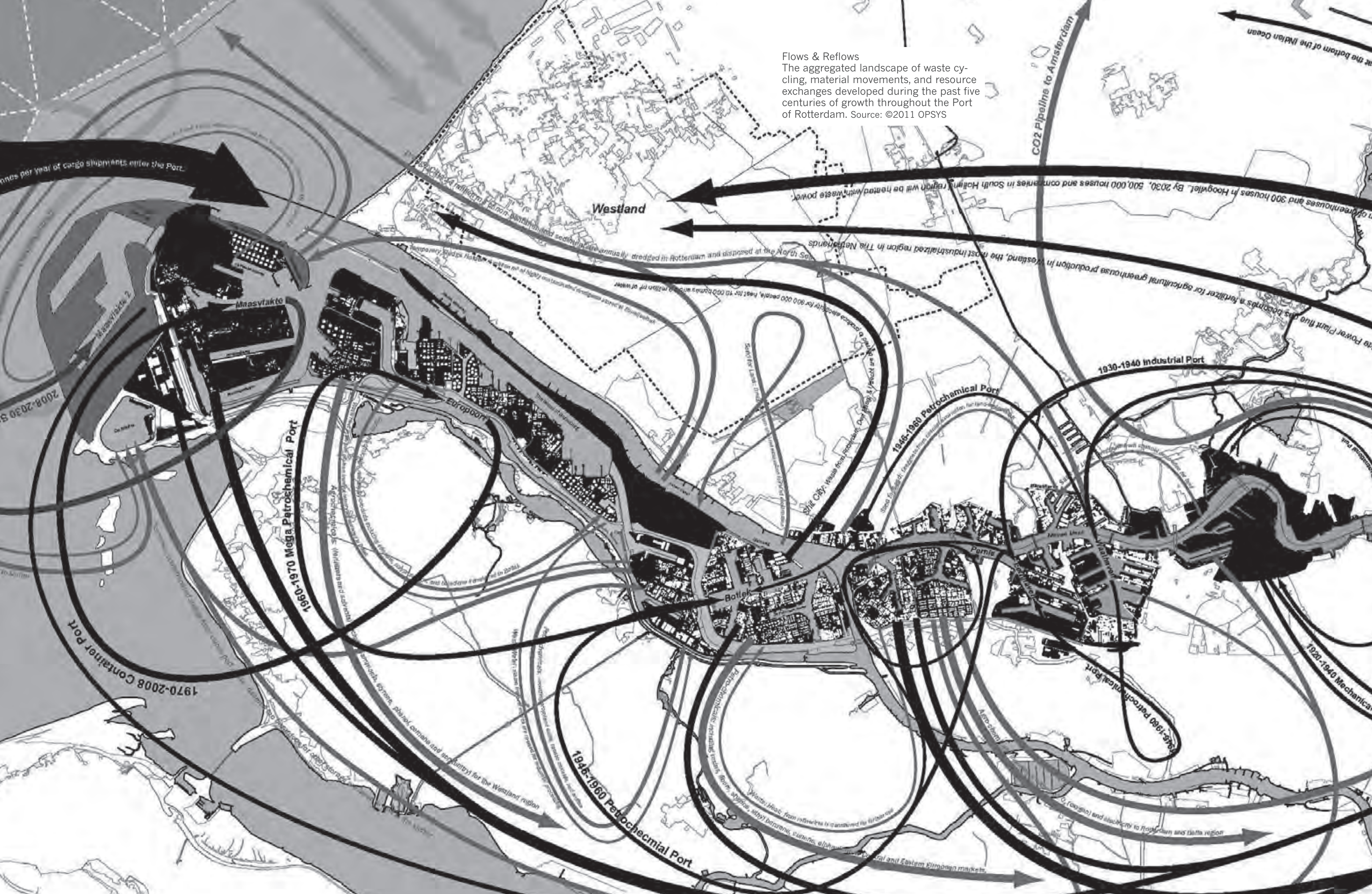
Still relatively nascent, the field of landscape supports a multitude of possibilities and protocols of engagement with this project. Despite the death-of-distance thesis foreshadowed in the late 1990s by globalization and communication networks,[63] the landscape of geography, ecology and urbanism figures more prominently today than ever before. Professionally and culturally, the recognition of landscape's directive capabilities in contemporary design culture is growing, especially with the rapidly growing understanding of ecological complexity worldwide.64 When considered outside the confines of disciplinary professionalization, a wider, more open-ended and diversified understanding of the field will liberate it from its past dependencies and borrowings on the architecture and urban planning disciplines as surrogates for its own history and evolution. If we consider infrastructure as a constructed landscape of channels, pipes, grids and networks that extend across vast territories and that precondition urban life, then we can borrow from several disciplines - urban geography, civil engineering, public administration, botany, horticulture – and combine that knowledge with biophysical resources to form the essential services of urban regions and construct new histories and new lineages. In this way, landscape becomes a beta-structure of processes, an instrumental pattern that shapes the urban world in which we live while enabling us to perceive it differently.

Indexing Ecology

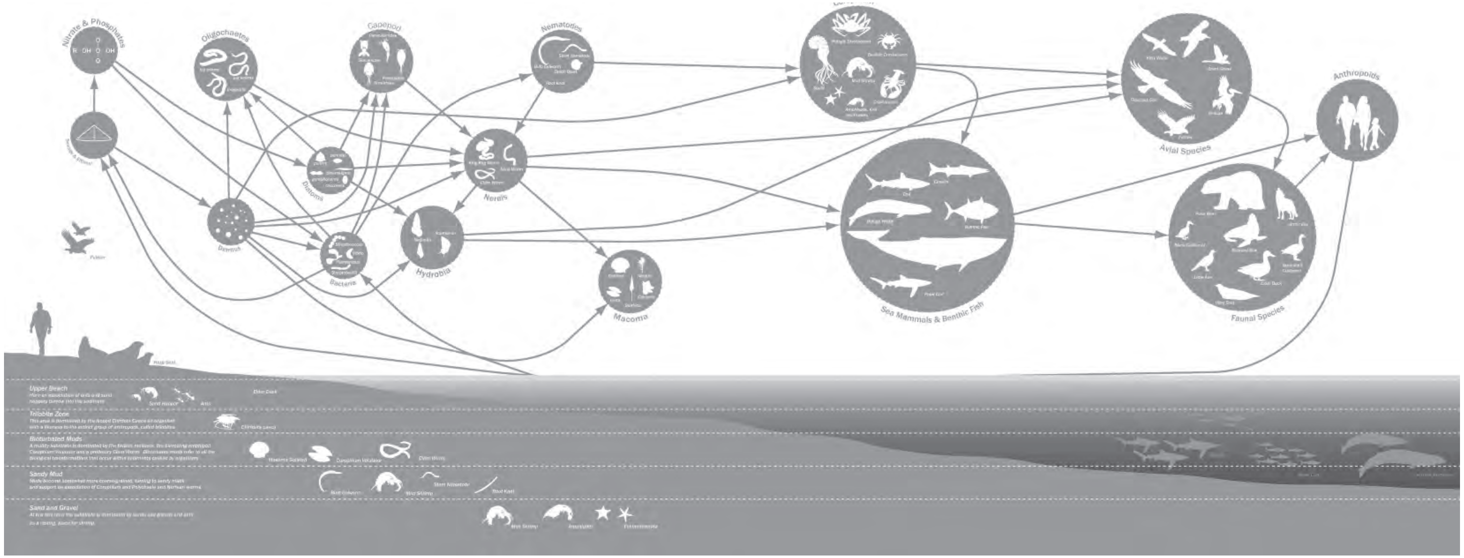
Rendering visible the living systems that underlie urban economies is a critical practice. As a projective method, representation through the mapping of complex levels of information is instrumental to the design of infrastructure and ecology. Whether by diagrams or maps, composite imaging provides an important alternative to the conventional orthographic methods of visualization inherited from engineers and architects. Those methods were intended exclusively as construction documents - blueprints that privileged drawings as contracts for the production of legal information through representation. Conversely, a recent body of work has begun to rethink the historic or exclusive role of the drawing as contractual document to consider drawings of disclosure and public communication.[65] In the public works realm, the visual communication of strategies, and the research that supports it, has become, in and of itself, an essential design practice.

The visibility of flows, processes and systems underlies much of the work to be done especially when displaying vast movements of information and people or managing huge volumes of natural resources that are often operating in remote or underground environments or at scales too large for the naked eye. New, multimedia modes of representation are seeking to redefine the conventions of design historically rooted in technical drafting or pictorial imaging. Architectural historian and theorist Kenneth Frampton reveals the purpose of this expanded representational role:

> "At broad scales, the creative use of landscape representation to project alternative futures for urban form, infrastructure investment, ecological restoration and environmental management can be a powerful counter to the technocratic dominance of other forms of knowledge. The understanding of the particularity and distinction of



Flows & Reflows
The aggregated landscape of waste cycling, material movements, and resource exchanges developed during the past five centuries of growth throughout the Port of Rotterdam. Source: ©2011 OPSYS



Food Web
Diagram of shoreline gradients, land use relationships, biodiversities & feeding patterns of aquatic species in estuaries, at the base of marine ecosystems. Source: ©2011 OPSYS

> local and regional landscapes can provide a point of resistance to the homogenizing effects of globalization."[66]

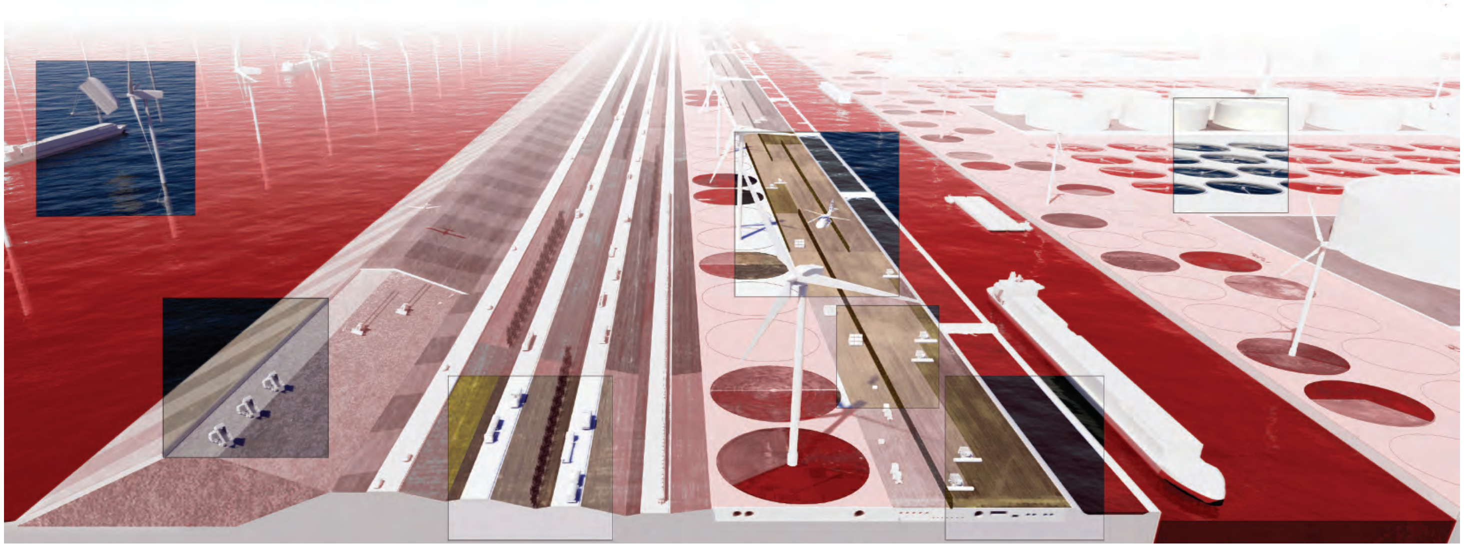
For example, the rise of master planning during the era of the City Beautiful Movement led to the domination of single, orthographic points of view that often excluded context and time. Constrained by a limited repertoire of design instruments (streets, blocks and buildings) these historically imposed limits on design overlooked powerful ecological flows and geographic patterns operating at large scales that cut across property boundaries. In contrast to the specificity of planometric forms of representation, the section provides a much more flexible means of communication, prototyping change across a large scale. The section, with all of its attendant variations (cutaways, developed, expanded and longitudinal), acts as a graphic interface between the surface and subsurface. It simultaneously reveals the invisibility of what is below ground or underwater, and translates what is downstream and what is upstream. For these reasons, sectional strategies have become the privileged interface between the complexity of the subsurface below (soils, foundations, wires, conduits, tunnels, pipelines) and the banality of the surface above (curbs, edges, surfaces, manholes, posts, grates, markings). Small and often minuscule changes of surface profiles in cross-section, can have pronounced effects across vast distances when seen from above. Dynamic conditions that were most often characterized as constraints, are now being projected as major opportunities, especially when laid out across time. Therefore, it is not surprising that hybrid formats of design - from sectional profiles to oblique aerial views to cutaway sections - have liberated the field from the stronghold of orthographic drawings and engage the design of relationships, associations and synergies across a multitude of sites. Foreshadowed by James Corner, mapping itself takes on a double agency as process and projection:

> "Mappings have agency because of the double-sided characteristic of all maps. First, their surfaces are directly analogous to actual ground conditions; as horizontal planes, they record the surface of the earth as direct impressions. [...] By contrast, the other side of this analogous characteristic is the inevitable abstractness of maps, the result of selection, omission, isolation, distance and codification."[67]

Through visualization and intervention, contemporary practice will rely on both the design and designation of new territories. The collaborative and interdisciplinary process of mapping becomes the program of the project, making it relatively fast and easy to think big. Modes of representation - such as design scenarios, section profiles and construction sequences - that enable a level of precise approximation and strategic generalization, can exploit situations of uncertainty and indeterminacy, collaboration and leadership. Time becomes, in and of itself, a medium, and time zones instrumental to the orchestration of large scale effects through simple interventions. Operating on prolonged time scales, the vegetal dimension of design - encompassing the horticultural, the botanical, the silvicultural, the fluvial, the agronomic - can then be integrated as organic infrastructure at scales that were previously undervalued and overlooked.

Fluid, Biotic, Contingent

Once the sole purview of the profession of civil engineering, infrastructure—the management of water, waste, food, transport and energy—is taking on extreme relevance for the design practices in the context of the changing, decentralizing structures of urban-regional economies. Food production and energy networks can no longer be engineered without considering the cascade of waste streams and the cycling of raw material inputs. Industries,



Post-Fordist Flexibility
Cross-sectional strategy showing the dualization of surface land uses and subsurface infrastructures proposed for the intensification of industrial corridors throughout the network of portlands in Rotterdam. Source: ©2011 OPSYS

>
Intelligent Flooding
Upswelling of the Danube River along the edges of the Donau-Insel, a flood protection island that deflects and distributes high water away from the historic centre of Vienna and transportation crossings, towards the National Parklands downriver. Photo courtesy of Wolfgang H. Wögerer, Wien, 2009

landfills, land farms, and logistics areas can no longer be designed without their wastesheds. Highway networks, sewage systems, and subdivisions can no longer be planned without their watersheds. Simply put, urban regions cannot shrink or expand without employing the geographies and climates of continental landscapes that eventually shape them. Designation of territories, zones of intervention, and modes of organization become design processes that eventually lead to the formation of new spatial morphologies and performative ecologies.

Over time, we can engage infrastructure as a landscape with strategic interventions that span extremely short and immediate intervals, sliding across different scales. At the exact moment construction ends, when blueprints are implemented, the penultimate objective of design management can begin. More often than not, design should be under-detailed leaving raw, open and often incomplete the assembly for unknown site circumstances and social change, where the beauty of the project lies in its banality and openness to change. As a medium, time becomes a dimension of design management and superintendence that is slow but enduring.

Design becomes telescopic, sliding across different scales, systems and strategies that are no longer defined by professional or political boundaries but rather by trans-disciplinary, trans-boundary collaborations. In contraposition to the hard, fixed infrastructures, this interpretation provides the room for the design of softer, looser ecological systems, with a concentration on the effects at macro and micro levels. Borne from performance and productivity, newly recognizable morphologies and topologies of the infrastructural landscape - meshes, webs, nodes, conduits, gardens and fields - are most often hybrids of invariable types molded by additional processes of flow, trade, exchange, conveyance, mobility and communications. Through this lens, we can begin opening a territory of new scales, systems, and synergies, upstream or downstream across the gradient of urban economies.

Invoking the unfinished project of landscape[68] as a geospatial and geobotanical practice with the softer, more fluid field of ecological systems pioneered by Sauer, Odum, and Bailey[68], the double-entendre of the landscape infrastructure project maintains an operative, polyfunctional objective dedicated to urban contraction and expansion through land use dualization and biophysical dynamics. Sponsoring transboundary cross-over, this nascent field implies a dual identity for single-use infrastructure along corridors of movement, where a synthesis of ecology preconditions the detail of implementation, where long term resource management is as important as the short term mobilization of capital, and where the commonwealth of public systems presides over the uncoordinated guise of self-interests, requiring the sustained engagement from public and private motives. Transcending jurisdictional boundaries, the integrative and horizontal enterprise of landscape infrastructure enlists geographic zoning, boundary realignments, strategic design, subsurface programming, sectional thickening and ecological engineering as some of the most influential mechanisms in the structural transformation of urban regions to effect change on the large scale operational and logistical aspects of urbanization. Staging uncertainty and harnessing contingency become the new urban imperatives, through the design of resilient and flexible edges, margins and peripheries.

From this position, this augmented capability condition explains the establishment of a more precise approach to the field of complex data without sacrificing the generalized levels of interpretation and reuse of the work. It further enforces a level of general approximation that defies the current convention of basing precise measures on undefined information, or the "institutionalized black boxing of models".[70] In the most extreme circumstances, the field of

landscape demonstrates its agility as le plan libre par excellence.[71]

Post-Carbon Public Works

Embodied by projects such as the Works Progress Administration (WPA) and other programs of FDR's New Deal – a historic period that defined US history through its infrastructural undertakings, the era of national public works is over. The great public works have defined the identity of America, or any great nation, are crumbling. Perpetuated by the discipline of civil engineering, national infrastructure projects are unrealistic, fading away in the background of increasing ecological complexity. The perceived promise of security and stability of centralized infrastructure, and its affiliation to notions of permanence and vertical growth, no longer provide the foundation for the more horizontal, distributed urban economies.[72]

The construction of urban ecologies and reclamation of biophysical processes provides much greater flexibility and adaptive potential. In the wake of this loosening grip of engineering and the weaker position of planning, the estimated $5.5 trillion project of urban renewal in North America, which will see the reconstruction of more than 200 billion square feet of space, as well as the defense of more than 2.5 billion people living within coastal zones presents an unprecedented opportunity. If we are to mold the future, beyond a few exceptional precedents, this project will involve the merger of the landscape of living systems and the territory of urban infrastructure, as interface to the contemporary conditions.

By design, the project of landscape infrastructure will be contingent on several processes and practices across an expanded "plane of services and performances":[73]

1. Flexibilities.
The division between land use classifications (residential, commercial, industrial) and characteristics (wet/dry, high/low), will have to make way for overlaps,

interconnections, and exchanges. Flexible, more porous formats of construction, design and maintenance that privilege ecological systems will enable tidal fluctuation, moisture variations, climactic regimes, bio-diversity and social functions to flourish and grow.

2. Synergies.
The dismantling and decoupling of bureaucratic land use controls and the decentralization of engineered infrastructure must make way for straightforward and practical reclamation of biophysical processes and reintegration of ecological flows. To generate multi-functionality and inter-operability, design scenarios will have to combine hardware and software to expand the effects, spin-offs and offsets of strategies. Moving beyond carbon dependence, we can begin to see buildings become batteries, highways as rolling warehouses, landfills as goldmines, suburbs as stormwater sponges, forests as carbon sinks, city coastlines as estuarine aprons. Requiring suppleness, infrastructural ecologies must employ existing capabilities and existing resources to be easily implementable and replicable.[74]

3. Cross-Collaborations.
While no single discipline or designer can lay claim to the design of infrastructure in the future, its complexity alone generates the potential of interdisciplinary partnerships and cultural cross-fertilization. Synergistic reasoning, strategic design and integrated social agency will loosen boundaries between public and private jurisdictions and open new possibilities for strategic project partnerships. Focusing on the synthesis of ecology, engineering and economy, complex

1650 — **Coal saves wood**
With the cost of firewood 8 times more than a century ago, and a supply of coal five times greater than the entire world, the British Empire pushes ahead a great coal-powered transformation of its towns into industrial cities.

1660 — **Sulfur into Static**

1670 — **Hydrogen & Hot Rocks**

1680 — **Steam Jet**

1690 — **Steam Power**

1700 — **Coal, Coke & Charcoal**

1710 — **Whale Power**
Off the coast of Nantucket, a sperm whale is harpooned for the first time, yielding far greater oil content, at 65 to 80 barrels.

1720 — **Tin & Steel**

1730 — **Mass-Industrialization**

1740 — **American Coal**
Virginia is the site of massive deposits of coal, for the next two centuries.

1750

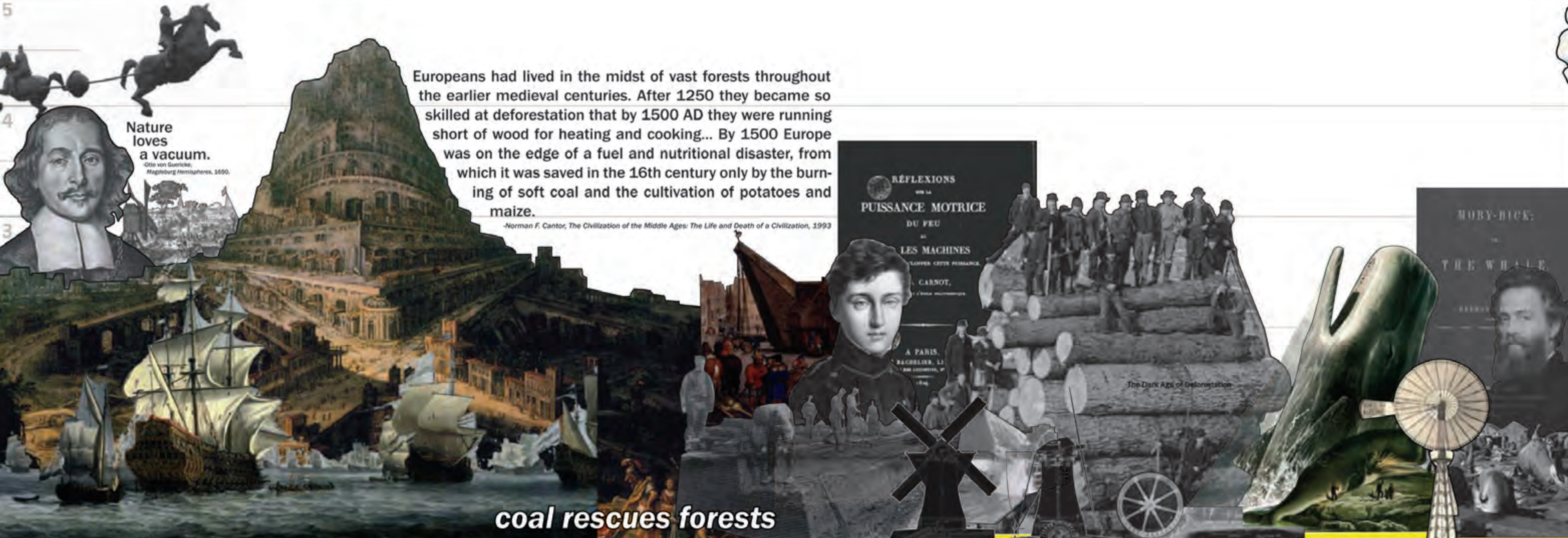
1760 — **Staples & Slaves**
Off the shore of Newport, commercial whale fishing takes off establishing global colonial trade between Europe, the Americas, the African regions, the Azores and the Canary Islands.

1770

1780

Food Fights

Time Scale: visual timeline of milestones in world energy during the past five hundred years as a result of technological innovation, world politics, energy resource substitution and decentralized power sources. How we map, model, and measure the landscape of energy for example, reveals an infrastructural ecology of urban complexities, conflicts, and contradictions through resource regions, economic regimes, commodity exchanges, social differentials and occupational patterns.
Diagram: ©2011 OPSYS



Europeans had lived in the midst of vast forests throughout the earlier medieval centuries. After 1250 they became so skilled at deforestation that by 1500 AD they were running short of wood for heating and cooking... By 1500 Europe was on the edge of a fuel and nutritional disaster, from which it was saved in the 16th century only by the burning of soft coal and the cultivation of potatoes and maize.

-Norman F. Cantor, The Civilization of the Middle Ages: The Life and Death of a Civilization, 1993

coal rescues forests

1439 Foot Power
The Great Crane, a Medieval European construction from the 14th century used in Bruges to lift wine barrels from a barge, the precursor of modern gantry cranes.

1824 Child of Thermodynamics
In his *Reflections on the Motive Power of Fire*, French physicist and military engineer Nicolas Carnot gives the first successful theoretical account of heat engines laying the foundations of the second law of thermodynamics.

1850-70 Peak Logging
Logging operations peak in North America, only 1300 years after the Roman empire fell from its own deforestation.

1850 Peak Whaling
Whale hunting operations peak globally.

1851 Th
Herman

1857 Bu
With the
by Mich
most so
ket.

1750

1760 **Staples & Slaves** Off the shore of Newport, commercial whale fishing takes off establishing global colonial trade between Europe, the Americas, the African regions, the Azores and the Canary Islands.

1770

1780

1790

1800 **Geo-Imperialism** The first large scale geological map published in the world catapulted Britain to the zenith of coal and gas mining.

1810 **Illumination** The first city in the world, Freiberg in Germany, lights up 51,000 houses with gas burners while Baltimore starts up its own coal gas plant for street illumination.

1820 **Out of Oil, Whale Oil** The price of oil peaks as whale populations begin to dwindle, the internal combustion engine gains momentum.

1830 **Electrocution** While others still toy with hydrogen as a fuel cell, Faraday discovers the basic principleof the electric dynamo leading him in generating constant electrical currents.

1840 **Animal Sentinels** Canaries become commonly used as gauges of oxygen levels in for coal miners in semi-atrophic underground shafts.

1850 **Carbs** Hydrocarbon fuels surpass whale oil as a fuel source for lighting.

1860 **1870 Peak Whaling** Final voyages are made for most commercial whale hunting, while Pennsylvania sees a state wide boom.

1870 **Combustion** First gasoline powered internal combustion engine.

1880 **Grids** By 18…

Energy Wars

HOLLAND'S FUTURE IN WORLD'S TRADE

It Occupies a Strategic Position as the Gateway to Central Europe.

IMPORTANCE OF ROTTERDAM

Equipped with Up-to-Date Machinery for the Speedy Discharge of Cargoes.

The place of the Netherlands in future international trade is the subject of a report by R. G. Dun & Co's. manager there. Its convenient situation at the very gateway of Central Europe and its network of canals and inland waterways gives the nation a foremost position in the maritime commerce in which it has been for centuries one of the leaders. There have been times when of necessity the import of bulk cargoes, such as grain, ore and coal at Rotterdam, the centre …

The fuel of the future is go… to come from fruit like that… mach out by the road, or fr… apples, weeds, sawdust –… most anything. There is fue… every vegetable matter th… can be fermented. Ther… enough alcohol on one's y… yield of an acre of potatoes… drive the machinery necess… to cultivate the field for a h… dred years. *Henry Ford, 1925*

The Jevons' Paradox

"Technological progress that increases the efficiency with which a resource is used, tends to increase (rather than decrease) the rate of consumption of that resource".

- William Stanley Jevons, *The Coal Question*, 1865.

1850 Peak Whaling
Whale hunting operations peak globally.

1851 The Last Whale
Herman Melville writes MobyDick

1857 Burner
With the invention of the kerosene burner by Michael Dietz, kerosene becomes the most sought-after illuminant on the market.

1882 Water Power
First hydroelectric station opens (Wisconsin, USA).

1845 Joule's Apparatus
In studying the nature of heat, James Prescott Joule develops the theory of conservation, leading to the first principle of thermodynamics.

1869 Chemistry as Modernity
Dmitri Mendeleev develops the periodic table of the elements during the time he was engaged in writing the first edition of a chemistry textbook, 'Osnovy Khimii' (*Principles of Chemistry*).

1846 Canadian Kerosene
Physicist and geologist, Abraham Gesner, invents kerosene, a liquid fuel refined from coal and later from asphaltic oil. By accident, Gesner becomes the founder of the modern petroleum industry as we know it today.

1853
Crude oil first distilled into kerosene by Ignacy Lukasiewicz, a Polish scientist, who amassed a fortune by developing commercial oil production and refineries in Eastern Europe.

1885
Karl Benz builds the first practical car.

1869 The Modernity of Chemistry
Dmitri Mendeleev publishes the first version of the periodic table of elements.

1876 Farming Wind
Griffiths Bros. & Co of Australia are credited with making the first commercial windmills.

1832 Dynamo
Michael Faraday introduces the conversion of the energy from a spinning magnet into electricity - the basis for hydro-electric power.

1877 Oil Baron
Rockefeller-owned Standard Oil controls 90% of oil refining in the United States of America.

1889 Windmill Wizard
Charles F. Brush arc light and windmills Charles F. Brush, of Cleveland Ohio, built what is today believed to be the first automatically operating wind turbine

1893 Hydro One
First dam designed solely for hydroelectric power built across Colorado River.

1869 Eurasia
The Suez Canal is completed, connecting the Mediterranean Sea to the Indian Ocean.

1891 Solar Water Heater
The world's first commercial solar water heater is invented in by Clarence Kemp.

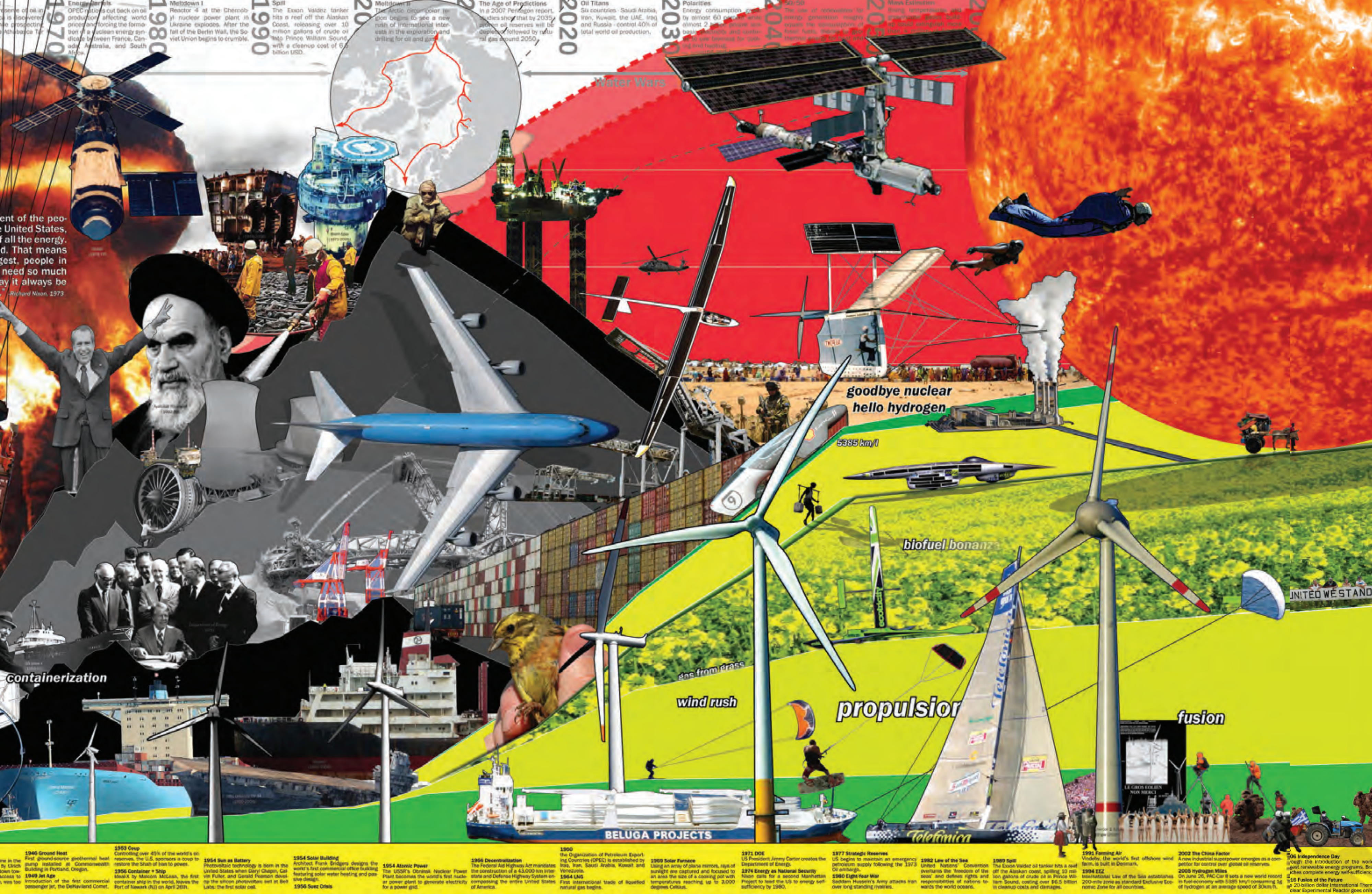
1895
The first prediction of global warming from the combustion of fossil fuels is made by Swedish chemist Svante August Arrhenius.

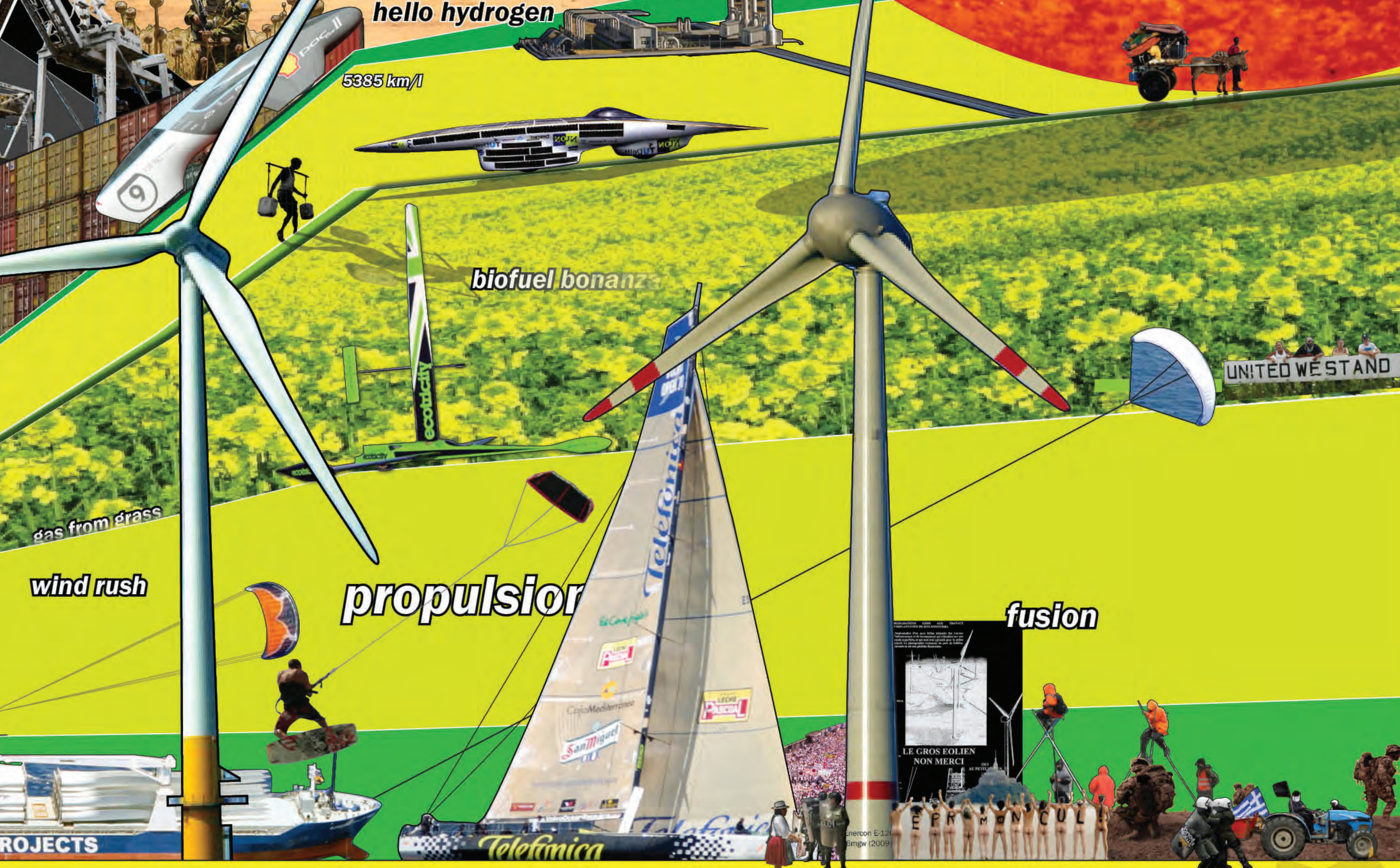
1898 Madame Radium
Marie Curie discovers the radioactive elements radium and polonium.

1896
First offshore oil production in history occurs from a 300m wooden pier off the shore of Summerland, California

1905 e=mc²
Albert Einstein publishe… photoelectric effect, alo… theory of relativity.

1908 The Danish Edison
Poul la Cour's experime… tricity at the Askov Folk H…


1970
Energy Cartels
OPEC nations cut back on oil production, affecting world prices and forcing the formation of a nuclear energy syndicate between France, Canada, Australia, and South Africa.
1980
Meltdown I
Reactor 4 at the Chernobyl nuclear power plant in Ukraine explodes. After the fall of the Berlin Wall, the Soviet Union begins to crumble.
1990
Spill
The Exxon Valdez tanker hits a reef off the Alaskan Coast, releasing over 10 million gallons of crude oil into Prince William Sound, with a cleanup cost of 6.5 billion USD.
Meltdown II
The Arctic circumpolar region begins to see a new rush of international interests in the exploration and drilling for oil and gas.
The Age of Predictions
In a 2007 Pentagon report, studies show that by 2035 proven oil reserves will be depleted, followed by natural gas around 2050.
2020
Oil Titans
Six countries - Saudi Arabia, Iran, Kuwait, the UAE, Iraq and Russia - control 40% of total world oil production.
2030
Polarities
Energy consumption grows by almost 60 percent while almost 2 billion people ...
2040
50/50
Mass Extinction
Water Wars
ent of the peo-
United States,
f all the energy.
d. That means
gest, people in
need so much
ay it always be
Richard Nixon, 1973
goodbye nuclear
hello hydrogen
5385 km/l
biofuel bonanza
UNITED WE STAND
containerization
gas from grass
wind rush
propulsion
fusion
LE GROS EOLIEN NON MERCI
BELUGA PROJECTS
Telefónica
1946 Ground Heat
First ground-source geothermal heat pump installed at Commonwealth Building in Portland, Oregon.
1949 Jet Age
Introduction of the first commercial passenger jet, the DeHaviland Comet.
1953 Coup
Controlling over 45% of the world's oil reserves, the U.S. sponsors a coup to restore the Shah of Iran to power.
1956 Container + Ship
Ideal-X by Malcom McLean, the first container ship in the world, leaves the Port of Newark (NJ) on April 26th.
1954 Sun as Battery
Photovoltaic technology is born in the United States when Daryl Chapin, Calvin Fuller, and Gerald Pearson develop the silicon photovoltaic cell at Bell Labs: the first solar cell.
1954 Solar Building
Architect Frank Bridgers designs the world's first commercial office building featuring solar water heating and passive design.
1956 Suez Crisis
1954 Atomic Power
The USSR's Obninsk Nuclear Power Plant becomes the world's first nuclear power plant to generate electricity for a power grid.
1956 Decentralization
The Federal Aid Highway Act mandates the construction of a 41,000 km interstate and Defense Highway System encompassing the entire United States of America.
1960
the Organization of Petroleum Exporting Countries (OPEC) is established by Iraq, Iran, Saudi Arabia, Kuwait and Venezuela.
1964 LNG
First international trade of liquefied natural gas begins.
1969 Solar Furnace
Using an array of plane mirrors, rays of sunlight are captured and focused to an area the size of a cooking pot with temperatures reaching up to 3,000 degrees Celsius.
1971 DOE
US President Jimmy Carter creates the Department of Energy.
1974 Energy as National Security
Nixon calls for a second Manhattan Project to lead the US to energy self-sufficiency by 1980.
1977 Strategic Reserves
US begins to maintain an emergency petroleum supply following the 1973 Oil embargo.
1980 Eight-Year War
Saddam Hussein's Army attacks Iran over long standing rivalries.
1982 Law of the Sea
United Nations' Convention overturns the 'freedom of the seas' and defines rights and responsibilities of nations towards the world oceans.
1989 Spill
The Exxon Valdez oil tanker hits a reef off the Alaskan coast, spilling 10 million gallons of crude oil in Prince William Sound, costing over $6.5 billion in cleanup costs and damages.
1991 Farming Air
Vindeby, the world's first offshore wind farm, is built in Denmark.
1994 EEZ
International Law of the Sea establishes 200-mile zone as standard Exclusive Economic Zone for all countries.
2002 The China Factor
A new industrial superpower emerges as a competitor for control over global oil reserves.
2005 Hydrogen Miles
On June 26, PAC-Car II sets a new world record in fuel-economy with 5385 km/l consuming 1g of hydrogen at an average speed of 30km/h.
06 Independence Day
ough the introduction of the wor
gest renewable energy programs, Bra
ches complete energy self-sufficienc
16 Fusion of the Future
20-billion dollar International Therm
clear Experimental Reactor goes onli



9 Solar Furnace
g an array of plane mirrors, rays of

1971 DOE
US President Jimmy Carter creates the Department of Energy.

1977 Strategic Reserves
US begins to maintain an emergency petroleum supply following the 1973 Oil embargo.

1982 Law of the Sea
United Nations' Convention

1989 Spill
The Exxon Valdez oil tanker hits a reef

1991 Farming Air
Vindeby, the world's first offshore wind farm, is built in Denmark.

2002 The China Factor
A new industrial superpower emerges as a competitor for control over global oil reserves.

2006 Independence Day
Through the introduction of the world's largest renewable energy programs, Brazil reaches complete energy self-sufficiency.

Post-Carbon Resource Park: view of the Svartsengi Geothermal Power Station in southwestern Iceland where geothermal effluents are re-circulated through a public health spa and wastewater lagoon, rich in blue-green algae, mineral salts and fine silica muds. Source: ©2009 Stephen Bunch

responsibilities are spread out and risks shared across a more lateral network of professional liabilities.

4. Speeds & Scales.
The exchange of resources, materials and information will drive the modification and reprogramming of urban surfaces to accommodate greater auto-mobility and auto-diversity as a result of increasing modes of mobility by way of the separation of different speeds of movements. Surface differentiation, markings and codifications at one end, and infrastructure of mobility will radically transform the built environment in the future.[75] Communication networks and polycentric nodes of knowledge are generating live-work patterns that, in contrast to the centralized 9-to-5 industrial model, are increasingly distributed and dispersed.

5. Distribution & Disaggregation.
Urban densities will persistently decline and regions spread wider as long as incomes increase and transportation remains relatively inexpensive.[76] The slackening of political and regulatory controls will help shape urban expansion, decongestion, fragmentation or diffusion. Through ecological engineering, those processes enable the formation of more hybridized morphologies and new financial mechanisms that join owners, users, stakeholders and regulators, over time.

6. Regionalization.
The dismantling of historical divide between city center and periphery, or the differentiation of cities from other cities, in order to engage the different footprints of urbanism and life cycles of infrastructure, to acknowledge the impermanence and flexibilities of growth, as well as continental forces, beyond the grey zones of cities on road maps. When factoring resource regions & biodynamic flows, infrastructural networks and social innovations, the restructured understanding of economic forms ultimately relies on the reclamation of capital flow as an intrinsically ecological strategy.[77] The visibility of resource urbanism will bring closer the sources of resource extraction with end uses and spaces of consumption.

Ecologies of Scale
In spite of the adolescence of the city building disciplines, the Athenian Oath that has been restraining urban designers for the past two thousand years can finally loosen its grip and make room for new instruments and methods for intervening at geospatial scales, beyond the city and into contemporary urban territories. The linear, fixed, and closed mechanisms of the industrial economy are quickly fading in the background of more flexible, circular and networked systems of urban economies. Releasing the pristine ideals of the city from the crutches of security, permanence or density opens a horizon of new social equities and regional synergies - a whole range of projects beyond that of a few exceptional precedents. Moving beyond conservation or preservation, the ecological imperative instigates the design of relationships, where associations and synergies become infrastructural. Softer, more fluid forms of urban configurations generate open, flexible infrastructures where risk becomes an opportunity, and morphology is based on contingency and indeterminacy of climate fluctuations.

Signaling a critical tipping point, the re-examination of historical practices reveals that the landscape of biological processes and natural resources that are integral to larger, regional systems cannot, and should not be segregated from the discourse or the design of urban

Estuarine Urbanism
The oyster cultivation region of Marennes-Oléron, located off the eastern coast of the Atlantic, in between the estuaries of La Charente and La Seudre River, whose yield accounts for almost 45% of the entire French oyster industry. Data Source: ©2011 GeoEye, ©2011 IGN-France, ©2011 TeleAtlas

infrastructure. To learn how to slide across scales, across disciplines, or across jurisdictions, the metrics, processes and protoecologies presented here offer preliminary examples of how designers can operate across the greatest and fullest extent of design over time: from the largest scales of geography and regions to the engineering and genetics of the smallest size. Through the redesign of infrastructure, our work in the future lies in the re-coupling, re-configuration, and re-calibration of these processes. Urgent and pressing, the project of the ecological readjustment of these systems - where transportation departments collaborate with conservation agencies or, where port authorities partner with fisheries organizations or, where power corporations work with waste recycling organizations - is a necessary corollary to the next generation of post-fordist, post-taylorist infrastructures.

We can posit a more fluid understanding of urbanization formed by new forces and flows such as capital and mobility, speed and communications, power and production, toxicity and ecology, contamination and cultivation, energetics and synergies, war and wealth, societies and networks which can be considered the main drivers and denominators in the design and construction of contemporary urban ecologies operating across different scales, magnitudes, and borders, with regional, continental and global capabilities.

In the wake of the over-planning, over-regulation and over-engineering of the past century, it is clear that the strategic engagement of the landscape of living systems as urban infrastructure is already moving ahead by governments and engineering consultancies worldwide, and being adopted by professional design offices and academic researchers. Either in slums, suburbs or skyscrapers, paradigms are changing: dispersal substitutes density, pace instead of space, sequence over speed, design instead of technology, concurrency over control, culture instead of growth. In short, ecology is urbanism's best insurance policy, landscape is infrastructure's most flexible strategy. For if we don't pay attention to the effects of global change and engage urban networks as constructed ecologies, it is not 'we' who will design the future flows of urbanization, but rather 'they' who will be designing us.

Endnotes

1 In "The Renewal of Landscape" (1931), urban theorist and critic Lewis Mumford recognized early on the foundation role of landscape in the shape of urban economies: "Now there are three main ways of modifying and humanizing the visible landscape. One of them is by agriculture and horticulture; it involves the orderly arrangement of the ploughed field, and the wood lot, the meadow and the pasture, the road and the enclosure. When these functions are undertaken consciously and intelligently, as they were by the country gentlemen of England in the eighteenth century, for example, they lead to landscape design. the second method is by city development and architecture; and the third is by works of engineering-bridges, viaducts, canals, highroads, docks, harbors, dams. These three modes intermingle, and it is impossible to neglect one without spoiling the effect of others. What is a beautiful city with bad drains, or a fine concrete highway in a barren landscape?" See Lewis Mumford, The Brown Decades: A Study of the Arts of America, 1865-1895 (New York, NY: Dover Publications, 1931): 60-61. More recently, the interrelated writings on landscape, infrastructure and ecology by Alan Berger, James Corner, Richard Forman, Chris Reed, Nina-Marie Lister, Eduardo Rico, Kelly Shannon and Charles Waldheim have provided important contributions to this fin-de-siècle discourse.

2. For more information on this crisis, see America in Ruins: The Decaying Infrastructure (Durham: Duke Press Paperbacks, 1983) by Pat Choate and Susan Walter, and Report Card for America's Infrastructure (2009) by the American Society of Civil Engineers, www.infrastructurereportcard.org

3. The capital stock of public US infrastructure is currently between 30 to 40 trillion dollars, an average of 100,000 USD per capita. See James Heintz, Robert Pollin and Heidi Garrett-Peltier, "How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth" (Amherst, MA: Political Economy Research Institute, 2009).

4. On the role of failure and disaster in engineering, see Henry Petroski, To Engineer is Human: The Role of Failure in Successful Design (New York, NY: Vintage Books, 1992).

5. For a longer discussion, see David Harvey, "Flexible Accumulation through Urbanization, Reflections on Post-Modernism in the American City" in Post-Fordism: A Reader edited by Ash Amin (Cambridge, MA: Blackwell, 1994): 361-386.

6. According to the Organisation for Economic Co-operation and Development (OECD), U.S. infrastructure ranks 23rd in the world. See Fareed Zakaria, "Are America's Best Days Behind Us?" Time (March 03, 2011): 28.

7. "Looking beyond the current paradoxical condition of 20th century engineering, it is clear that "there is no "end of engineering" in the sense that it is disappearing. If anything, engineering-like activities are expanding. What is disappearing is engineering as a coherent and independent profession that is defined by well-understood relationships with industrial and other social organizations, with the material world, and with guiding principles such as functionality...Engineering emerged in a world in which its mission was the control of non-human nature and in which that mission was defined by strong institutional authorities. Now it exists in a hybrid world in which there is no longer a clear boundary between autonomous, non-human nature and human generated processes." See Rosalind Williams, Retooling: A Historian Confronts Technological Change (Cambridge, MA: MIT Press, 2003): 31.

8. The re-reading of engineering objectives has naturally followed a concurrent course in the profession of urban planning. This contemporary view is captured by Charles Siegel in his discussion of the legacy of over-planning of the American landscape in Unplanning: Livable Cities and Political Choices (Berkeley, CA: Preservation Institute, 2010).

9. In his Norton Lectures (1938-39), Swiss-trained architectural historian and Harvard Professor Sigfried Giedion observed the proximity of civil engineering to the practice of urban planning dating back to the nineteenth century when "construction was ahead of architecture in expressing, often unconsciously, the true constituent forces of the period. The engineer has often been nearer to future developments than the town planner, who has too frequently been concerned exclusively with the reorganization of the body of the city itself." See Space, Time, and Architecture: The Growth of a New Tradition (Cambridge, MA: Harvard University Press, 1941): 823.

10. Maurie J. Cohen argues that the American environmental lobby, as a loosely associated group of small organizations, failed to gain any significant traction in its causes due to an overwhelming reliance as a strategy of resistance to urban development. See "Ecological Modernization and its Discontents: The American Environmental Movement's Resistance to an Innovation-driven future" in Futures 38 (2006): 528–547.

11. Gary L. Strang , "Infrastructure as Landscape" Places Vol.10 No.3 (Summer 1996): 15.

12. In Space, Time, Architecture (Cambridge, MA: Harvard University Press, 1941), Giedion recognized the significance of this turning point more than a half century ago: "the world has now become aware of the impasse to which we have been led through an emphasis on purely rational thought. We have become conscious of the limits of logic and rationality. We again realize that the principles of form are based on more profound and significant elements than rigid logic. [...] What we have to do in the realm of architecture is to find a method of linking rationality with the organic in such a way that the organic becomes dominant and rationality is reduced to a menial position." (872-873)

13. For example, more than 30% of freshwater is lost in piping systems through conveyance.

14. Wayne Bachis, "Enabling Urban Sprawl: Revisiting The Supreme Court's Seminal Zoning Decision Euclid v. Ambler in The 21st Century" Virginia Journal of Social Policy & the Law Vol. 17:3 (Spring 2010): 373-403.

15. The 2003 blackout in the Northeast demonstrated that most major cities only carry a 2- to 3-day supply of perishable food. See New York City Emergency Response Task Force, "Enhancing New York City's Emergency Preparedness: A Report to Mayor Michael R. Bloomberg" (October 2003). http://www.nyc.gov/html/om/pdf/em_task_force_final_10_28_03.pdf

16. For more on the colonization effect of the engineering project as a form of 'hypermodernism', see Gene Moriarty's chapter, The Engineering Project: Its Nature, Ethics, and Promise (University Park, PA: Pennsylvania State Press, 2008): 85.

17. Positivism entails a scientific belief based on a rational logic and verifiable evidence, and it is closely affiliated with linear forms of Taylorist management and Fordist production. In Beyond Engineering: How Society Shapes Technology (New York: Oxford University Press, 1997), Robert Pool describes the limits of positivistic views inherent to 20th century engineering by explaining how "non technical factors have come to exert an influence that is unprecedented in the history of technology...the past century has seen a dramatic change in Western society, with a resulting in people's attitudes towards technology. As countries have become more prosperous and more secure, their citizens have become less concerned with increasing their material well-being and more considered about such aesthetic considerations as maintaining a clean environment.[...] The result is that the public now exerts a much greater influence on the development of technologies - particularly those seen as risky or otherwise undesirable-than was true one hundred, or even fifty, years ago." (7)

18. Designers must acknowledge the hierarchy associated with the design of urban systems, where the numbers alone provide an indication of the food chain of the disciplines and the prominence of civil engineering. For example, according to the respective associations, professional membership in 2010 included 26,700 Landscape Architects, 38,400 Urban & Regional Planners, 141,000 Architects, 551,000 Construction Managers, and 971,000 Engineers (combining civil, mechanical, industrial, electrical, environmental). See the Bureau of Labor Statistics, Occupational Outlook Handbook, 2010-11 Edition, www.bls.gov/oco/

19. For example, consider one of the earliest texts in the social sciences by Louis Wirth, "Urbanism as a Way of Life" in Cities and Society, edited by Paul K. Hatt and Albert J. Reiss, Jr. (Glencoe, IL: Free Press, 1957): 62-62.

20. The traditional reliance on landmarks and annual reviews of large public works projects as the unifying discourse of the civil engineering discipline has more recently been put into question. In Civil Engineering Practice in the 21st Century: Knowledge and Skills in Design and Management (Reston, VA: ASCE Press, 2001), Neil S. Grigg et al. provide an important direction in disciplinary discourse as they rethink the role of civil engineering in society.

21. Neil S. Grigg et al., 103.

22. Jean-Louis Paucelle, "From Taylorism to Post-Taylorism: Simultaneously Pursuing Several Management Objectives", Journal of Organizational Change Management, Vol. 13 No.5 (2000): 452-467.

23. The turn of the century rise of the design laboratory, a midway point between the factory and the studio, promises considerable potential in the formation of flexible project teams dedicated to specific spatial and ecological challenges. See Peter Galison & Caroline A. Jones, "Factory, Laboratory, Studio: Dispersing Sites of Production" in The Architecture of Science (Cambridge: MIT Press, 1999): 497-540.

24. For a comprehensive critique of the notions of density and compactness in contemporary urban design, see Rafi Segal, "Urbanism Without Density" in Architectural Design AD Vol. 78, No. 1 (Jan.-Feb. 2008): 6-11. Segal provides a thorough discussion of the counterproductive distinction between the urban and the non-urban is thoroughly assessed in favor of degrees, distributions and gradients of urbanization.

25. For a comprehensive rethinking of growth as an economic driver of urbanization and the notion of stability, see Andrea Branzi's "Weak and Diffuse Modernity: The World of Projects at the beginning of the 21st Century" (Milan: Skira, 2006) and Charles Waldheim's "Weak Work: Charles Waldheim, "Weak Work: Andrea Branzi's 'Weak Metropolis' and the Projective Potential of an 'Ecological Urbanism'," edited by Mohsen Mostafavi with Gareth Doherty (Cambridge, MA: Harvard GSD/Lars Müller, 2010), 114-121.

26. See "Dimensions in Global Urban Expansion" in Shlomo Angel with Jason Parent, Daniel L. Civco, and Alejandro M. Blei, The Persistent Decline in Urban Densities: Global and Historical Evidence of 'Sprawl' (Cambridge, MA: Lincoln Institute of Land Policy, 2011).

27. A brief but concise account of engineering's early influence in North America and European antecedents can be found in John Stilgoe's Common Landscape of America, 1580 to 1845 (New Haven, CT: Yale University Press, 1982): 121-128.

28. See Todd Shallat, "The West Point Connection" in Structures in the Stream: Water Science, and the rise of the U.S. Army Corps of Engineers (Austin, TX: University of Texas, 1994): 79-116.

29. We may also attribute the overexertion of civil engineering techniques to concurrent innovations in steel and concrete construction after the Industrial Revolution, evolving rapidly from traditional practices of earthworks and topographic engineering.

30.. For an in-depth critique of the seamlessness of infrastructure, see Paul Edwards, "Infrastructure & Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems" in Modernity and Technology edited by Thomas J. Misa, Philip Brey and Andrew Feenberg (Cambridge, MA: MIT Press, 2003): 185-226.

31. See Allen, Stan. "Infrastructural Urbanism" in Points + Lines: Diagrams for the City (New York, NY: Princeton Architectural Press, 1999): 46-89.

32. See Joel Kotkin, "Urban Legends: Why Suburbs, Not Dense Cities, are the Future" in Foreign Policy (September/October 2010).

33. The events at the First Planning Conference in 1909, with the ensuing conflicts between social reformer Benjamin Clarke Marsh and Frederick Law Olmsted, Jr., provide an important understanding of the waning of architecture's influence and the rise of planning at the beginning of the 20th century. See Stuart Meck and Rebecca C. Retzlaff, "A Familiar Ring: A Retrospective on the First National Conference on City Planning (1909)" Planning & Environmental Law Vol.61 No.4 (April 2009): 3-10.

34. See Raymond Mohl's The Rise of Urban America (Lanham, MD: Rowman & Littlefield, 2006).

35. "Urban population now exceeds rural, more than 51 per cent live in cities and towns, the Census Announces"

The New York Times, January 14, 1921.

36. Between 1880 and 1890, almost 40 percent of the townships in the United States saw a decrease in rural population as a result of urban migration. The National Census revealed that in 1920, half of the country's population lived in cities and suburbs instead of rural areas. See Margo J. Anderson, The American Census: A Social History (New Haven CFT: Yale University Press, 1990) and Ken Ringle, "Unearthing America's Urban Roots; Archive Releases Pivotal 1920 Census" The Washington Post (March 3, 1992).

37. See Norman Johnston, Forms of Constraint: A History of Prison Architecture (Champaign-Urbana, IL: University of Illinois Press, 2000) and Jeremy Bentham's classic "Panopticon" (1787 Letters) in The Panopticon Writings edited by Miran Bozovic (London: Verso, 1995). p. 29-95.

38. Throughout his career, the renowned urban planner C.A. Doxiadis capitalized on the perpetuation of urbanism as a global problem. See "The Universal Urban Crisis" in his study on Detroit and the Great Lakes Megalopolis, Emergence and Growth of an Urban Region, Vol.3: A Concept for Future Development (Detroit, MI: Detroit Edison Co., 1970): 3-8.

39. John Kenneth Galbraith, The New Industrial State (New York: Houghton Mifflin Company, 1967): 388.

40. Richard T. LeGates describes well the scientific origins of city planning in Early Urban Planning, Volume 9 (London, UK: Thoemmes Press, 1935).

41. The profession of urban planning divorced itself from the foundations of geography by retreating into the social sciences. Except for Canada, the mid 20th century also saw the closure of geography departments altogether across North America. The most pronounced example of this was at Harvard University where the geography department closed in the 40s with the attendant rise of urban and regional planning departments, including those at MIT, University of North Carolina, Michigan State University and University of Washington. See Jill Pearlman, Inventing American Modernism: Joseph Hudnut, Walter Gropius, and the Bauhaus Legacy at Harvard (Charlottesville, VA: University of Virginia Press, 2007).

42. Urbanism in North America is often recounted through the discipline of urban planning which stems from the social sciences or from the discipline of urban design rooted architecture. In the context of North America, both of these mainstream lineages overlook the important influence that wartime planning and military engineering has had on the shape of the North American urban landscape.

43. The growth and presence of large regulatory agencies such as the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers are representative examples.

44. Howard W. Odum and Harry Estill Moore, "The Rise and Incidence of American Regionalism" in American Regionalism: A Cultural-Historical Approach to National Integration (New York: Henry Holt & Company, 1938): 5.

45. In Sprawl: A Compact History (Chicago, IL: University of Chicago Press, 2006), Robert Bruegmann discusses at great length the inevitability of sprawl and how efforts to thwart it may be doomed.

46. See Thomas L. Friedman, The World Is Flat: A Brief History of the Twenty- First Century. New York: Farrar, Straus and Giroux, 2005).

47. Bruegmann, 220.

48. In his essay "Irony and Contradiction in an Age of Precision", James Corner discusses the advantages and drawbacks of metrics in design especially when flexibility and risk are involved, in Taking Measure across the American Landscape (New Haven, CT: Yale University Press, 1996): 25-37. See also Robert Pool's discussion on control and collaboration in Beyond Engineering: How Society Shapes Technology (New York: Oxford, 1997): 215-248.

49. Charles Siegel discusses this observation in "The Failures of Planning" and "The Failure of Growth" in his Unplanning: Livable Cities and Political Choices (Berkeley, CA: Preservation Institute, 2010).

50. See Todd Shallat, "Prologue: A Nation Builder" in Structures in the Stream: Water Science, and the Rise of the U.S. Army Corps of Engineers (Austin, TX: University of Texas, 1994): 1-9.

51. This phenomenon is manifest in the rise of the Sun Belt, the Broiler Belt, Washington's Internet Alley, the Great Lakes Region, the California Delta as well as the rise of regional cultural publications such as Garden & Gun, Space Coast, or Highway Star.

52. Economic stimulus plan under the American Recovery and Reinvestment Act by the Obama Administration is comparable to the National Industry Recovery Act of 1933 conceived under Roosevelt after the Great Depression and the Dust Bowl Decade. See The "New New Deal" issue of Time Magazine Vol.172 No.21 (November 24, 2008).

53. The search for formal, spatial orders in design mainly stems from a lopsided understanding of modernization as a state rather than as an ongoing process of transformation that incorporates non-formal logics, most often associated with a more operative view of ecology, with softer morphologies such as flow patterns, organizations and synergies.

54. Sanford Kwinter, Far from Equilibrium: Essays on Technology & Design Culture (Barcelona, Spain: Actar): 39.

55. Rem Koolhaas, "Bigness or the Problem of Large" in S,M,L,XL (New York, NY: Monacelli Press, 1995): 498

56. Rem Koolhaas, "Whatever Happened to Urbanism?" in S,M,L,XL (New York, NY: Monacelli Press, 1995): 969.

57. Key to this understanding is the difference between engineering and design. On one hand, engineering is premised on the notion of 'closed systems', whereby all the scientific aspects that can be controlled are enlisted as part of the scope of work and where all the other variables are externalized. On the other hand, design is a form of synthesis that often revels in complexity when dealing with diffuse, indeterminate, fluctuating processes or dynamics, most often found in biophysical processes, social networks, or urban conditions.

58. The separation of surface and structure is synonymous with the separation of civil engineering from urban design. Alternatively, design can disclose and reveal subsurface conditions, namely through networks of access, vegetal systems and degrees of permeability. Whereby land uses have formerly been laid out in plan, we can begin to design geographic territories in section across vast scales, where minute changes in profile can have significant effect over long distances.

59. Gary L. Strang , "Infrastructure as Landscape" Places Vol.10 No.3 (Summer 1996): 15.

60. Identified early on in the work of systems ecologist, Howard T. Odum, See "Energy, Ecology, Economics" Ambio Vol.2 No.6 (1973): 220-227.

61. In "The Pattern of the Metropolis" (1961), Kevin Lynch proposes that "the pattern of urban development critically affects a surprising number of problems, by reason of the spacing of buildings, the location of activities, the disposition of the lines of circulation. Some of these problems might be eliminated if only we would begin to coordinate metropolitan development so as to balance services and growth, prevent premature abandonment or inefficient use, and see that decisions do not negate one another. In such cases, the form of the urban area, whether concentrated or dispersed, becomes of relatively minor importance." See Kevin Lynch, "The Pattern of the Metropolis" in Daedalus Vol. 90, No. 1, The Future Metropolis (Winter, 1961): 79-98.

62. Overemphasis on vertical form and growth through density obscured the importance of civil engineering in the construction of large scale projects especially during the megastructures movement of the 1960s. In Megastructure: Urban Futures of the Recent Past (New York, Thames & Hudson, 1976), Reyner Banham recounts: "The architectural concept of the megastructure, popular several years ago, was roughly that of a skeletal framework comprising the essential functions of the building, into which are inserted the individual, more or less temporary, installations. The advantages of the megastructure are that the individual is provided with necessary facilities and also a greater freedom of choice." Additionally, exactly ten years earlier, notable landscape geographer and theorist J.B. Jackson proposed landscape as megastructure: "The megastructure is prior to the individual installation and presumably, more lasting. Few of us realize that the there is another kind of megastructure in terms of the whole environment; one of the oldest creations of man. This megastructure consisting of the environment organized by man can be called the public landscape. A more correct term would be the political landscape, but since we associate that word not within citizenship as we should, but with politicians and politics, the term public is more effective." See John Brinkerhoff, "The Public Landscape (1966)" in Landscapes: Selected Writings by J.B. Jackson edited by Ervin H. Zube (Amherst: The University of Massachusetts Press, 1970): 153.

63. Frances Cairncross, The Death of Distance: How the Communications Revolution Will Change Our Lives (Boston, MA: Harvard Business School Press, 1997).

64. Landscape architecture departments are unable to keep up with growth demands as functions historically associated with urban design and planning have either lost ground or become isolated.

65. e James Corner, "The Agency of Mapping: Speculation, Critique and Intervention" in Mappings edited by Denis Cosgrove (London, UK: Reaktion Books, 1999): 231-252.

66. Kenneth Frampton, "Towards a Critical Regionalism: Six Points for an Architecture of Resistance", in The Anti-Aesthetic. Essays on Postmodern Culture edited by Hal Foster (Port Townsend, WA: 1983).

67. See James Corner, "The Agency of Mapping: Speculation, Critique and Intervention" in Mappings edited by Denis Cosgrove (London, UK: Reaktion Books, 1999): 231-252.

68. The project of landscape infrastructure is seen here as the natural and new convergence of landscape architecture and civil engineering.

69. For a collective account of their contributions, see Jeff Dozier and William Marsh, Landscape: An Introduction to Physical Geography (Reading, MA: Addison-Wesley Publishing, 1981), Carl Ortwin Sauer, Agricultural Origins and Dispersals. Bowman Memorial Lectures Vol.2, Ser. 2. (New York, NY: The American Geographical Society, 1952), Liberty Hyde Bailey, The Horticulturist's Rule-Book; a Compendium of Useful Information for Fruit Growers, Truck Gardeners, Florists, and Others. (Norwood, MA: Norwood Press, 1895).

70. Mary P. Anderson, "Groundwater Modeling - The Emperor has No Clothes" Ground Water Vol.21 No.6 (November 1983): 669.

71. Borrowing from two historic strategies, this formulation conflates the notion of 'le plan libre' expressed by Le Corbusier in his "Cinq Points de l'Architecture Moderne" in Vers Une Architecture (1923) in which he discusses the freedom gained through the use of concrete construction and load bearing walls. Secondly, it borrows from the free soil movement of the mid-19th century that emerged from Jeffersonian agrarian ideals that equate land and freedom through free speech, free society and the equal division of land.

72. For example, the original efficiency that was once relied upon from the use of fertilizers in the production of large, monocultural crops is now contested. The organic urbanism of Havana,or organopónicos is one of its best examples. As the former communist colony in the Antilles, the island of Cuba developed a unique decentralized strategy for the cultivation of food in the absence of imported petro-chemical fertilizers and machinery necessary for intensive agriculture. Since the late 1980s, with the collapse of the Soviet bloc and a punitive US trade embargo, Cuba has undergone a major structural reorganization of its agriculture and food production system which has privileged the resurgence of small urban and regional farms along with a series of agrarian formats across a range of scales. See Hugh Warwick, "Cuba's Organic Revolution" The Ecologist Vol. 29, No.8 (December 1999).

73. Andrea Branzi, "The Hybrid Metropolis" in Learning from Milan: Design and the Second Modernity (Cambridge, MA: MIT Press, 1988): 24.

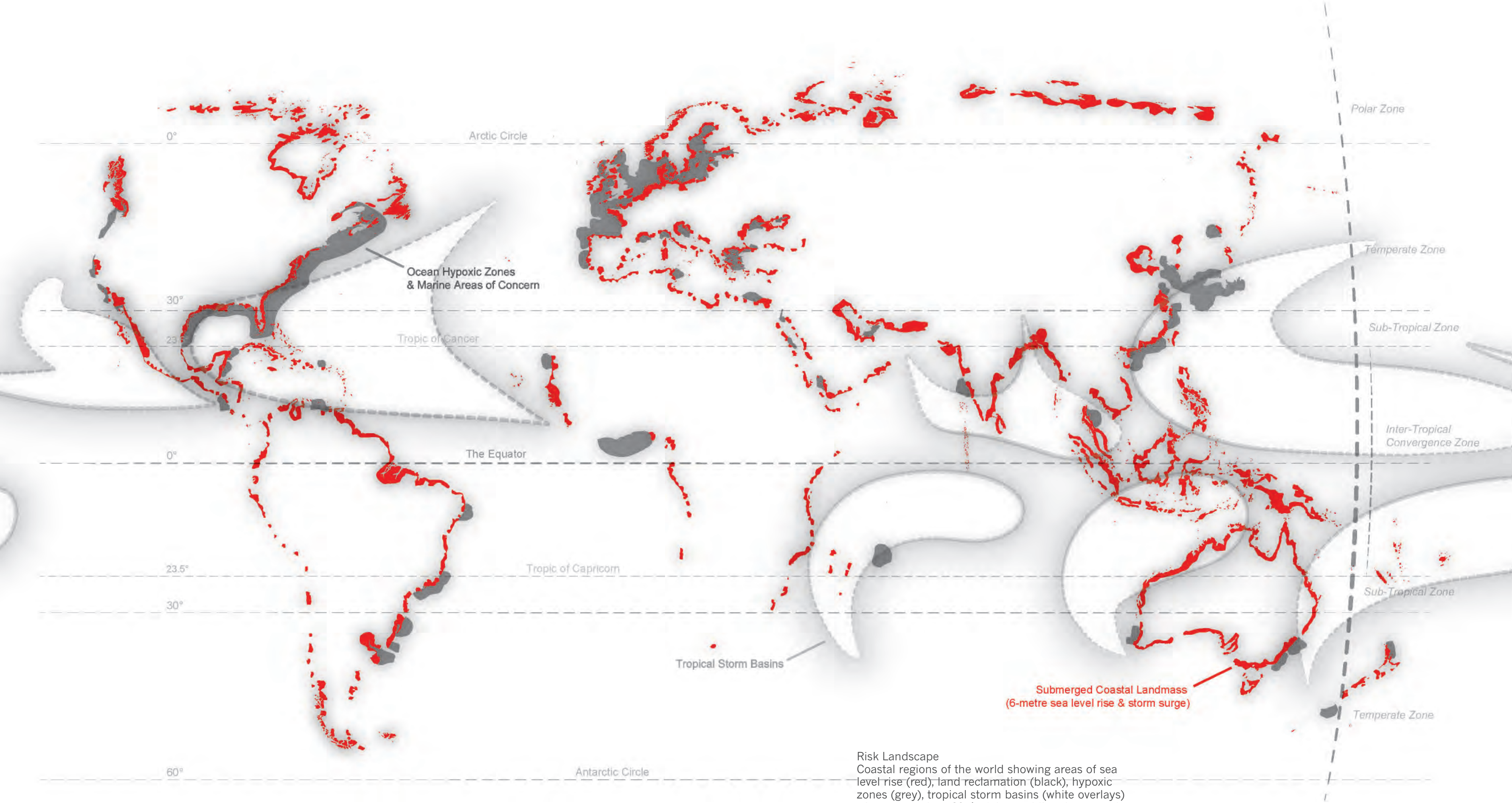
74. Drawing from the example of the Great Lakes Region in the U.S. and Canada, the emergence of bio-industries, waste economies and urban ecologies will be dominant drivers of economic growth and urban structure in the future of shrinking cities and decentralizing urban regions. See Pierre Bélanger, "Regionalisation", JOLA - The Journal of Landscape Architecture (Fall 2010): 6-23.

75. Marcel Smets & Kelly Shannon, The Landscape of Contemporary Infrastructure (Rotterdam, Netherlands: NAI Publishers, 2010).

76. shlomo Angel with Jason Parent, Daniel L. Civco, and Alejandro M. Blei, The Persistent Decline in Urban Densities: Global and Historical Evidence of 'Sprawl' (Cambridge, MA: Lincoln Institute of Land Policy, 2010).

77. In Ecology & the Accumulation of Capital: A Brief Environmental History of Neoliberalism (Prepared for the workshop, Food, Energy, Environment: Crisis of the Modern World-System, Fernand Braudel Center, Binghamton University, 9-10 October), Jason W. Moore explains this conceptualization much further in his critique of the historically flawed differentiation between environmentalism and industrial society by bluntly stating a new way of thinking is that "capitalism is an ecological regime" (4). For Moore, capitalist development is best understood when seen as complementary to a specific mode of environmental transformation where there is a generative relation between accumulation and transformation.

Originally published in Infrastructure Sustainability & Design *edited by Spiro N. Pollalis, Daniel Schodek, Andreas Georgoulias and Stephen J. Ramos (London: Routledge, 2012): 276-315.*



Risk Landscape
Coastal regions of the world showing areas of sea level rise (red), land reclamation (black), hypoxic zones (grey), tropical storm basins (white overlays) where more than 60% of the world's urban population will be living by 2030 according to the United Nations. Source: ©2011 OPSYS, with data from NOAA, NASA, UNDP

An Urban Manifesto.

As the invisible background and mud of modern life,[1] infrastructure is often been perceived through the pervasiveness of roads and highways, the remoteness of power plants and landfills, phone lines overhead and sewers below ground. Yet, for all the monumentality of these projects and their positivistic undertones, this drive-by understanding gives us only a small glimpse of what it actually takes to support urban life. We spend very little time thinking about where our water comes from, or how our power is produced, where our food is grown, how far it travels or where our shit goes.

Infrastructure does not exist in a disciplinary vacuum nor does it remain separate from its surroundings. Infrastructure is not asocial nor is it apolitical. It divides as much as it connects. It is fragmented while remaining continuous. Nor, is infrastructure neutral. It excludes as much as it integrates. It is confined by caps and controls, while simultaneously open with outlets and exits. It produces externalities and is affected by forces beyond its boundaries. As subliminal media, infrastructure generates vectors of movements but can also produce zones of occupation. So large and so vast it may be, that infrastructure may be imperceptible to the naked eye but its effects - from connection to segregation to apartheid - are usually prevalent and visible, intended or unintended. A 20th century outcome of large-scale technological systems, infrastructure is therefore not isolated, nor independent of natural systems. More than just steel, cement and asphalt, infrastructure therefore forms distinctively complex, urban ecologies, a vast and immense landscape of biophysical and geospatial systems, an expansive field of resources, services and agents that together form the landscape of urban economies.

From Engineering to Design

Yet, the preeminence of civil engineers in city building during the past century - engineers as master planners - has largely gone unnoticed by the cult of architects and clique urban of designers alike. Often perceived as technocrats or tinkerers, the ascent of civil engineers has remained peripheral to urban design discourse of the West, from its early origins as the military planners of the 19th century to the master builders of the 20th century. When in fact, not only are they more important, they vastly outnumber the design professions by more than 5 to 1.[2] How these so-called backyard scientists have attained such prominent status in the past century with very little notice or mention is perplexing. In fact, how engineers rule the world[3] is both awesome and astonishing.[4]

Whereas other urban disciplines recoiled from the complexity of large scale urbanization or devolved into legislative jurisprudence, civil engineering has reveled in it.[5,6] The silent majority of engineers and construction managers have not only embraced bigness and complexity but have innovated and multiplied the complexities and challenges of the geographic proportions that urbanization offers.[7,8] Since the 20th century could simply not be encapsulated by a single architecture or a single policy as was proposed during the Megastructures Movement of the 1960s or the Environmental Movement of the 1970s, civil engineering embraced large scale complexity by breaking it down into constituent parts and processes, through measures and manuals, tests and trials, standards and specs, exploiting hyper levels of specialization, inventing a multitude of sub-disciplines and cross-collaborations, concurrently.[9]

Through audacious achievements, the unfettered ambition of civil engineers is best captured in the form of actions and verbs, where building takes on the dimension of a process instead of an object, construction as an innovation instead of administration, without sacrificing nor fetishizing the end product.[10] While urban designers were retreating from the failure of their foray into bigger ambitions in the 1980s, the US Army Corps of Engineers (USACE) for example - the largest, most emblematic agency of civil engineering in the world - was already hard at work for well over a century, not theorizing, but building their ambitions: harbors and canals at home, military bases and highways abroad, as well as power corridors and power plants, road and sewer systems across nations, while remaining on standby to provide essential support services and reconstruction efforts at times of national disasters in the US.[11]

Edified by the Annual Top Ten Public Works by the American Society of Civil Engineers (ASCE) and scholars alike,[12] the timeline of the US Army Corps of Engineers reveals an overwhelming success. As outgrowth from military origins,[13] it has succeeded by virtue of a simple attitude: responding swiftly to spatial and environmental complexities with readily deployable techniques in the face of security threats, disasters and catastrophes. Like Boy Scouts or Brownies, engineers have secured a position in society that is not only based on common sense or, on the foundations of technology as some may have it, but that hinges on an entire chain of ideals, impulses and inclinations. Together, they form an unbreakable bond of beliefs that transcend public consciousness across a wide societal spectrum:

see next page >

infrastructure – technology – engineering – strength – stability – security - precision – protection - permanence – public works – federalism – national identity – economy – growth - development

infrastructure—technology—engineering—strength—stability—security—

permanence—public works—federalism—national identity—economy—growth

The patriotic positivism quietly practiced by these technological brokers sharply contrasts the aesthetic affiliations and individualistic ideologies perpetuated and preached by architects. Rather than relying on any single theory or ideology, engineers simply rely on a motto:

Essayons!

This historic refrain - simply translated as *Bring It On!* or, *Let Us Try!*[14] - captures both its capacities and ambitions: ready, able, global. But below the disguise of banality and the undertone of dumbness of infrastructure, the audacity of engineers reveals deep, spatial tendencies. With most of it buried underground or submerged underwater, their work lends an appearance of performance through virtual utility, over the more formal, megalomaniac attitude of architects and urban designers.[15] As the invisible frames of anonymous architectures, the products of these so-called functionalists are analogous to facade-less buildings. Voids, without shells. Housings, without envelopes. Interiors, freed from their exteriors. Here, the context can be constructed, content can be anything, as engineers subliminally imply: Fuck the Content, Context is Everything.[16] It is, as if for the engineers, the modern, hegemonic idea of 'space' means practically nothing, but rather where 'speed' and 'pace' - through movements, velocities and rates - means everything. In the banality of this fluid landscape lies their anonymity and their success.[17] Put simply, form does not just follow function, form follows flow.[18]

Under the trademark banner of the USACE, Building Strong™, and the authoritative stature of the ASCE, civil engineers have garnered a level of notoriety where infrastructure investment has become the unquestioned path to economic recovery and growth.[19] Together, through federal leadership, government investment, and best practices, civil engineers have mounted an unshakable case for new infrastructure across the United States, of an order of magnitude of 2.2 trillion dollars over the next 5 years.[20] After all, who could contest the simple corollary: infrastructure = economy?

This paradox of pervasive influence and invisible power is perplexing: the discipline of engineering has yet to ever produce a single manifesto.[21]

So, do engineers operate in a world without theory?[22] Their work, their language, their education, are determined by standards, specifications and systems, as well as by methods, models and measures. They relish in the isolation of variables and exclusion of social dynamics to reduce complexities down to verifiable quantities, certainties and solutions. Their work sits on a razor's edge of precision and a thin, hairline of probability in order to produce exactitudes from indeterminacies. As an outgrowth from this culture of optimization, it is assumed that, at its best, infrastructure is a public benefit and, at the very least, it is an economic necessity. After all, who could argue with the delivery of your tap water, the supply of your electricity, or the removal of your garbage from the curb?

Counter intuitively, is it possible that one of the greatest strengths of civil engineering is that it has remained relatively mute in the face of urban sprawl? In stark contrast to the incessant over-theorization of academic architects and unending indictment by the coalition of armchair lawyers and economists that have hijacked the planning profession.[23] Instead, the engineers simply march on, applying fordist economies of scale from the industrial era, across cities, continents and oceans. Although these tendencies and inclinations may seem less aesthetic, their motivations are definitely geographic. Sponsoring the onward movement of *urban decentralization*, they have uncritically orchestrated large scale and expansive infrastructures, aided and abetted by a 1960s culture of automobility and logistics. Using highways and roads as horizontal elevators, they are the stationary attendants that have fueled and propelled patterns of spatial diffusion and decentralization; a process that continues to be the greatest, most important force in the world.[24]

Decentralization & Dispersal

But if the singular continuity of centralized infrastructure has provided the path for Western urbanization, then the gloss of contemporary urban life - safe, stable, accessible - is maintained by the illusion of permanence that infrastructure projects outwards. Beyond the seamless buff of technological and mechanical systems, very rarely do we see the physical extents of this vast infrastructural territory, let alone understand the longevity of this large technological apparatus. After all, infrastructure only becomes visible at the precise moment that it fails. In the past decade, pictures of blackouts and amateur videos of bridge collapses, front page news of plummeting concrete from tunnels, serve as previews of the fragility that infrastructure falls under. But so far, this vast technological apparatus has been portrayed as an essential, permanent, and necessary fixture of contemporary society.

However, we could also assert that infrastructure works almost too well. And, that civil engineering is without reproach: the water always runs, the lights always come on, and the heat always fires up when temperatures drop. If Hoover's dams and Eisenhower's highways represent the zenith of civil engineering through the might of American Presidents and Federal Public Works, then their wear-and-tear, their breakdown, might reflect the impermanence

Networks as Closed Systems (Baran, 1964)

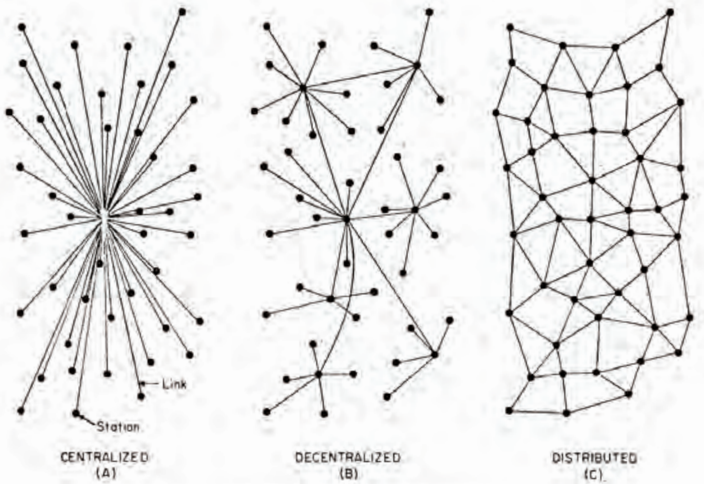


FIG. I — Centralized, Decentralized and Distributed Networks

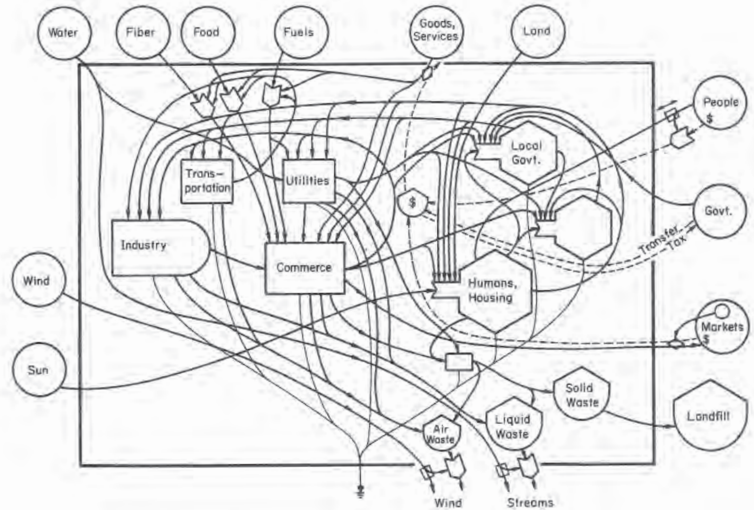


FIGURE 25-21. Representative city system.

Ecologies as Open Systems (Odum, 1983)

Form & Function, Flows & Fluids

Historic comparison of models of spatial and ecological organization, illustrating the difference between networks (closed systems) and ecologies (open systems). On the left, the diagrams shown here draw from mid-century theories of spatial organization showing a range of typological network variations rooted and representative of central place theory developed by German geographer Walter Christaller (*Central Place Theory*, 1933-1972) characterized here through the network diagrams of systems engineer Paul Baran (*On Distributed Communication Networks*, RAND, 1962). On the right, from late century, ecological models of spatial organization through open systems theories, developed by the ecologist Howard T. Odum (*Ecological & General Systems*, 1966-83). The main difference between these models of spatial organization, between networks and systems, demonstrates how the modern concept of networks addresses form and physical space (operationalized through a closed systems of points and lines), compared to how the post-modern concept of systems addresses fluidity and flows (animated through vectors, flows, fields, inputs, outputs, energies, exchanges, patterns, processes). If network thinking characterizes the mid century approach to urban design, then open systems thinking, that is the ecologic optic, is applicable to complex, indeterminate conditions, risks and hazards that are typical of contemporary urban patterns.

of that might and the weathering of that power. As indicators of the limits of single purpose infrastructure, bridge breakdowns and dam cracks are now informing a new generation of practitioners - urbanists - who are putting into question industrial economies of scale upon which the growth of 20th century contemporary society has been built on, asking important questions about the future:[25] what infrastructure should be rebuilt? How should it be rebuilt? Should it be rebuilt at all?[26]

With greater frequency of incidents and accidents in the past two decades, the buildup and breakdown of infrastructure as well as their unintended environmental consequences have decisively put into question the necessity for total infrastructural reconstruction, including the imperative for infrastructure itself. Over time, the radiant permanence lent by the continuous, uninterrupted appearance of infrastructure's magnitude begins to fade under exposure to its imperfection, fragility and incompleteness.

Today, the externalities of the industrial economies of scale that underlie civil engineering practice are stress tests of centralized infrastructures showing signs of irreparable wear, hazardous risks, and environmental spillovers. As postwar infrastructures in North America near the end of their serviceable lifespan, we can now understand that single-purpose infrastructure of the 20th century (curbs, pipes, roads, tunnels) and its offspring, single-purpose land use zoning (residential, commercial, institutional, industrial),[27] that sought to subdivide and segregate, can no longer keep separate systems and technologies from the resources and regions they require and convey. It is through the filter of regionalization - the geographic, economic and ecological process of characterizing and forming regions around different geopolitical and biophysical boundaries - that infrastructure can be redefined and redesigned. Clearly, infrastructure is more than just the sum of civil engineering and transportation planning alone. Whether it involves freshwater lakes or coastal estuaries, resource deposits or river watersheds, agricultural soils or forest fuels, underground aquifers or aboveground airspace, micro-climate or macrobiotics, the coupling of technological and biophysical processes can serve as synthetic ecologies that underlie urban populations.

By redefining infrastructure, the re-questioning of the oversupply of infrastructure illustrates the exclusive purview of civil engineering in its delivery. Made possible by industrial economies of scale, the oversupply and apparent seamlessness of infrastructure parallels other recent over-abundances: the oversupply of single family housing, single purpose transport, and single energy choice. All of which are being re-questioned today. And, at their base, is an oversupply of credit, one that was promoted by the banking and lending industries, both principal cause and effect of the current economic crisis and countless environmental fallouts.[28]

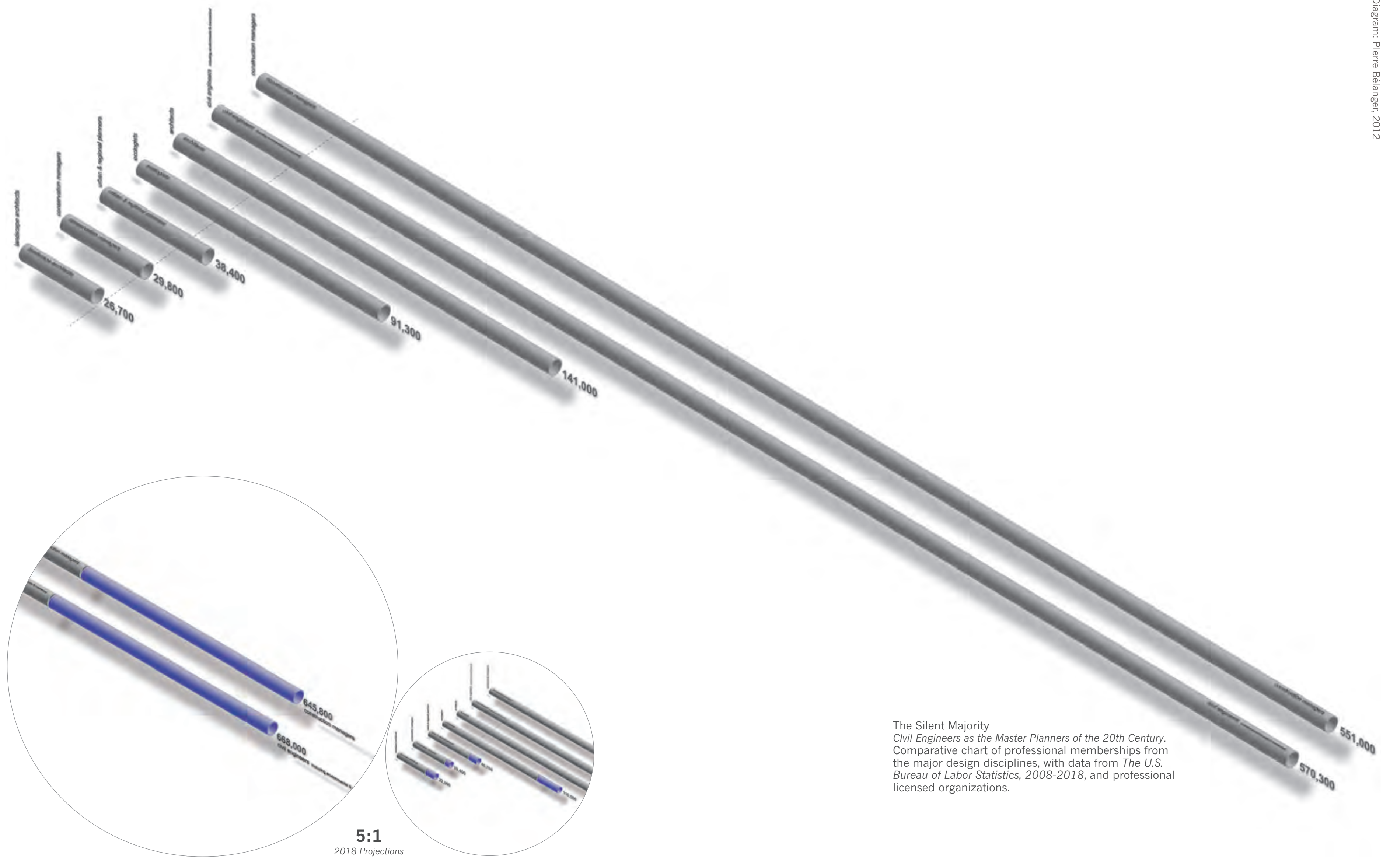
These overexertions mark the co-incidence of the breakdown of single purpose infrastructure and other centralized structures: nationalities, governments, agencies, religions, borders, technologies, and instrumentalities. This process of spatial decentralization also parallels social decentralization through the dissolution of centricity and breakdown of hierarchy, in favor of a sociogeographic sprawl and cultural concentrations that are spreading across the planet.[29] And while many may see the force of decentralization as destructive or wasteful,[30] the persistence of decentralization demonstrates its resilience and its intelligence. From the weakening of welfare states and the destabilization of dictatorships to the daylighting of underground streams and recycling of waste effluents to the migration of populations and climate zones to the accumulation of nitrogen and carbon, the diffusion of spatial structures is yielding new, and contemporary geospatial patterns that are counteracting the imperial hegemonies and weakening industrial orders of the past.

Reformulated through readings of urban diffusion,[31] the so-called "mindless juggernaut of subtopia" population patterns and spatial leapfrogging is yielding unprecedented formats of urbanization of new "regional significance".[32] Decentralization is opening territories of knowledge whose most critical effect is the changing concept of urban from settlement to exchange, away from the unilateral pole of the industrial settlement (the city as industrial metropolis), and instead towards landscapes of exchange.[33]

Convergences & Crossovers

If the overexertion of engineering and inertia of urban planning are the fallout of the last quarter of the 20th century, then it is of no coincidence that the revival of geography and emergence of ecology are the blooms of the 21st century. Today, the linear, fixed and closed structures of the industrial economies of supply are violently being supplanted by more complex, flexible and circular systems of the urban economies of demand. It is around these emerging urban economies that new urban ecologies are growing.

In one of the most critical texts in the history of engineering, "Cultural Origins and Environmental Implications of Large Technological Systems" (Science in Context, 1993), Rosalind Williams observes :



The Silent Majority
Civil Engineers as the Master Planners of the 20th Century.
Comparative chart of professional memberships from the major design disciplines, with data from *The U.S. Bureau of Labor Statistics, 2008-2018*, and professional licensed organizations.

Diagram: Pierre Bélanger, 2012

"the outstanding feature of modern cultural landscapes is the dominance of pathways over settlements,...the pathways of modern life are also corridors of power, with power being understood in both its technological and political senses. By channeling the circulation of people, goods, and messages, they have transformed spatial relations by establishing lines of force that are privileged over the places and people left outside those lines."[34]

In the wake of the exhaustion of the environmental lobby[35] and the proliferation of these new market economies, pours out an array of unprecedented knowledge ecologies. The ripple effects across this new landscape are recombined areas of knowledge such as in the fields of ecology, energy, economics,[36] as well as design, planning, engineering. As the operative notion of ecology[37] is radically expanding, the early work of systems ecology in the 1970s is finding new relevance. Innovating a pluralistic interpretation of ecology through complex configurations of open systems and circular flows, the work of systems ecologists such as Howard Odum for example have come to expose the skewed, scientific positivism of linear, closed systems that, thanks to industrial systems engineers, perpetuated one of the most dangerous misconceptions of the 20th century: *urbanization as problem*.[38] Through flawed notions of carrying capacity, growth limits and resource scarcities, visions of world apocalypse and environmental destruction perpetuated by the roster of MIT systems engineers such as Jay Forrester in the Club of Rome's "Limits to Growth" (1972) have now dissipated through the representations of urbanization as fluid, circular and strategic, thanks to the work of open systems ecologists. The fantastic, planetary visions of technological fixes[39] pushed by systems engineers to "solve" the urban problématique has now faded under the more calibrated knowledge of systems ecologists, while avoiding classic Newtonian positivism.

Furthermore, when viewed as both urbanist and geographer, Odum reveals the flawed, centripetal view of urbanization that has predominated Western social thought in the last two centuries.[40] Rather than exclude the black sites and brown fields of urban economies, Odum's ecological lens integrates them. Through this open systems optic, Odum's view proposes a requalification of urbanization through patterns, processes, exchanges and interactions. Waste ecologies are its best example through an infinite multitude of backflows, overflows, reflows, leakages, impurities, spillovers, discards, disassemblies, material residuals, secondary energies. Whereas urban form may have historically been expressed through the design of streets, blocks and buildings thanks to the 19th century architects of the Beaux Arts, Odum's synthetic view of ecologies opens the potential for the design of urban flows, where fluidity in and of itself, generates form. As a consequence, the pluralization of ecological knowledge contributes towards a renewal of interest in the basic, indivisible flows of urbanization: waste and water, food and fuel, flora & biota, mobility and energy. Ultimately, this reformulated understanding of urbanization breaks open the centrality and singularity of infrastructure, towards new social forces and geospatial formations that operate as infrastructural ecologies, the lifeblood of circular, urban economies.

In this expanded, geographic understanding, urbanization then becomes a field of shared, polyvalent practices as opposed to a specialized, or exclusive discipline such as architecture or urban design. In this expanded field, the designation, delineation and direction of these ecological processes takes on new priority and relevance and precedence as practice. Counteracting the paradigms of control and containment of engineering-based planning practices, the active deployment of living, dynamic processes becomes synonymous with the design of relationships, associations, synergies, reciprocities, contingencies expressed in the configuration of the ground, the programming of horizontal surface materials, the construction of vertical equipment, the cultivation of outgrowths and territorial inscriptions where social agents are producers that nourish the culture of urban economies.

As the vertical, hierarchical differences between engineering as technological discipline and ecology as a scientific subject break down, a new design agency spills out. Combined, the effects of the fin-de-siècle recuperation of the geographic subject from the den of military hibernation and the emergence of ecology out of the exhaustion of the environmental lobby are exponential and earth moving. In this strategic accouplement of disciplines, Rosalind William's tectonic observations are instructive:

"the concept of connective systems is primarily phenomenological rather than sociological. These constructions are tangible structures existing in geographical space, and their components are related primarily in physical rather than in social terms. When engineering involves the creation of such structures, it looks more like a 'mirror twin' of landscape architecture or of urban planning than of science."[41]

Ecologies of Scale

It is from these different conjunctions and proliferating crossovers, across a spectrum of urban disciplines - between ecology and engineering, geography and planning[42] - that this position has emerged. Located in the zones between intellectual jurisdictions, the position of this thesis brings together a series of texts written that present the landscape of urbanization, including its geographies and ecologies, as a conflation of complex processes, natural and constructed, across several scales, simultaneously.[43] Through the syn-

Motto as Motivation

A brief, graphic analysis and semiotic interpretation of the US Army Corps of Engineers' motivations (USACE) drawing from its collection of symbols, insignias, and crests. Source information for this 'Corps Anatomy' includes *The USACE Graphic Standards Manual EP 310-1-6 9* (revised 9/94), the official document for graphic design of manuals, circulars, pamphlets and special publications, as well as the digital archive of the 150th Construction Engineer Battalion *"U.S. Army Engineer: History & Traditions"*, and Todd Shallat's *Structures in the Stream: Water, Science and the Rise of the U.S. Army Corps of Engineers* (Austin, TX: University of Texas, 1994).

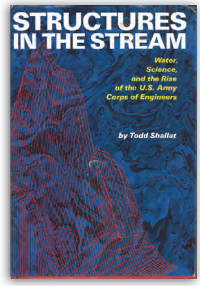
Signs & Symbols, Myths & Motifs.

The crest and shield consists in the mark of a Bald Eagle, the National Emblem of the United States, mounted on a white and scarlet tower, upholding the banner of the Corps' motto "Essayons", looking over the world as a shield. The *General Orders of 1840* explain the mythology of gold color saturation: "An eagle holding in his beak a scroll with the word "Essayons", a bastion with embrasures in the distance, surrounded by water, and rising sun; the figures to be of dead gold upon a bright field."

The legacy between the engineers from the US Corps and those from France dates back over two centuries. In *U.S. Army Engineer: History & Traditions*, compiled by the 150th Combat Engineer Battalion of World War II, the historic relation between American and French engineers/combatants was both technical and cultural: "During Europe's Middle Ages, the French coined the term "génie" to represent the Engineers. Over the years, "génie" evolved into the old English word "enginator" meaning one who operates the engines of war, such as siege towers, battering rams, catapults and the like. With the support of professional French Military Engineers, our young Army Corps of Engineers was created during America's War for Independence, 1775–1783". Source: *150th Combat Engineer Battalion of WWII*, www.150th.com/history/

But, as Corps Historians Frank E. Snyder and Brian H. Guss elaborate, French influence on American ingenuity had limits: "At first practical and eclectic, partaking of selected practices and theories of the Europeans, American engineering began in the 1830's to assert a native character through construction of the transportation systems and development of the techniques which would become the tools of the Industrial Revolution. The American method stands out uniquely by the colossal scale of its works and by its pursuit of techniques to improve the general life style proliferated through mass production." (234)

"ESSAYONS"
borrowed from the French,
loosely interpreted, and translated as:
"Let Us Try", "Forward", "Bring It On"



Structures in the Stream
Water, Science & the Rise of the U.S. Army Corps of Engineers.
by Todd Shallat (Boise)
(Austin, TX: U. of Texas, 1994)

Tour de Force.

Adopted in 1839, the form of the official *Communication Mark* of the US Army Corps of Engineers is derived from the traditional symbol of a castle, referencing the Castle of Verdun, an old fortress in Southern France. The castle was originally recommended as official insignia by General Joseph G. Totten, Chief of Engineers. Corps archivists & historians suggest that "the heraldic significance of the castle and armorial symbol may be derived directly and logically form the original function of the Corps: the design and construction of fortifications." Stemming from heraldry, the traditional medieval castle and architectural symbology, saturated in a striking, emergency-red scarlet hue, is inseparably connected with notions of might, force, and expediency, and once employed as the coat-of-arms for those who built castles or those who successfully assaulted them. As the *Communication Mark* of the US Army Corps of Engineers, the traditional castle symbol is the key graphic element in the Corps' uniform graphic identification system. The symbol of the castle has been applied to the strongest of the USACE's early fortifications, including the entire system of permanent defenses of the United States, at home, and around the world.

Source: Frank E. Snyder and Brian H. Guss, *The District: A History of the Philadelphia District, U.S. Army Corps of Engineers, 1866-1971* (Philadelphia, PA: USACE District Philadelphia, 1974).

Corps Anatomy.

"The Corps has been called America's preeminent engineering organization. A nation builder. A bureaucratic superstar. Also a public enemy, a diligent destroyer of wetlands, a military aristocracy, a lobby that can't be licked."
(Prologue, Shallat-1994)

Power & Peace, Planetary-Style.

Wrapped around the world, at the base of the tower, tucked in below the eagle, is a protective wreath. Like a bird's nest, the world is an egg, supported by signs of fortitude, captured by the oak branch on the left, and sustained by the peaceful nature of the Corps' mission, symbolized by the olive branch on the right. Like an inverted victory crown, the olive wreath is often interpreted through the laurel, a representation of accomplishment and achievement. While the "branches symbolize the agency's concern for the environment", the gridded globe unmistakably delineates the total, transnational reach of the Corps' central ideals around the planet.

The symbol featured in the center is the Offical "Essayons" *Unit Crest* worn by USACE military personnel.
Refer to Section 2-4 of the USACE GSM (16)

Typography: Bold Precision, Subtle Substitution.

Combining clear legibility and engineered precision, the historic timeliness of Swiss typography, *Helvetica Medium* and *Helvetica Regular* are the official type styles used in all Corps signatures. "This versatile family of typography is extremely useful in publication design as well as in the more permanent identification applications shown in the manual" (*USACE Graphic Standards Manual*, Section 3-4). Both elements, including the 'USACE' and 'Building Strong' motto, are always "placed flush to the left. This signature is to be used as the graphic identifier on those items common to the entire Corps of Engineers" (*USACE GSM Section 1-3*). Although the *1994 Graphic Standards Manual* provides strict standards for typeface and typography—including layout and design in combination with other logos and symbols, its more widespread American cousin - the Arial Font Typeface - is often used as an easy, yet subtle substitute, being the official font of its parent organization, the US Army.

US Army Corps of Engineers
BUILDING STRONG®
(USACE Typeface: Helvetica Bold)

US Army Corps of Engineers
BUILDING STRONG®
(US ARMY Typeface: Arial Bold)

thesis of ecology and infrastructure together, this position propose strategies that engage urban culture beyond the dogma of industrial production, as an inversion of the industrial economies of scale that have regulated the shape of urbanization during the past century.

Both telescopic[45] and stratified,[45] this strategic position proposes disciplinary contraventions by sliding across scales and trespassing professional territories across planning and policy, engineering to ecology, architecture to urban design. In “Infrastructure & Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems” (2003), the catalytic work of historian and communications theorist Paul N. Edwards articulates this methodology as an intellectual imperative:

> “Multiscalar analysis requires an enormous depth of knowledge - more than can be expected of most individuals. Social and historical scholarship has few precedents for genuine-team based approaches which requires a complex process of coordination, agreement on methods and division of intellectual labor. It may be too much to hope that our disciplines will evolve in this direction, particular given the present reward structures of most academic institutions. But if I am right that multiscalar analysis holds the key to an understanding of technology and modernity, we must at least make the attempt.”[46]

The disciplinary slippages and sliding scales underlying this position represent that attempt. By profiling methods, models and measures, different levels of intervention are engaged and proposed. Casting a wide net across different flows, forces and formation of urbanization, the position cross-references semiotic interpretations (hermeneutic, syntactic, signified) with strategic propositions (relational, spatial, territorial). More than a chronological compilation, what holds this compendium together is the basic redefinition and representation of infrastructure, as the gel of urbanization, hold the potential for the rebuilding of its basic, irreducible ecologies: from waste and water, food and fuel, flora & biota, mobility and power.

The focus of this position is twofold. From one level, the writings are intended to recast the role of 20th century urban designers vis-à-vis the emerging ecological knowledge of our time where urban economies consist in more than just the sum of streets, blocks and buildings. From another level, the focus targets scientists and technocrats whose daily work is dictated exclusively by quantitative information and often divorced from social, ecological and biophysical complexities. With an aim towards bringing several disparate disciplines together, engineering with ecology, landscape and infrastructure, zoning and design, planning and history, specialists of these individual areas of knowledge and disciplines and practices will no doubt find holes and cleavages in the historic information provided. The undisguised adolescence of this position purposely acknowledges the imperfections, impurities and imbalances of urbanization to bridge several gaps and less chartered areas. Through precise approximations and operative generalizations, the strategic imperfection of this position is intended as an invitation for so-called non-urbanists - the social groups, the logistics companies, the conservation organizations, the labor forces - to engage and participate in the discourse of urbanization by design, or by demand.

From these dual ends, the position is also both an appraisal of current conditions and proposal for the future. As an anticipatory and projective endeavor, this compilation of writings goes beyond observations and interpretations compiled here to propose and advance a series of synergies and strategies. Purposely kept dumb, the operative observations are extracted from ready-made formats of construction and processes of urbanization that are easily interchangeable, modifiable, and scalable. They propose standards that can be re-standardized or de-standardized.

Together, they foreground a field of intervention where landscape figures as both strata and spectrum of urbanization - from super urbanization to dis-urbanization - rather than from a pure ideology of production, form, or concept. The content extends across a range of sites, networks, and geographies shaped by patterns and processes in continuous formations and deformations, in various modes of assemblies and disassemblies. Starting from the essential utilities that make urban economies, the thesis transposes major dimensions of urban infrastructure in all their different permutations and interfaces - the surfaces, subsurfaces, operations, events, atmospheres, altitudes - of the urban world that we live and breathe in.

The transposition of landscape and infrastructure therefore outlines how the field of landscape - once a surrogate to the discipline of architecture and outgrowth of the late 19th century City Beautiful Movement and early 20th century Beaux Arts Revival - can exploit its affiliation to ecology, engineering and geography, reengaging large scale planning, re-imagining small scale surfaces and material, through reform of existing urban infrastructures and the projection of urban regions. But, to go beyond engineering and propose new strategies of intervention - through the project of landscape infrastructure - requires a leap beyond disciplinary cadres, in response to the more intangible, the more complex, the more contingent, the more indeterminate and sometimes unknown challenges that lie ahead. Whether it calls for the design of that future or its un-design, the cultural theorist Sanford Kwinter anticipates:

Do engineers operate
in a world without theory,
while architects overdose on it?

> "Despite the customary, fashionable genuflection towards infrastructural questions and concerns today, little attention is being paid to the more radical, more disturbing reality: that infrastructural demands are not only becoming exponentially more importunate today but that these infrastructural demands are breeding and mutating in kind and not only in degree. We have no choice today but to deal with the new "soft" infrastructures: knowledge infrastructure, program infrastructure, cultural infrastructure, virtual infrastructure. The demand for design -- and de-design -- in our over-engineered, over-mediated world is both enormous and pervasive, yet the majority of architects still respond to it with the medieval language of the stoic, autonomous building. Today's design world is stratified, with an emerging class structure, its associated embedded conflicts, and an emerging new proletariat increasingly separated from the principle means of production."[47]

This double-entendre entails the design of urbanization through new faculties and facilities, through new forces and flows, through new formations and deformations, through different formats of exchange and diversified markets, new interplays and interactions, alternative codes and protocols. Rather than propose a universal theory or new ideology, these reciprocal possibilities provide substructures that support new attitudes and appetites for crossovers, whether it is by design, by improvisation, or by coincidence.

This twin interpretation also posits a new and expanded understanding of what infrastructure is, and what it is becoming. It positions the field of landscape as infrastructure, an instrumental strategy across a range of jurisdictions, interests and stakeholders, inviting new investors, users and agents. No longer can it remain the exclusive purview of the engineer or the technocrat. No longer are we just talking about roads, sewers or power plants anymore. We are referring to the systemic field of bio-physical resources, socio-technological services and exchange spaces, held together by a mesh of hardware and software that calibrates and conditions urban economies. As we move further and further away from the mono-functionality of infrastructure, as well as from the problématique of urbanization, the cultures of design, engineering and policy move closer and bring new positions, alignments and orientations across a vast landscape of proto-infrastructures and proto-ecologies.

From the silent majority of engineers to the exuberant minority of architects, this unauthorized, unsolicited autobiography may well find itself in the outnumbered hands of designers and planners who can hopefully equally gain from a closer appreciation of the perceived banality of infrastructure, shedding light on the synthetic, social, subversive ecologies that precondition it. As offspring of the recovery of geography and the blossoming of ecology at the dawn of the 21st century, the disposition and potential of this thesis therefore serves as an anonymous manifesto for engineers, a preliminary primer for planners and conceptual guide for the emerging urbanist treading this new ground.

Endnotes

1. Preeminent systems theorist Paul Edwards suggests the notion of infrastructure as media and interface: "Mature technological systems - cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers in the majority of their uses -- reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt. Our civilizations fundamentally depend on them, yet we notice them mainly when they fail, which they rarely do. They are the connective tissues and the circulatory systems of modernity. In short, these systems have become infrastructures." See "Infrastructure & Modernity: Force, Time & Social Organization in the History of Sociotechnical Systems" in *Modernity and Technology* edited by Thomas J. Misa, Philip Brey, Andrew Feenberg (Cambridge, MIT Press, 2003): 185.

2. Civil and environmental engineers currently outnumber the small contingent of designers (architects, landscape architects and urban planners) by a factor of more than 5 to1. According to *The Bureau of Labor Statistics in the US* and professional associations across North America, there are more than 500,000 civil engineers (including professional associations of civil engineers, together with mechanical and environmental engineers), in addition to the more than 500,000 construction managers (the so-called 'failed architects'), that build the urban world.

3. This expression is borrowed from a common adage that has historically been repeated over and over by engineers at the University of Toronto. Like many other universities in North America, the common refrain "Engineers-Rule-The-World" is rehearsed over and over again during 'frosh' initiation week, ritualized by aspiring engineers clothed in blue coveralls, with their faces and hands dipped in purple dye. In keeping with this tradition, the associated acronym E.R.T.W. is pervasively scribbled on wall surfaces and bathroom stalls. However juvenile or archaic this may seem, this dogmatic ritual and graffiti reveals a disciplinary arrogance and superiority instilled from a very early stage of professional education taking on the form of a rite of passage. The University of Toronto Department of Engineering and Applied Sciences is ranked 13th worldwide, and the largest schools in Canada, with an enrollment of about 6500 students. Comparatively, the University of Toronto Daniels School of Architecture, Landscape, and Design counts approximately 500-750 students.

4. This observation echoes the few, self-critical texts in the discipline of civil engineering. See the observations of Neil S. Grigg in his declaration on the profession of engineering, *Civil Engineering Practice In The 21st Century* (Washington, DC: ASCE Press, 2001) and A. Emin Aktan in "The Civil Engineer in the New Millenium" Paper Invited for the Ersoy Symposium (Middle East Technical University, Ankara: May 16, 1999).

5. See "Bigness, or the Problem of Large" in *S,M,L,XL* by Rem Koolhaas and Bruce Mau (New York: Monacelli Press, 1998). Koolhaas' text appears in the early 1990s at the precise moment that architecture and urban design retreated from extra large scales. Important to reconsider is the historic interrelationship between design and engineering that existed as far back as the work Leonardo da Vinci for example, prior to the specialization of disciplines, and how the discipline of architecture has retreated from large scale, geographic urbanization. Now isolated as an elitist practice of singular buildings and prestige projects, its urban proxy - that of urban planning - has been taken hostage by lawyers and economists who devolved spatial practices into dispensing of policy and procedure at the expense of spatial, physical design of large territories. From a distance, the 'Bigness' text appears less as a manifesto on scale, but rather a plea for recapitulating architecture's longstanding lineage with its parent discipline, capital 'E' Engineering.

6. The importance of the split between engineering and architecture was discussed early on by urban historian Sigfried Giedion, more than a half century ago, in his Norton Lectures between 1938 and 1939 at Harvard University: "But as long as scientific and technological advances were used in architecture without being absorbed by it, the engineer remained subordinate to and detached from the architect. The architect, on the other hand, was left isolated from the most important movements going on in the world about him. Until he succeeded in coming to terms with the changed environment, until he recognized the architectonic possibilities in modern constructional methods, no new tradition relevant to the age could develop. It was out of those technical innovations which appear only behind the scenes in nineteenth century architecture that the architecture of the future had to grow. Construction was, as it were, the subconsciousness of architecture; there lay dormant in it impulses that only much later found explicit theoretical statement. [...] Hence the interest in these apparently trivial developments, these timid introductions of new materials and new methods, have for the historian. Tendencies, still living and active in our day, the constituent facts of contemporary architecture, trace back to just such unpretentious beginnings. The advent of the structural engineer with speedier, industrialized form-giving components broke up the artistic bombast and shattered the privileged position of the architect and provided the basis for present-day developments. The nineteenth-century engineer unconsciously assumed the role of the guardian of the new elements he was continually delivering to the architects. He was developing forms that were both anonymous and universal." in *Space, Time & Architecture: the Growth of a New Tradition - 5th edition* (Cambridge, MA: Harvard University Press, 1941): p.183.

7. In addition to the fracking of disciplines and professionalization of practice, the mid 20th century period simultaneously witnessed the involuntary exodus of geography from academia towards the military as the partial fallout of the split between architecture, engineering and planning between the 1930s and 50s. This era equally marks turbulent periods of geography and engineering legacy at Harvard University. See Neil Smith, "Academic War over the Field of Geography: The Elimination of Geography at Harvard, 1947-1951" *Annals of the Association of American Geographers* Vol. 77, No. 2 (Jun., 1987): 155-172.

8. Pedagogically, the disciplinary rift between engineering and architecture dealt a dramatic blow to the future of design (keeping in mind that they were practically one of the same less than a century before, for well over 2000 years). For better or worse, the Graduate School of Design and Harvard University have arguably been in the shadows of MIT - the engineering giant - especially after the World Wars and rise of military research during the Cold War. Furthermore, the research focus of both universities reveals their intentions and agendas: MIT's School of Civil & Environmental Engineering invests between 8 and 10 times more in research than Harvard University for example. See *The Top American Research Universities: 2010 Annual Report*, by the Center for Measuring University Performance (Pheonix, AZ: Arizona State University: 2010).

9. See the work of well known civil engineer, Henry Petroski, *Success through Failure: the Paradox of Design* (Princeton, NJ: Princeton University Press, 2008). In deference to other forms of design where individuals are single project authors, the engineering of infrastructure has evolved into sub-disciplines of engineering that relate the complexity of a bridge or power plant to that of an airplane, where no single discipline can claim total design, but rather because of its size, entails a level of complexity necessitating a level of cross-collaboration and interdisciplinarity that naturally grows in unprecedented ways.

10. See AnnaLisa Meyboom, "Infrastructure as Practice" *Journal for Architectural Education* Vol.62 No.4 (May 2009): 72-81.

11. See The History of the U.S. Army Corps of Engineers, by the *USACE Office of History* (Honolulu, HI: University Press of the Pacific, 2003).

12. For example, see the work of Daniel L. Schodek from the Harvard Graduate School of Design, *Landmarks in Civil Engineering* (Cambridge, MA: MIT Press, 1987).

13. Civil engineering is an outgrowth of military engineering during a prolonged period of peace at the end of the 19th century, and during a period of significant urban change at the dawn of the 20th century. Its origins are also rooted in the lesser known, yet equally important legacy of topographic engineers. See Henry P. Beers, "A History of US Topographical Engineers, 1818-1863", *The Military Engineer* 34 (June 1942): 287-91 & (July 1942): 348-52.

14. See "The 150th Engineer Combat Engineer Battalion, History & Traditions"

http://www.150th.com/history/essayons.htm

15. The disciplines of Architecture and Urban Design have further marginalized themselves by theorizing the world through the singularity of bigger and bigger buildings; a phenomenon eulogized in *Megastructures: Urban Futures of the Recent Past* (New York, NY: Harper & Row, 1976) by Reyner Banham, the exiled British urban planner to the US. Concurrently, the discipline of Urban Planning balked at the seemingly uncontrollable spread of suburbanization by promoting greater compactness and smaller footprints through regulatory controls. By postponing the emphasis of form as driver of urban economies, landscape urbanist Charles Waldheim proposes that "a focus on infrastructure" may provide "a riposte to civil engineering's impervious attitude toward the subject" while avoiding "the clichéd naiveté of much that stands for an infrastructural approach to urbanism today." See Charles Waldheim's "Urbanism after Form" in *Pamphlet Architecture 30 - Coupling: Strategies for Infrastructural Opportunism* by Infranet Lab/Lateral Office (New York: Princeton Architectural Press, 2011): 4. Acclaimed urbanist Abdoumaliq Simone takes this view radically further in "Urbanism beyond Architecture: African Cities as Infrastructure - Conversation with Filip de Boeck and Rao Vyjayanthi," in African Cities Reader edited by Ntone Edjabe and Edgar Pieterse (Vlaeberg, South Africa: African Centre for Cities & Chimurenga, 2010): 23-40.

16. This statement inflects an earlier declaration by Rem Koolhaas: "Bigness is no longer apart of any urban tissue. It exists; at most, it coexists. It's subtext is fuck context." See "Bigness or the Problem of Large," in *S, M, L, XL* (New York, NY: Monacelli Press, 1995): 502.

17. Civil engineers are typically less interested in the boutique cities that designers sponsor, often ignoring or yawning at the visions of yuppie urbanism promoted by contemporary architects and urban designers, often displayed in exceptional, three-dimensional renderings and photoshopped utopias of metropolitan life.

18. This proposition challenges the modern and industrial adage, form follows function, popularized by modern architects (Louis Sullivan and Frank Lloyd Wright, for example), and other industrial designers in the automotive industry during the early 20th century.

19. See the 5 Key Solutions proposed by the American Society of Civil Engineers that respectively rely on federal leadership, sustainability and resilience, planning, maintenance, and investment, in *The 2009 Report Card for America's Infrastructure* http://www.infrastructurereportcard.org/solutions

20. See *The 2009 Report Card for America's Infrastructure* by the American Society of Civil Engineers (ASCE): http://www.infrastructurereportcard.org/

21. The manifest relationship between urbanization and engineering has a small but growing membership that has produced a few important texts in the past decade. In an edition of the journal *The Bridge* in 1999, pre-eminent systems engineer and innovator of industrial ecology Robert A. Frosch establishes the premise and promise of urban conditions facing civil engineering. Yet its technological positivism is reflective of the distance that the discipline maintains from the spatial, ecological and social complexities in urban environments. In Frosch's words, vis-à-vis these complexities: "But be of good cheer: There is engineering work to do!" See "Facing Urbanization: The Engineering Challenges" in *The Bridge* Vol.29 No.4 (Winter 1999): 3.

22. Edwin Layton Jr.'s early manifesto in 1971, *The Revolt of Engineers: Social Responsibility and the American Engineering Profession* (Baltimore, MD: The Johns Hopkins University Press, 1986), is a rappel à l'ordre for the discipline of engineering as it faces contemporary challenges to the social vacuum and technological frame in which it operates. Beyond disciplinary confines, three of the most important thinkers in the past century to address the collective anonymity of engineers and a lack of critical discourse, include Sigfried Giedion (1888-1968), Rosalind Williams (19xx-), and Antoine Picon (19xx-), Working in separate historic periods and contexts, they have all established critical correlations and differentiations between histories, thought pro-

cesses, technological influences, technical inferences, and disciplinary cadres of engineering. See *Time, Space and Architecture: the Growth of a New Tradition* (Harvard University Press, 1941) by Sigfried Giedion, and (Cambridge: Harvard University Press, 2010), *Retooling: A Historian confronts Technological Change* (Cambridge: MIT Press, 2002) by Rosalind Williams, and "Engineers and Engineering History: Problems & Perspectives", *History and Technology* Vol. 20 No. 4 (December 2004): 421–436 by Antoine Picon. To different extents, their work aptly captures the paradoxical nature of engineering, how the practice shapes spatial patterns and transforms natural processes, obliquely proposing historiographic reviews of engineering practice as the discipline enjoys greater and greater influence on urbanism for the foreseeable future.

23. Rosalind Williams proposes that the social vacuum and technological frame in which engineers operate has lead to "the expansive disintegration of engineering", outlined in the second chapter of her *Retooling: A Historian confronts Technological Change* (Cambridge: MIT Press, 2002): 29-89.

24. There is an important legacy in the field that demonstrates the intellectual grappling with the phenomenon of decentralization. While the architectural historian Sigfried Giedion wrote the book *Space, Time & Architecture* during his Norton lectures at Harvard University in 1938-39, landscape architect Christopher Tunnard from Western Canada, who was also at the Graduate School of Design by invitation from Walter Gropius between 1938-43, completed his book *Man-Made America: Chaos or Control* while at Yale University's School of Planning afterwards. Albeit published more than a decade apart, the comparison of the two books by Giedion and Tunnard is compelling as their research was incubated almost simultaneously. Both bear striking resemblance in terms of their affinities for geographic scale and complexities engendered by the magnitude of urban change during the mid 20th century. This intellectual coincidence is not accidental nor is it insignificant. It was a response to the coupling of historic lineages between design and engineering, history and urbanism, landscape and infrastructure, from a very early beginning at the Graduate School of Design, where all fields of design could be active and involved, seemingly crossing over each other. Arguably, that coupling was severed between the 1930s and 1960s with the disappearance of geography from Harvard and other American Universities, as well as the creation of the first Urban Design Program in the world in 1960 by Catalan architect and city planner Josep Lluís Sert, then Dean of the Graduate School of Design.

25. In *Roads to Power: Britain invents the Infrastructure State* (Cambridge, MA: Harvard University Press, 2011), Landscape Historian Jo Guldi elevates the discourse on the invention of infrastructure by excavating the geopolitical context and socio-spatial effects of building infrastructure as a nation-building project. Her views emerge at a time when the discourse on infrastructure has shifted across technical, ideological, economic polarities. But Guldi reminds us of the great forces of centralization and decentralization at work across formal and informal entities such as people, cities, nations and continents. For Guldi, infrastructure is not merely an artifact of the past, but it is also a progenitor, a builder of the future.

26. In "Infrastructural Ecologies: Principles for Post-Industrial Public Works" (Places, October 2010), Hilary Brown outlines the potential for multi-purpose infrastructure by proposing how the design of urban ecologies is central to the new project of urban renewal to overcome "governmental shortcomings and obsolete bureaucracies". http://places.designobserver.com/feature/infrastructural-ecologies-principles-for-post-industrial-public-works/15568/

27. See Michael Allan Wolf, *The Zoning of America: Euclid v. Ambler* (Lawrence, KS: University Press of Kansas, 2007).

28. See "A Crisis of What? Mortgage Credit Markets and the Social Policy of Promoting Homeownership in the United States and in Europe" by Waltraud Schelkle in *Politics & Society* Vol. 40 No. 1 (March 2012): 59-80.

29. See *La Révolution Urbaine* (The Urban Revolution) by Henri Lefebvre (Paris: Galimard, 1970).

30. Decentralization is often exclusively and erroneously associated with the phenomenon of sprawl.

31. See H.G. Wells, "The Probable Diffusion of Great Cities" in Anticipations, of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought (London: Chapman & Hall, 1902): 14-26.

32. See Christopher Tunnard & Boris Pushkarev, *Man-Made America: Chaos or Control? An Inquiry into Selected Problems of Design in the Urbanized Landscape* (New Haven, CT: Yale University Press, 1963): 5.

33. Originally formulated by the landscape geographer Carl Sauer from the Berkeley School, then later reiterated by his friend and collaborator, Lewis Mumford, Sauerian students William Marsh and Jeff Dozier developed the expanded notion of 'landscape' as geographic subject in *Landscape: An Introduction to Physical Geography* (New York: John Wiley & Sons, 1981), where landscape in and of itself became lens by which to understand contemporary geography, in terms of its pre-existing processes and anthropogenic changes.

34. See Rosalind Williams, "Cultural Origins and Environmental of Large Technological Systems", *Science in Context* 6 (1993): 381, 395.

35. See Ted Nordhaus and Michael Shellenberger, "The Death of Environmentalism: Global Warming Politics in a Post-Environmental World", *Meeting of the Environmental Grantmakers Association* (October, 2004)

36. Howard Odum, *Ecological & General Systems Theory: An Introduction to Systems Ecology* (Boulder: University of Colorado Press, 1983).

37. As a modern subject, ecology can also be understood as a characterization of the resistance to the virtual and the aspatial through the inclusion of several dimensions of the spatial and dynamic: fluid, ephemeral, intransigent, incremental, and atmopsheric. The ecological subject further opens a horizon on the externalities of the virtual by extolling the effects of virtual entities, that are often considered aspatial: corporations, credit, jurisdictions, borders,...that together divide and partition systems that are most often indivisible. The challenge and opportunity of urban ecologies is to make possible a level of fragmentation that is symptomatic of complex, urban conditions, while maintaining a level of fluidity and continuity.

38. See The Club of Rome's 1970 proposal "The Predicament of Mankind" which immediately preceded the MIT Report Limits to Growth (New York: Universe Books, 1972). Both focused primarily on the problematization of the urban condition based on the assumption that population increase would outstrip food resources near the beginning of the 21st century. Outlined in Predicament of Mankind, yet absent from The Limits to Growth, is the important outline of "Continuous Critical Problems" (p.14-16) at the root of this problematization of the urban. The outline broke down the world "problématique" into an illustrative, itemized list of 49 specific problems from explosive population growth to resource extraction.

39. Funded in part by Battelle (an American-based, research laboratory and innovation institute) and Volkswagen Foundation, The Club of Rome affected an entire generation's view on the characterization of the urban as a problem, to be solved, technologically. This portrayal was based on a Neo-Malthusian vision of the future where resource depletion would outpace population growth, leading to famine, war and pollution. The work of MIT computer scientist and management engineer, Jay W. Forrester is important to consider since his theories of closed, industrial systems were applied to the modeling of world dynamics, then extrapolated by the Club of Rome with the work of other MIT scientists including Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, William W. Behrens III in Limits to Growth (New York: Universe Books, 1972).

40. Fueled in part by the overemphasis on the industrial metropolis as site and subject, the central focus on the city as the locus of urban development are attributable in part to several spatial theories including that of German geographer, Walter Christaller, in his development of "Central Place Theory". See K.H. Hottes, R. Hottes and P. Schoeller, "Walter Christaller 1893-1969" in Geographers Bibliographical Studies, Vol.7. edited by T.W. Freeman (London: Mansell, 1983): 11-16.

41. See Rosalind Williams, "Cultural Origins and Environmental of Large Technological Systems", Science in Context 6 (1993): 377-403.

42. In the reclamation of the discourse on infrastructure, geography and ecology, it is also important to note that this project has legacy that dates back to the well known inception of Landscape Architecture at Harvard in 1900, but also in the short-lived but influential legacy of the Program of Landscape Architecture at MIT, from 1900 to 1909 under the leadership of Guy Lowell. Both programs are important as they emerged during a time of technological specialization and professionalization during the urban bomb and the infrastructure boom at the start of the 20th century. Although it remained in the shadows of MIT's giant engineering world, landscape architecture at MIT maintained a commitment to the recruitment of women in the landscape architecture program, 40 years before Harvard. From those few MIT landscape architecture graduates, several of them distinctively referred to themselves as 'landscape engineers' as opposed to surrogate appellations from of other disciplines. See Eran Ben-Joseph, Holly D. Ben Joseph and Anne C. Dodge, "Against all Odds: MIT's Pioneering Women of Landscape Architecture" (Cambridge, MA: MIT School of Architecture & Planning, City Design & Development Group, 2006).

43. See David C. Schneider, "The Rise of the Concept of Scale in Ecology", *BioScience* Vol. 51 No. 7 (July 2001): 545-553.

44. 'Telescopic' refers to an operative lens that opens on different physicals extents, and temporal scales.

45. 'Stratified' refers to a layering process that reveals different levels, depths, dimensions and altitudes.

46. See Paul N. Edwards, "Infrastructure & Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems" in *Modernity and Technology* edited by Thomas J. Misa, Philip Brey and Andrew Feenberg (Cambridge, MA: MIT Press, 2003): 226.

47. Sanford Kwinter, "Mach 1 (and Other Mystic Visitations)" in Far from Equilibrium: Essays on Technology & Design Culture (Barcelona, Spain: Actar, 2008): 39, originally published in ANY 21, "How the Critic Sees" (1997).

A Primer.

This reference bibliography compiles a series of texts, maps and timelines that provide an introduction to the field of landscape from an infrastructural vantage. Responding to contemporary ecological pressures, decaying infrastructures and mobile populations worldwide, the compilation presents a series of influential views from a range of design disciplines to address pressing urban issues related to waste, water, energy, food, and mobility. Vis-à-vis the overexertion of civil engineering and the inertia of urban planning at the turn of the 21st century, the compilation re-examines influential plans and projects throughout the history of North America and other parts of the world - from Geddes to Gottmann, Mackaye to Mumford, Olmsted to Odum - towards elucidating the latent reciprocity between ecology and economy, infrastructure and urbanism, growth and decline.

Organized through a sequence of cumulative subjects, each set of readings establishes a lineage of practices, projects and paradigms historically overlooked by an exclusively Old World View of New World Urbanism. Using a reverse chronological order, the readings work backwards through the past 100 years when the urbanization of the North American continent took on new proportions at the dawn of the 20th century. The readings are further enhanced by a selection of reference maps and timelines that chart urban processes over time, further contextualizing the readings within a larger geography and broader time scale.

Challenging the laissez-faire dogma of neo-liberalist economics, Fordist forms of civil engineering, and Euclidean planning policies that marked the past century, the bibliography proposes an augmented agency for the emergent field of landscape as base operating system for urbanization. Foreshadowing the preeminence of ecology for urban regions and infrastructural systems in the future, the motive of this compilation is to open a contemporary horizon on infrastructure as design medium and to prime a clear, cogent discourse on the field of landscape as it becomes the locus of intellectual, ecological and economic significance, both regionally and globally.

As references, the texts also profile the convergence of urbanism, infrastructure and ecology, as seen through the lens of infrastructure. The texts draw from an array of urbanists, designers, ecologists, industrialists, engineers and planners, mostly from North America, who have articulated canonical views during the past century, giving relevance to the processes and patterns of contemporary urbanization. Historically segregated by the professionalization of design disciplines, the following source texts provide a foundation for the re-engagement of an urban discourse that synthesizes practices of planning, zoning, and engineering through the polyvalent agency of design:

> Rosalind Williams, "Cultural Origins and Environmental of Large Technological Systems", *Science in Context* 6 (1993): 377-403.
>
> Howard Odum, *Ecological & General Systems Theory: An Introduction to Systems Ecology* (Boulder: University of Colorado Press, 1983)
>
> William Marsh, Jeff Dozier, *Landscape: An Introduction to Physical Geography* (New York: John Wiley & Sons, 1981)
>
> Christopher Tunnard & Boris Pushkarev, *Man-Made America: Chaos or Control* (New Haven, CT: Yale University Press, 1963)
>
> Carl O. Sauer, *Agricultural Origins & Dispersals* (New York: The American Geographical Society, 1952)
>
> Sigfried Giedion, *Space, Time & Architecture: the Growth of a New Traditio*n (Cambridge, MA: Harvard University Press, 1941)

These readings open a range of contemporary urban discourses that acknowledge critical, fin-de-siècle tendencies occurring worldwide: the emergence of ecology, the revival of geography, the overexertion of engineering, the spatial apartheid of infrastructure and the inertia of urban planning vis-à-vis the pace of urban change today.

The following bibliography is organized into two main groups of texts outlining preliminary knowledge on urbanism, landscape and infrastructure (Preconditions & Processes) followed by a second, more projective section on design methodologies and directive ecologies (Projections & Protoecologies). The sub-list of texts in each section are organized in reverse chronology, starting with the most recent and contemporary reference, leading back through history (early 19th c.) to trace unique lineages across different fields of knowledge and propose relevant associations or applications.

PRECONDITIONS & PROCESSES

From Industrialization to Urbanization

Brenner, Neil & Christian Schmid. "Planetary Urbanization" in *Urban Constellations edited by* Matthew Gandy (Berlin: Jovis, 2012): 11-13.

Ouroussoff, Nicolai. "The Silent Radicals", *New York Times - Arts Section* (July 20, 2007).

Waldheim, Charles. "Landscape as Urbanism" in *The Landscape Urbanism Reader* (New York, NY: Princeton Architectural Press, 2006): 35-54.

Welter, Volker M. "The Region-City: A Step toward Conurbations and the World City" in *Biopolis: Patrick Geddes and the City of Life* (Cambridge, MA: MIT Press, 2002): 70-75.

Frampton, Kenneth. "Towards an Urban Landscape", *Columbia Documents of Architecture and Theory*, Vol.4 (1995): 83-93.

Koolhaas, Rem. "Whatever Happened to Urbanism?" in *S, M, L, XL* (New York, NY: Monacelli Press, 1995): 958-971.

Hough, Michael. "The Urban Landscape: The Hidden Frontier", *Bulletin of the Association for Preservation Technology – Landscape Preservation*, Vol.15, No.4 (1983): 9-14.

Reps, John William. "European Planning on the Eve of American Colonization" in *Making of Urban America: a History of City Planning in the United States* (Princeton, NJ: Princeton University Press, 1965): 1-25.

Wirth, Louis. "Urbanism as a Way of Life" in *Cities and Society*, edited by Paul K. Hatt and Albert J. Reiss, Jr. (Glencoe, IL: Free Press, 1957): 62-62.

Mumford, Lewis. "The Natural History of Urbanization" in *Man's Role in the Changing the Face of the Earth*, edited by William L. Thomas, Jr. (Chicago: University of Chicago Press, 1956): 382-398.

Giedion, Siegfried. Space, Time, and Architecture: The Growth of a New Tradition (Cambridge, MA: Harvard University Press, 1941).

Geddes, Patrick. "The Evolution of Cities" in *Cities in Evolution: an introduction to the town planning movement and to the study of civics* (London, UK: Williams and Norgate, 1915): 1-24.

Olmsted, Frederick Law. "Expanding Cities: Random Versus Organized Growth (1868) " in *Civilizing American Cities: Writings on City Landscapes* edited by S.B. Sutton (Cambridge, MA: MIT Press, 1971): 21-99.

*Scruton, Paul. "The New Urban World" (graphic), *The Guardian* (Saturday, June 27, 2007).

Infrastructure, & the Ascent of Civil Engineering

Bélanger, Pierre. "Redefining Infrastructure" in *Ecological Urbanism* edited by Mohsen Mostafavi and Gareth Doherty (Baden, Switzerland: Lars Müller Publishers, 2010): 332-349.

Meyboom, AnnaLisa. "Infrastructure as Practice", *Journal for Architectural Education* Vol.62 No.4 (May 2009): 72-81.

Petroski, Henry. "Things Small and Large" in *Success through Failure: the Paradox of Design* (Princeton, NJ: Princeton University Press, 2006): 97-115.

Jones, Peter. "Cultivating the Art of the Impossible" in *Ove Arup: Master Builder of the Twentieth Century* (New Haven, CT: Yale Uni-versity Press, 2006): 282-301.

Picon, Antoine. "Engineers and Engineering History: Problems and Perspectives", *History and Technology* Vol. 20, No. 4, (December 2004): 421–436.

Edwards, Paul N. "Infrastructure & Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems" in *Modernity and Technology* edited by Thomas J. Misa, Philip Brey and Andrew Feenberg (Cambridge, MA: MIT Press, 2003): 185-226.

Williams, Rosalind. *Retooling: A Historian confronts Technological Change* (Cambridge: MIT Press, 2002).

Grigg, Neil S. et al. "Civil Engineering: History, Heritage, and Future" in *Civil Engineering Practice in the Twenty-First Century: Knowledge and Skills for Design and Management* (Reston VA: ASCE Press, 2001): 13-44.

Koolhaas, Rem. "Bigness or the Problem of Large" in *S,M,L,XL* (New York: Monacelli Press, 1995): 494-517.

Schodek, Daniel L. *Landmarks in Civil Engineering* (Cambridge, MA: MIT Press, 1987).

Layton, Edwin. *The Revolt of Engineers: Social Responsibility and the American Engineering Profession* (Baltimore, MD: The Johns Hopkins University Press, 1986).

Choate, Pat and Susan Walter. "Declining Facilities/Declining Investments" in *America in Ruins: The Decaying Infrastructure* (Durham: Duke Press Paperbacks, 1983): 1-29.

de Camp, L. Sprague. *The Ancient Engineers* (New York, NY: Ballantine Books, 1960).

Ley, Willy. *Engineer's Dreams* (New York: The Viking Press, 1954).

Beers, Henry P. "A History of the U.S. Topographical Engineers, 1813-1863", *Military Engineering* 34 (June, 1942): 287-91 and (July, 1942): 348-52.

*Thom, W. Taylor. "Science and Engineering and the Future of Man" in *Science and the Future of Mankind* (World Academy of Art & Science - Series 1) edited by Hugo Boyko (Bloomington, IN: Indiana University Press, 1961): 256.

Whatever Happened to Planning?
Zoning, after Euclid

Wolf, Michael A. "On the Road to Zoning" in *The Zoning of America: Euclid vs. Ambler* (Lawrence, KS: University Press of Kansas, 2008): 17-31.

Light, Jennifer S. "Introduction" and "Planning for the Atomic Age" in *From Warfare and Welfare: Defense Intellectuals and Urban Problems in Cold War America* (Baltimore, MD: The John Hopkins University Press, 2003): 1-31.

Davidson, Joel. "Building for War, Preparing for Peace: World War II and the Military-Industrial Complex" in *World War II and the American Dream: How Wartime Building Changed a Nation* edited by Donald Albrecht (Cambridge, MA: MIT Press, 1995): 184-229.

Nelson, Robert H. "Zoning Myth and Practice - from Euclid into the Future" in *Zoning and the American Dream* edited by Jerold Kayden and Charles M. Haar (Chicago, IL.: Planners Press, 1989): 299-318.

Boyer, M. Christine. "The Rise of the Planning Mentality" in *Dreaming the Rational City: The Myth of American City Planning* (Cambridge, MA: MIT Press, 1983): 59-82.

Galbraith, John Kenneth. "The Planning System" in *Economics and the Public Purpose* (New York, NY: Penguin Books, 1973): 96-190.

Wilhem, Sidney W. "Introduction" in *Urban Zoning and Land Use Theory* (New York: Free Press of Glencoe, 1962): 1-11.

Wiener, Norbert. "How US Cities Can Prepare for Atomic War", *Time Magazine* Life Publications (Dec. 18 1950): 77-86.

Hilberseimer, Ludwig. "Cities and Defense (c.1945)" in *In the Shadow of Mies: Ludwig Hilberseimer: Architect, Educator and Urban Planner* by Richard Pommer, David Spaeth and Kevin Harrington with selected writings by Ludwig Hilberseimer (Chicago, IL: Art Institute of Chicago & Rizzoli International, 1988): 89-93.

*Choay, Françoise. "The Modern City: Planning in the 19th Century" in *Planning and Cities* edited by George R. Collins (London: Studio Vista, 1969): 121-125.

Sub-Urbanization & Super-Urbanization

Segal, Rafi. "Urbanism Without Density" in *Architectural Design AD* Vol. 78, No. 1 (Jan.-Feb. 2008): 6-11.

Davis, Mike. "The Urban Climateric" and "the Prevalence of Slums" in *Planet of Slums* (New York, NY: Verso, 2006): 1-19, 20-50.

Bruegmann, Robert. "Defining Sprawl" and "Early Sprawl" in *Sprawl: A Compact History* (Chicago, IL: University of Chicago Press, 2005): 17-20, 21-32.

Sieverts, Thomas. "The Living Space of the Majority of Mankind: an Anonymous Space with no Visual Quality" in *Cities without Cities* (London, UK: Spon Press, 2003): 1-47.

Simone, AbdouMaliq. "At the Frontier of the Urban Periphery" in *Sarai Reader 2007: Frontiers* edited by Monica Narula, Shuddhabrata Sengupta, Jeebesh Bagchi and Ravi Sundaram (Delhi, India: Centre for the Study of Developing Societies, 2007): 462-470.

Lerup, Lars. "Stim and Dross: Rethinking the Metropolis" in *After the City* (Cambridge, MA: MIT Press, 2000): 46-63.

Harvey, David. "Flexible Accumulation through Urbanization, Reflections on Post-Modernism in the American City" in *Post-Fordism: A Reader* edited by Ash Amin (Cambridge, MA: Blackwell, 1994): 361-386.

Gottman, Jean. "The Main Street of the Nation" and "The Dynamics of Urbanization" in *Megalopolis* (New York, NY: Twentieth Century Fund, 1961): 3-22.

Wright, Frank Lloyd. "Decentralization" in The Living City (New York: Horizon Press, 1958): 77-105.

Gruen, Victor. "Dynamic Planning for Retail Areas", *Harvard Business Review* (Nov.-Dec. 1954): 53-62.

*Thomas, Gary Scott. "Micropolitan America" (map) in *American Demographics* 20 (1 May 1989): 1-2, and U.S. Department Of Commerce Economics and Statistics Administration, *Metropolitan and Micropolitan Statistical Areas of the United States and Puerto Rico* (Washington DC: US CENSUS Bureau Geography Division, December, 2006).

Ecological Emergence & Urban Complexity

Reed, Chris. "The Agency of Ecology" in *Ecological Urbanism* edited by Mohsen Mostafavi and Gareth Doherty (Baden, Switzerland: Lars Müller Publishers, 2010): 324-329.

Del Tredici, Peter. "Brave New Ecology", *Landscape Architecture* 96 (February, 2006): 46-52.

Kangas, Patrick. "Designing New Ecosystems" and "Principles of Ecological Engineering" in *Ecological Engineering: Principles and Practice* (Boca Raton, FA: CRC Press, 2004): 13-24.

Nordhaus, Ted and Shellenberger, Michael. "The Death of Environmentalism: Global Warming Politics in a Post-Environmental World", *The Break Through Institute*, http://thebreakthrough.org/PDF/Death_of_Environmentalism.pdf

Mol, Arthur P.J. "The Environmental Transformation of the Modern Order" in *Modernity and Technology* edited by Thomas J. Misa, Philip Brey and Andrew Feenberg (Cambridge, MIT Press, 2003): 303-325.

Forman, Richard T.T. "The Emergence of Landscape Ecology" in *Landscape Ecology* edited by Richard T.T. Forman and Michel Godron (New York, NY: John Wiley & Sons, 1986): 3-31.

Odum, Howard T. "Cities and Regions" in *Ecological and General Systems: An Introduction to Systems Ecology* (New York, NY: John Wiley & Sons, 1983): 532-553.

McHale, John. "Dimensions of Change", "An Ecological Overview" in *The Future of the Future* (New York, NY: Braziller, 1969): 57-74.

McHarg, Ian. "An Ecological Method for Landscape Architecture", *Landscape Architecture* 57 (January 1967): 105-107.

Sears, Paul B. "Ecology - A Subversive Subject", *Bioscience* Vol.14 No.7 (1964): 11-13.

*Amir Djalali with Piet Vollaard. "The Complex History of Sustainability: An Index of Trends, Authors, Projects and Fiction", *VOLUME* #18 - After Zero (2008): 33-41.

PROJECTIONS & PROTOECOLOGIES

Constructed Ecologies & Soft Systems

Bélanger, Pierre. "Landscape as Infrastructure", *Landscape Journal* 28 (Spring 2009): 79-95.

Allen, Stan. "Infrastructural Urbanism" in *Points + Lines: Diagrams for the City* (New York, NY: Princeton Architectural Press, 1999): 46-89.

Corner, James. "Eidetic Operations & New Landscapes" in *Recovering Landscape: Essays in Contemporary Landscape Architecture*, edited by James Corner (New York: Princeton Architectural Press, 1999): 153-170.

Frampton, Kenneth. "Megaform as Urban Landscape", *1999 Raoul Wallenberg Lecture* (Ann Arbor, MI: University of Michigan Press, 1999): 1-42.

Corner, James. "Measures of Land" and "Measures of Control" in *Taking Measures Across the American Landscape* (New Haven, CT: Yale University Press, 1996): 41-96.

Easterling, Keller. "Network Ecology", *Landscapes - Felix Journal of Media Arts & Communication* 2 No.1 (1995): 258-265.

Banham, Reyner. "Antecedents, Analogies, and Mégastructures trouvées" in *Megastructures: Urban Futures of the Recent Past* (London, UK: Thames and Hudson, 1976): 13-32.

Jackson, John Brinkerhoff. "The Public Landscape (1966)" in *Landscapes: Selected Writings by J.B. Jackson* edited by Ervin H. Zube (Amherst: The University of Massachusetts Press, 1970): 153-160.

Lynch, Kevin. "Earthwork & Utilities" in *Site Planning* (Cambridge: MIT Press, 1962): 157-188.

Ely, Richard T., and George S. Wehrwein. *Land Economics* (New York, NY: The MacMillan Company, 1940): 1-23, 50-73.

Mumford, Lewis. "The Renewal of the Landscape" in *The Brown Decades: A Study of the Arts of America*, 1865-1895 (New York, NY: Dover Publications, 1931): 75-106.

*Bélanger, Pierre. "Venice Lagoon 2100: A Strategy for the economy and ecology of the Venice Lagoon" in *Concurso 2G Competition: Venice Lagoon Park* edited by Mónica Gili (Barcelona, Spain: 2G International Review, 2008): 52-53, with Odum, Howard T. "Representative City System" in Ecological and General Systems (New York, NY: John Wiley & Sons, 1983): 548.

Water:
Public Works, Hydrological Systems & Coastal Dynamics

Mathur, Anuradha and Dilip Da Cunha. "Monsoon in an Estuary" and "Estuary in a Monsoon" in *SOAK: Mumbai in an Estuary* (New Delhi, India: Rupa and Co., 2009), 3-9, 185-187.

De Meulder, Brian and Kelly Shannon. "Water and the City: the 'Great Stink' and Clean Urbanism" in *Water Urbanisms* edited by De Meulder, V. d'Auria, J. Gosseye and K. Shannon (Amsterdam, NL: SUN, 2008): 5-9.

Barles, Sabine. "The Nitrogen Question", *Journal of Urban History* 33 (2007): 794-812.

Picon, Antoine. "Constructing Landscape by Engineering Water" in *Landscape Architecture in Mutation: Essays on Urban Landscapes by Institute for Landscape Architecture*, ETH Zurich (Zurich, Switzerland: gta Verlag, 2005), 99-114.

Schlesinger, Arthur M., Jr. "The Battle for Public Development and Remaking the Tennessee Valley" in *The Coming of the New Deal, 1933-1935* (Boston, MA: Houghton Mifflin, 2003): 319-334.

Wolff, Jane. "A Brief History of the Delta" in *Delta Primer: A Field Guide to the Cali-fornia Delta* (San Francisco, CA: William Stout Publishers, 2003): 37-45.

Gandy, Matthew. "Water, Space, and Power" in *Concrete and Clay: Reworking Nature in New York City* (Cambridge, MA: MIT Press, 2002): 19-75.

Melosi, Martin. "Pure and Plentiful: from Protosystems to Modern Water Works", "Subterranean Networks: Wastewater Systems as Works in Progress" in *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: John Hopkins University Press, 2000): 50-68.

Rogers, Peter. "Water Resources and Public Policy" in *America's Water: Federal Roles and Responsibilities* (Cambridge, MA: MIT Press, 1993): 1-24.

Leuba, Clarence. "The Tennessee Valley Authority: Accomplishments & Disappointments" in *A Road to Creativity: Arthur Morgan - Engineer, Educator, Administrator* (North Quincy, MA: The Christopher Publishing House, 1971): 163-202.

Illich, Ivan. "The Dirt of Cities" in *H20 & The Waters of Forgetfulness* (London, UK: Maryon Boyars Publishers, 1986): pp.45-76.

Wolman, Abel. "The Metabolism of Cities", *Scientific American* Vol. 213 No.3 (1965): 178-193.

*Bélanger, Pierre. "Risk Landscape: Coastal Flood Zones, Land Reclamation & Hypotrophic Zones of the World" (graphic) in *Maasvlakte 2100* by OPSYS (Rotterdam, Netherlands: Rotterdam Port Authority, 2010): 171-172.

Waste:
Landscape of Surplus, Cycling & Accumulation

Bélanger, Pierre. "Airspace: The Ecologies and Economies of Landfilling in Michigan and Ontario" in *Trash* edited by John Knechtel (Cambridge, MA: MIT Press, 2006): 132-155.

Berger, Alan. "The Production of Waste Landscape" and "Post-Fordism: Waste Landscape through Accumulation" in *Drosscape: Wasting Land in Urban America* (New York: Princeton Architectural Press, 2006): 46-52, 53-75.

Engler, Mira. "Contemplating Waste: Theories and Constructs" in *Designing America's Waste Landscapes* (Baltimore, MD: Johns Hopkins University Press, 2004): 1-41.

Berger, Alan. "The Altered Western Landscape" in *Reclaiming the American West* (New York, NY: Princeton Architectural Press, 2002): 15-55.

Bélanger, Pierre. "Jankara Jetty: Recycling Cloverleaf", and "Ebute Ero: Market Economies" in *Harvard Project on the City: Lagos* edited by Rem Koolhaas and Jeffrey Inaba (Cambridge, MA: Graduate School of Design, 2000).

Kirkwood, Niall. “Manufactured Sites: Integrating Technology and Design in Reclaimed Landscapes” in *Manufactured Sites: Re-Thinking the Post-Industrial Landscape* edited by Niall Kirkwood (London, UK: SPON Press, 2001): 3-11.

Miller, Benjamin. “Prologue: Garbage” in *Fat of the Land: Garbage in New York - The Last Two Hundred Years* (New York, NY: Four Walls Eight Windows, 2000): 1-16.

Hawken, Paul. “The Creation of Waste” in *The Ecology of Commerce: A Declaration of Sustainability* (New York, NY: Harper Collins, 1993): 37-55.

Frosch, Robert A. and Nicholas E. Gallopoulos. “Strategies for Manufacturing”, *Scientific American* - Special Issue: Man-aging Planet Earth (1989): 94-102.

Ford, Henry. “Learning from Waste” in *Today and Tomorrow* (Garden City, NY: Doubleday, Page, 1926): 89-98.

*Bélanger, Pierre. “Shit City: Aggregate landscape of waste flows, exchanges and synergies accumulated during the past five centuries in the Port of Rotterdam“ (graphic) in *Maasvlakte 2100* by OPSYS (Rotterdam, Netherlands: Rotterdam Port Authority, 2010): 60-61.

Food:
Agrarian Landscapes, Market Economies,
& Harvest Regions

Imbert, Dorothée. “Let Them Eat Kale”, *Architecture Boston* (Fall 2010): 24-26.

Rice, Andrew. “Agro-Imperialism?”, *NY Times Magazine* (Nov. 2, 2009): 46-51.

Bélanger, Pierre and Angela Iarocci. “Foodshed: The Global Infrastructure of the Ontario Food Terminal” in *TRASH* edited by John Knechtel (Cambridge, MA: MIT Press, 2007): 116-138.

Pollan, Michael. “The Farm” in *The Omnivore’s Dilemma: a Natural History of Four Meals* (New York, NY: Penguin Press, 2006): 32-56.

Branzi, Andrea. “Agronica” in *Weak & Diffuse Modernity: The World of Projects at the Beginning of the 21st century* (Milan, IT: Skira, 2006): 132-146.

Mazoyer, Marcel and Laurence Roudart. “Humanity’s Agrarian Heritage” in *A History of World Agriculture: From the Neolithic Age to the Current Crisis*, trans. James H. Membrez (New York, NY: Monthly Review Press, 2006): 9-26.

Diamond, Jared. “From Food to Guns, Germs and Steel: The Evolution of Technology” in *Guns, Germs, and Steel: The Fates of Human Societies* (New York, UK: Norton & Company, 1999): 239-264.

Hough, Michael. “City Farming” in *Cities & Natural Process: A Basis for Sustainability* (London, UK: Routledge, 1995): 160-188.

Giedion, Siegfried. “Mechanization and the Soil: Agriculture” in *Mechanization Takes Command: A Contribution to an Anonymous History* (New York, NY: W.W. Norton, 1969): 130-147.

Hedden, Walter P. “The Food Supply of a Great City” in *How Great Cities are Fed* (New York, NY: D.C. Heath, 1929): 1-16.

Piotr Kropotkin, “The Possibilities of Agriculture” (Chapters 3-4) in *Fields, Factories And Workshops: or Industry Combined with Agriculture and Brain Work with Manual Work* (London, UK: Thomas Nelson & Sons, 1912): 79-187.

*Brandford, Sue. “Global Land Grab” (graphic), The Guardian (22 November 2008). Bélanger, Pierre. Global Foodshed & PLU Landscape (graphic) (Toronto, ON: Ontario Food Terminal Board, 2007).

Fuel: Energy Networks & the Carbon Landscape

Ghosn, Rania. “Energy as Spatial Project” in *Landscapes of Energy - New Geographies Journal* 02 (2009): 7-10.

Friedmann, S. Julio and Thomas Homer-Dixon. “Out of the Energy Box”, *Foreign Affairs*, Volume 83, No. 6 (Novem-ber/December 2004): 72-83.

Ascher, Kate. “Power” in *The Works: Anatomy of a City* (New York, NY: Penguin Press, 2005): 94-121.

Jakob, Michael. “Conversation with Paul Virilio”, and “Architecture and Energy or the History of an Invisible Presence” in *2G International Architecture Review* No. 18 (2001): 4-32.

Brennan, Teresa. “Energetics” in *Exhausting Modernity: Grounds for a New Economy* (New York: Routledge, 2000): 41-54.

Ausubel, Jesse H. “The Liberation of the Environment: Technological Development and Global Environmental Change”, *Daedalus* Vol.125 No.3 (Summer 1996): 1-17.

Dozier, Jeff and William Marsh. “Energy Processes on the Earth’s Surface” in *Landscape: An Introduction to Physical Geography* (Reading, MA: Addison-Wesley Publishing, 1981): 1-20.

Ilich, Ivan. *Energy and Equity* (London, UK: Calder and Boyars, 1974): 1-29.

Odum, Howard T. “Energy, Ecology, Economics”, *Ambio* Vol.2 No.6 Energy in Society: A Special Issue (1973): 220-227.

Mumford, Lewis. “Power & Mobility” in *Technics and Civilization* (New York, NY: Harcourt, Brace & Company, 1934): 235-239.

*Bélanger, Pierre. “Power Perestroika” in New Geographies 02 - *Landscapes of Energy* edited by Rania Ghosn (Cambridge, MA: Harvard University Press): 119-124.

Logistics:
Industrialization, Decentralization & Disassembly

Waldheim, Charles and Alan Berger. “Logistics Landscape” in *Landscape Journal* Vol.27 No.2 (2008): 219-246.

Bélanger, Pierre. “Landscapes of Disassembly” in *Topos* 60 (October, 2007): 83-91.

Schumacher, Patrik and Christian Rogner. “After Ford” in *Stalking Detroit* edited by Georgia Daskalakis, Charles Waldheim and Jason Young (Actar, Barcelona, 2001): 48-56.

Nash, Gary B. “The Social Evolution of Pre-Industrial American Cities, 1700-1820” in *The Making of Urban America*, edited by Raymond A. Mohl (Wilmington, Del.: Scholarly Resources, 1997): 15-36.

Dandaneau, Steven P. “Introduction: Ideology and Dependent Deindustrialization” in *A Town Abandoned: Flint, Michigan Confronts Deindustrialization* (Albany State University of New York Press, 1994): xix-xxviii.

Garreau, Joel. “The Foundry” in *The Nine Nations of North America* (New York: Houghton Mifflin Co., 1981): 48-97.

Conway, McKinley. “Emergence of the Park Concept and Proliferation of Units” and “Types of Parks” in *Industrial Park Growth: an Environmental Success Story* (Atlanta: Conway Publications, 1979):5-20, 45-62.

Galbraith, John Kenneth. “The Nature of Industrial Planning” in *The New Industrial State* (Boston: Houghton Mifflin Company, 1967): 25-41.

Reps, John William. “The Towns that Companies Built” in *Making of Urban America: a History of City Planning in the United States* (Princeton, NJ: Princeton University Press, 1965): 414-448.

Mumford, Lewis. “Paleotechnic Paradise: Coketown” in *The City in History* (New York: Harcourt Brace Jovanovich, 1961): 446-481.

*Bélanger, Pierre. “Kalundborg’s Protoecology & Wasteshed” (graphic) in *Topos* 60 (October, 2007): 88, and Fuller, Buckminster. *Acceleration in the Discoveries of Science: Profile of the Industrial Revolution* (1946, 1964).

Mobility I:
Speed, Transportation & Surface Networks

Guldi, Jo. “Road to Rule” in *Roads to Power: Britain Invents the Infrastructure State* (Cambridge: Harvard University Press, 2012): 1-24.

Bélanger, Pierre. “Synthetic Surfaces” in *The Landscape Urbanism Reader* edited by Charles Waldheim (New York: Princeton Architectural Press, 2006): 239-265.

Schnapp, Jeffrey T. “Three Pieces of Asphalt” in *Grey Room 11* (Spring, 2003): 5-21.

McPhee, John. “Fleet of One: Eighty thousand Pounds of Dangerous Goods” in *The New Yorker - Annals of Transport* Section, (February 17-24, 2003): 148-162.

Gregotti, Vittorio. “The Road: Layout and Built Object” in *Casabella* No.553-554 (January-February 1989): 2-5, 118.

Virilio, Paul. “The Dromocratic Revolution” in *Speed & Politics: An Essay on Dromology*, translated by Mark Polizzotti (New York: Autonomedia Press, 1986): 1-34.

Mumford, Lewis. “Landscape and Townscape”, “The Highway and the City” in *The Highway and the City* (Westport, CT: Greenwood Press, 1981): 233-256.

Frampton, Kenneth. “The Generic Street as a Continuous Built Form” in *On Streets* edited by Stanford Anderson (Cam-bridge: The Institute for Architecture and Urban Studies, MIT Press, 1978): 308-336.

Newton, Norman T. “Parkways and Their Offpsring” in *Design on the Land: The Development of Landscape Architecture* (Cambridge: Belknap Press of Harvard University Press, 1971): 596-619.

Ritter, Paul. “History of Traffic Segregation” in *Planning for Man and Motor* (Oxford: Pergamon Press, 1964): 314-330.

Jellicoe, Sir Geoffrey “Segregation of Traffic” in *Motopia: Evolution of the Urban Landscape* (New York: Praeger, 1961): 117-140.

Olmsted, Frederick Law. “History of Streets” (Washington, D.C.: Frederick Law Olmsted Papers, Manuscript Division, Library of Congress, 1888).

*Staley, E. “Technical Progress in Travel Time” (graphic) in *World Economy in Transition* (New York: Council on Foreign Relations, 1939): 6.

Mobility II:
Communications, Broadband
& Subterranean Urbanism

NY Times, “A Plan for Broadband”, *New York Times* OP-ED Section (Sunday, March 21, 2010): 1.

Wu, Tim. “Bandwidth Is the New Black Gold”, *Time Magazine* (Thursday, Mar. 11, 2010)

Schnapp, Jeffrey T. “Fast (Slow) Modern” in *Speed Limits* (Montreal, QC: CCA, 2009): 26-37.

Varnelis, Kazys. “Invisible City: Telecommunications” in *The Infrastructural City: Networked Ecologies in Los Angeles* (Barcelona; New York: Actar, 2008): 118-129.

Bélanger, Pierre. “Underground Landscape: The Urbanism & Infrastructure of Toronto’s Downtown Pedestrian Network”, *Journal of Underground Space and Tunnelling* Vol. 22 No.3 (October 2006): 272-292.

Alonzo, Eric. “De la place-carrefour à l’échangeur, instrumentalisation du système giratoire” and “Le réseau des giratoires, vers une nouvelle organisation des territoires urbains”, in *Du Rond-Point au Giratoire* (Paris, FR: Parenthèses, 2005): 84-100, 127-33.

Wall, Alex. “Programming the Urban Surface” in *Recovering Landscape: Essays in Contemporary Landscape Architecture* edited by James Corner (New York: Princeton Architectural Press, 1999): 233-250.

Schmandt, Jurgen, Frederick Williams, Robert H. Wilson and Sharon Strover, editors. “Introduction” in *The New Urban Infrastructure: Cities and Telecommunications* (New York: Praeger, 1990): 1-6.

McCluskey, Jim. “Networks” in *Road Form and Townscape* (London: Architectural Press, 1979): 12-38.

Giedion, Siegfried. “Movement” in *Mechanization Takes Command: A Contribution to an Anonymous History* (New York: W.W. Norton, 1969): 14-44.

*McHale, John. “Vertical Mobility” (graphic) in *The Future of the Future* (New York: Braziller, 1969): 69.

From Globalization to Regionalization

Bélanger, Pierre. “Regionalisation”, *JOLA - The Journal of Landscape Architecture* (Fall 2010): 6-23.

Forman, Richard T. T. “Urban Region Planning” in *Urban Regions: Ecology and Planning Beyond the City* (Oxford: Cambridge University Press, 2008): 45-50.

Wolff, Jane. “Redefining Landscape” in *The Tennessee Valley Authority: Design and Persuasion edited by Tim Culvahouse* (New York: Princeton Architectural Press, 2007): 52-63.

Easterling, Keller. “Partition: Watershed & Wayside” in *Organization Space: Landscapes, Houses and Highways in America* (Cambridge: MIT Press, 1999): 54-66.

Branzi, Andrea. “The Hybrid Metropolis” in *Learning from Milan: Design and the Second Modernity* (Cambridge, MA: MIT Press, 1988): 20-24.

Gregotti, Vittorio. “La Forme du Territoire (The Shape of Landscape)”, *AA L’Architecture d’Aujourd’hui* No. 218 (December 1981): 10-15.

Dal Co, Francesco. “From Parks to the Region: Progressive Ideology and the Reform of the American City” in *The American City: From the Civil War and the New Deal* edited by Giorgio Cucci, Francesco Dal Co, Mario Manieri-Elia and Manfredo Tafuri (Cambridge, MA: MIT Press, 1979): 143-292.

McHarg, Ian. “The City: Process & Form” in *Design with Nature* (Garden City, NY: Natural History Press, 1969): 175-186.

Odum, Howard W. and Harry Estill Moore. “The Rise and Incidence of American Regionalism” in *American Regionalism: A Cultural-Historical Approach to National Integration* (New York: Henry Holt & Company, 1938): 3-34.

Mackaye, Benton. “Appalachian America – A World Empire” in *The New Exploration: A Philosophy of Regional Planning* (New York, NY: Harcourt, Brace and Company, 1928): 95-119.

APPENDIX

Landscape Cartography & the Agency of Mapping

Rosenberg, Daniel & Anthony Grafton. *Cartographies of Time* (New York, NY: Princeton Architectural Press, 2010).

Dodge, Martin, Perkins, Chris, and Kitchin, Rob. “Mapping Modes, Methods and Moments: A Manifesto for Map Studies” in *Rethinking Maps: New Frontiers in Cartographic Theory* (New York: Routledge, 2009): 220-243.

Schäfer, Wolf. “Ptolemy’s Revenge: A Critique of Historical Cartography” in *Coordinates* Series A-3 (August 29, 2005): 1-16.

Archibald, Sasha, and Rosenberg, Daniel. “A Timeline of Timelines”, *Cabinet* 13 - Futures (Spring 2004).

Cosgrove, D. “Mapping Meaning” in *Mappings* (London: Reaktion, 1999): 1-23.

Kwinter, Sanford. “The Genealogy of Models”, *Any* 23: Diagram Work (Fall 1998): 59.

Corner, James. “Aerial Representation & The Making of Landscape” in *Taking Measure across the American Landscape* by James Corner & Alex S. Mclean (New Haven, CT: Yale University Press, 1996): 15-20.

O’Hara, Robert J. “Representations of the Natural System in the Nineteenth Century” in *Biology and Philosophy* 6 (1991): 255-274.

Monmonier, Mark S. “Introduction” in *How to Lie with Maps* (Chicago, IL: University of Chicago Press, 1991): 1-4.

Harley, J.B. “Deconstructing the Map”, *Cartographica* 26: 2 (1989): 1-20.

Harley, J.B. “Maps, Knowledge, and Power” in *The Iconography of the Landscape* edited by D. Cosgrove and S. Daniels (Cambridge: Cambridge University Press, 1988): 277-312.

Wood, Denis. and Fels, John. “Designs on Signs / Myth and Meaning in Maps” in *Cartographica* Vol.23 No.3 (1986): 54-103.

Bertin, Jacques. *Sémiologie Graphique: Les Diagrammes, les Réseaux, les Cartes* (Paris, FR: Gauthier-Villars, 1967).

Fisher, Howard T. *Mapping Information: The Graphic Display of Quantitative Information* (Cambridge, MA: Abt Books, 1982).

Bunge, William. *Theoretical Geography* (Lund, Sweden: Gleerup, 1962).

Urban Hazards: Risk, Contingency & Indeterminate Landscapes

Meyer, Elizabeth K. “Slow Landscapes” in *Harvard Design Magazine* Vol. 31 (Fall/Winter 2010): 22-31.

Lister, Nina-Marie. “Bridging Science and Values: The Challenge of Biodiversity Preservation” in *The Ecosystem Approach* edited by James J. Kay, Nina-Marie E. Lister and David Waltner-Toews (New York, NY: Columbia University Press, 2008): 83-108.

Berrizbeitia, Anita. “Re-Placing Process” in *Large Parks* edited by Julia Czerniak and George Hargreaves (New York, NY: Princeton Architectural Press, 2007): 175-198.

Klemeš, Vit. “Risk Analysis: The Unbearable Cleverness of Bluffing” in *Risk, Reliability, Uncertainty, and Robustness of Water Resource Systems* edited by János Bogárdi and Zbigniew Kundzewicz (Cambridge, UK: Cambridge University Press, 2002): 22-29.

Mathur, Anuradha. “Mississippi Horizons” in *Mississippi Floods: Designing a Shifting Landscape* (New Haven, CT: Yale Uni-versity Press, 2001): 1-31.

Latz, Peter. “The Idea of Making Time Visible”, *Topos* Vol. 33 (2000): 94-99.

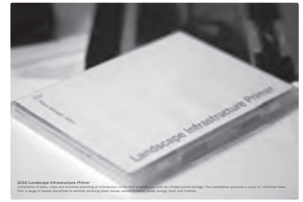
Beck, Ulrich. “Environment, Knowledge, and Indeterminacy: Beyond Modernist Ecology?” in *Risk, Environment & Modernity* edited by Scott Lash, Bronislaw Szerszynski and Brian Wynne (London, Sage Publications, 1996): 27-43.

Forman, Richard T. T. “Landscape Change” in *Landscape Ecology* by Richard T. T. Forman and Michel Godron (New York: Wiley, 1986): 427-458.

Perrow, Charles. “Living with High-Risk Technologies” in *Normal Accidents: Living with High-Risk Technologies* (New York: Basic Books, 1984): 305-352.

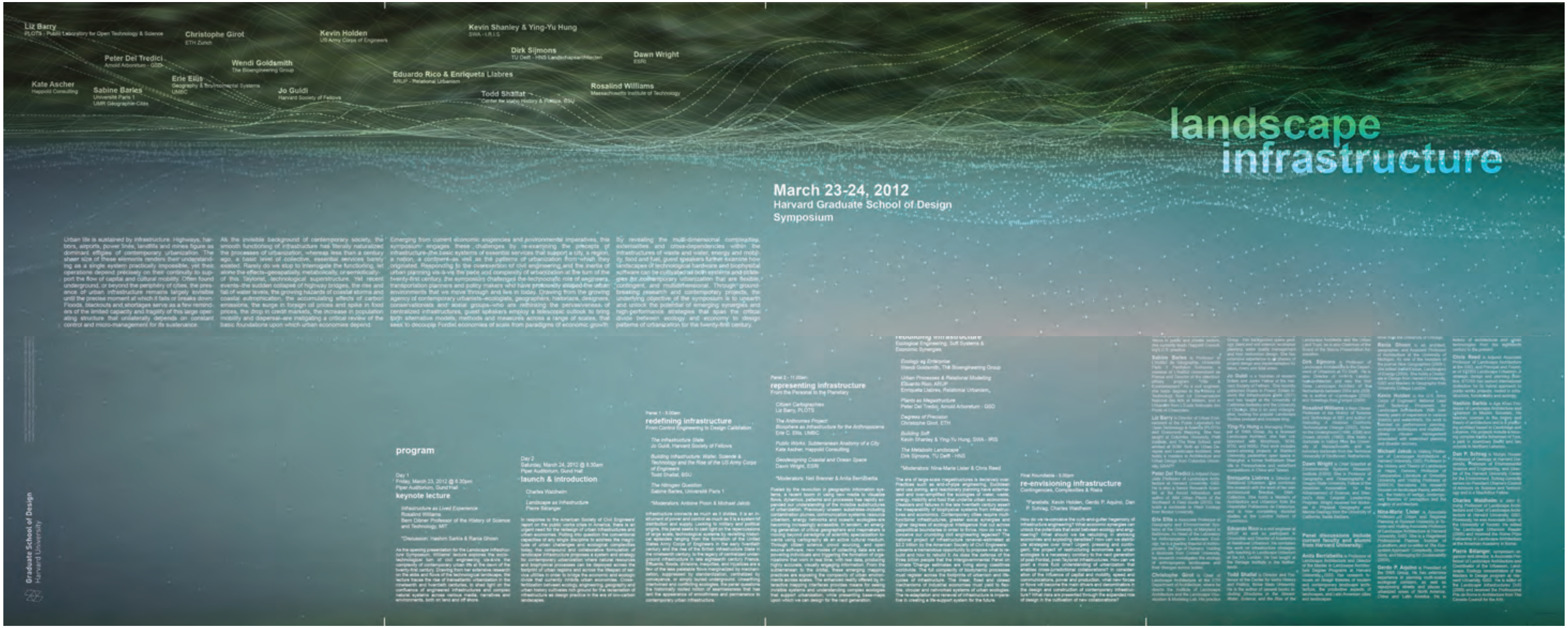
Appendix.

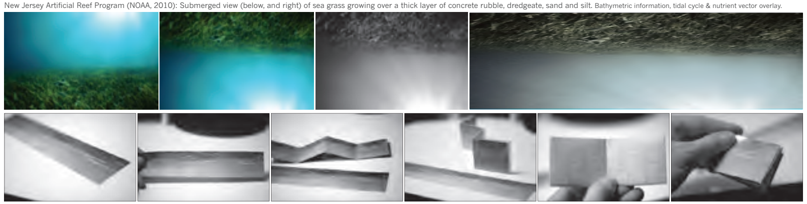
Landscape Infrastructures Conference & Exhibition (University of Toronto, 2009)



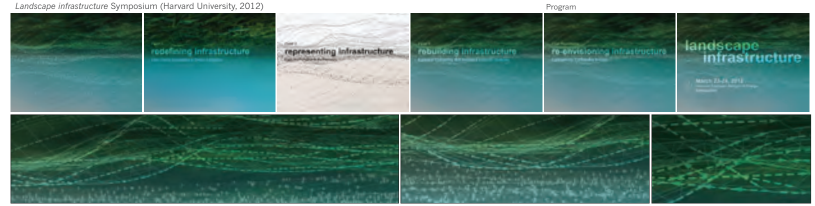
Landscape Infrastructure Primer (Reference Reader, 2011)

Landscape Infrastructures DVD (Conference Proceedings, 2010)





New Jersey Artificial Reef Program (NOAA, 2010): Submerged view (below, and right) of sea grass growing over a thick layer of concrete rubble, dredgeate, sand and silt. Bathymetric information, tidal cycle & nutrient vector overlay.



Landscape infrastructure Symposium (Harvard University, 2012)

Program

Harvard GSD - USACE

Landscape Infrastructure Internship

Harvard University's Graduate School of Design (GSD) and the U.S. Army Corps of Engineers (USACE) have teamed up to present the first annual design internship in landscape infrastructure. Dedicated to expanding the involvement of designers in the role of infrastructure in the US and abroad, the internship provides a one-a-kind experience to work in a range of Corps regions, nationally and internationally. With a focus on the areas of design, planning, construction, technology and ecology, the activities and facilities taken on by the Corps involve watersheds and water resources, rivers & dams, harbors & dredging, levees and spillways, reclamation and restoration, as well as military facilities such as bases, airfields and transportation systems.

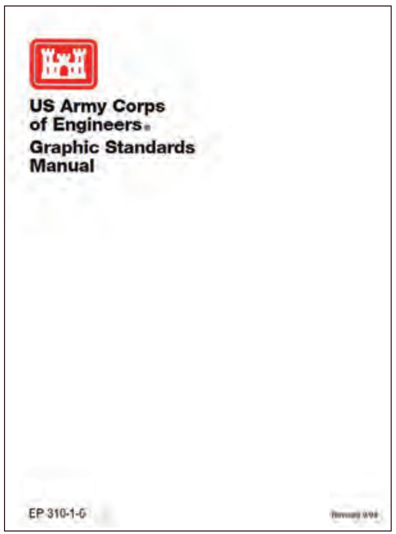
Internship opportunities engage the full spectrum of disciplines that involve designers and planners including engineering, ecology, energy, economics and geography. Through immersion with the Corps, the internship will provide a once-in-a-lifetime opportunity for graduate students to interact with a body of civilian and military personnel involved in a range of urban-based projects that are combining regional flood programs with recreational amenities, port dredging programs with mine reclamation techniques, or disaster reconstruction projects with urban renewal plans. The Harvard GSD - USACE internship offers a unique experience to gain design experience and leadership in a national agency of international recognition through personal insight to specific construction techniques, infrastructure design standards, regional watershed planning methods, R&D activities, and national program innovations that are on the cutting edge of ecological engineering, landscape infrastructure and geospatial design. The Corps is energizing the economy by dredging America's waterways to support the movement of critical commodities and providing recreation opportunities at our campgrounds, lakes and marinas. And by devising hurricane and storm damage reduction infrastructure, the Corps is reducing risks from disasters. Our men and women are protecting and restoring the Nation's environment including critical efforts in the Everglades, the Louisiana coast, and along many of our Nation's major waterways. The Corps is also cleaning sites contaminated with hazardous, toxic or radioactive waste and material in an effort to sustain the environment. Together, the GSD and the Corps invites young, and emerging design professionals to apply and join in this unique professional experience.

About the GSD
The Harvard Graduate School of Design (GSD) is a professional graduate school at Harvard University. It offers several masters degree programs in Landscape Architecture, Urban Planning and Architecture as well as a range of post-graduate studies program and executive education opportunities. As the leading design school in the US, the GSD's international faculty provides a broad range of design philosophies and visions that engage the future of urbanism, landscape and ecology.

About the USACE
The US Army Corps of Engineers (USACE) is the world's premier engineering agency, with approximately 37,000 dedicated civilians and soldiers delivering engineering services to customers in more than 90 countries worldwide. With environmental sustainability as its guiding principle, the Corps team works diligently to strengthen the Nation's security by building and maintaining America's infrastructure and providing military facilities where service members train, work and live.

For more information, contact:
Pierre Bélanger, Associate Professor of Landscape Architecture, Harvard Graduate School of Design
Kevin Holden, Community of Practice Leader - Landscape Architecture, US Army Corps of Engineers

Harvard GSD Landscape Infrastructure Internship


US Army Corps
of Engineers®
Graphic Standards
Manual

EP 310-1-6

About the Format

The layout and format of this document is based on, and adapted from the Graphic Standards Manual (EP 310-1-6), a guideline for the production of a variety of different media and communications published by the US Army Corps of Engineers. Typographic recommendations combine three standard typefaces (Century Schoolbook, Times New Roman, Helvetica) for readability and clarity. Revered for its legibility, the official use of the Swiss typeface 'Helvetica' is commonly substituted with its North American equivalent, the Arial family of fonts (combined here with the use of News Gothic MT). The publication format is a hybrid between the standard 8.5"x 11" Quality Publication/Technical Publication types that use a variable three-column working grid as a base structure for the organization of textual and graphic information. For portability, this flexible grid format is adapted here to an overall book size of 7.5"x10". These dimensions are commonly found in reference texts from the applied, ecological sciences. The base typeface color and swatch is an adaptation of the USACE's 'Communication Gray'. The important difference and departure from these graphic guidelines involve the handling of notes and references. Throughout the writings, the footnotes are treated as parallel, concurrent texts that are located on the side of, or in relation to, the appropriate text body. This practice purposely contrasts the usual treatment of references as endnotes. Finally, the use and depiction of heraldic symbology - such as the US Army Corps of Engineers Communication Mark, Official Essayons Unit Crest, Traditional Tower Symbol, and Building Strong Logo - is intended for descriptive, explanatory, research purposes only. Their use is not intended as an endorsement nor infringement of the USACE's mission, identity, policies, or copyrights.

Biography

Pierre Bélanger is Landscape Architect, Urban Planner and Associate Professor of Landscape Architecture at Harvard University's Graduate School of Design. As part of the Department of Landscape Architecture and the Advanced Studies Program, he teaches and coordinates graduate courses on the convergence of ecology, infrastructure and urbanism in the interrelated fields of design, planning and engineering.

Responding to the growing inertia of urban planning and the overexertion of civil engineering in public works today, Bélanger has formulated the term "landscape infrastructure" used today by governments, professionals and academics worldwide to designate how the field of landscape is redefining the morphology of urban infrastructure in research, pedagogy and practice vis-à-vis the complexities of sub-urbanization and super-urbanization. Foregrounding and augmenting the biophysical landscape of living systems that has been marginalized by the historical divide between economy and ecology of industrial economies, the double-entendre of the landscape infrastructure project aims to reposition the agency of ecology as a sophisticated, instrumental system of essential services, resources, processes and agents that underpin contemporary urban economies towards the 22nd century.

Cited by urbanists such as AbdouMaliq Simone, Elizabeth K. Meyer and Dirk Sijmons, Bélanger's research work is published in planning, design and engineering journals and books including Journal of Landscape Architecture, Ecological Urbanism, New Geographies, Landscape Journal, Topos, The Landscape Urbanism Reader, Geoinformatics, Journal of Tunneling and Underground Space Technology, Trash, Food, and Canadian Architect. Bélanger's most recent publications include Landscape Infrastructure: Urbanism Beyond Engineering (2012), The Agronomic Landscape (2011), Regionalization (2010), Redefining Infrastructure (2010), Power Perestroika (2010), Landscape as Infrastructure (2009), Landscapes of Disassembly (2007), Synthetic Surfaces (2007), Foodshed: The Cosmopolitan Infrastructure of the Ontario Food Terminal (2007) and Airspace: The Economy and Ecology of Landfilling in Michigan (2006). Bélanger has received several international prizes in planning and design competitions including Zurich's 2011 Dübendorf Military Airport Competition, Australia's Sea Change 2030+ Competition, ASLA's 2010 Professional Awards, EDRA's 2010 Great Places Awards, the 2009 World Sustainability Centre Competition, 2G's 2008 Venice Lagoon Competition, the AIA's 2007 Columbus Rewired Design Competition, the 2007 Chicago Prize, and the Architectural Association 2006 Environmental Tectonics Competition. Bélanger is recipient of the Professional Prix de Rome in Architecture awarded by the Canada Council for the Arts.

As a member of the internationally recognized Harvard Project on the City led by architect and urbanist Rem Koolhaas, Bélanger completed graduate studies for the Masters in Landscape Architecture at Harvard University's Graduate School of Design where he received the Janet Darling Webel and Norman T. Newton Prizes in design. Prior to that, he worked as a project manager for Brinkman & Associates, Canada's largest reforestation and bioengineering contractor. Bélanger is professionally registered as a Landscape Architect and Urban Planner as well as certified in Canada as a Surface Miner, skilled in precision earthmoving and heavy equipment operations.

Combining knowledge from the earth, engineering and economic sciences, Bélanger collaborates with government agencies, resource industries, regional authorities, professional organizations, universities, corporations and a team of interdisciplinary practitioners in the reclamation of regional systems and large urban landscapes. Through the inception of the Landscape Infra-structure Lab in 2006 (a federally incorporated, non-profit, design-research organization in Canada), Bélanger initiates and coordinates a portfolio of projects funded by public/private partnerships that include the Canada Foundation for Innovation, Transport Canada, Foreign Affairs & International Trade Canada, the Social Sciences & Humanities Research Council, the Toronto Region Conservation Authority, the Greater Toronto Airports Authority, Cadillac Fairview Corporation, Waste Management Inc., the City of Toronto, Aéroport Régional de Mont-Joli, the Charles River Conservancy and the U.S. Army Corps of Engineers.

Abstract

LANDSCAPE INFRASTRUCTURE *Urbanism beyond Engineering*
(English)

As ecology becomes the new engineering, the project of *Landscape Infrastructure* - a contemporary, synthetic alignment of the disciplines of landscape architecture, civil engineering and urban planning - is proposed here. Predominant challenges facing urban regions today are addressed, including changing climates, resource flows, and population mobilities. Responding to the inertia of land use zoning and overexertion of technological systems at the end of 20th century, the thesis argues for the strategic design of "infrastructural ecologies", a synthetic landscape of live, biophysical systems that operate as urban infrastructures to shape and direct the future of urban economies into the 21st century.

LANDSCHAPSINFRASTRUCTUUR *Stendenbouw buiten Techniek*
(Dutch)

Daar ecologie de nieuwe techniek wordt, het project van *Landschap Infrastructuur* - een eigentijdse, synthetische instelling van de landschaparchitectuur disciplines, civiele techniek en stedenbouw planning - wordt hier ter overweging gegeven. Overheersende uitdagingen waarmee stedelijke regio's vandaag worden aangepakt, inclusief klimaat veranderingen, stromingen of hulpbronnen en de bevolking mobiliteiten. In reactie op de inertie of land dat zoning en overbelasting van technologishe systemen gebruikt op het eind van de 20ste eeuw, het proefschrift pleit voor het strategische ontwerp van "infrastructurele ecologie", een synthetisch landschap, biofysische systemen die opereren als stedelijke infrastructuur en geven vorm aan en direct de toekomst van de stedelijke economieen in de 21 ste eeuw.

INFRASTRUCTURE DU PAYSAGE *L'Urbanisme, au-delà des Ponts-et-Chaussées*
(French)

Comme l'écologie devient la nouvelle ingénierie, le projet de l'*Infrastructure du Paysage* - une convergence contemporaine des domaines de l'architecture de paysage, génie civil et urbanisme - s'y est proposé. Défis prédominants auxquels les régions urbaines aujourd'hui sont abordés, notamment les flux climatiques, transformations des ressources et mouvements migratoires. Répondant à l'inertie de la planification urbaine centralisée et le surmenage des systèmes technologiques du 20ème siècle, cette thèse propose la conception stratégique des "écologies infrastructurelles", un paysage synthétique composée de systèmes biophysiques, vivants, qui fonctionnent comme infrastructures urbaines pour l'avenir des économies urbaines du 21ème siècle.

The research described in this thesis was financially supported by Wageningen University and the Landscape Architecture Chair Group.

Financial support from Wageningen University, Harvard Graduate School of Design, Landscape Architecture Canada Foundation, Netherlands Architecture Fund, Canada Foundation for Innovation, Social Sciences & Humanities Research Council, University of Toronto Daniels School of Architecture, Landscape & Design.

This dissertation is dedicated to the memory of Michael Hough (1928-2013), who was an exceptional visionary with a long term optic and near distance focus.