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Thick matters: De-optimizing Infrastructural Redundancies, Pt. 1

Marco Ravini

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Closed system design methodologies have produced infrastructures that anticipate only a single lifetime use. This approach has burdened many urban areas with defective infrastructures in need of perpetual modification and repair. Rather than continue to over-engineer these vital frameworks to resist the inevitable failure of individual components, the next generation of public infrastructure needs to exceed its technical specifications and seek ways to create spatial reciprocity among systems.

This thesis calls for a renewed understanding of redundancy in order to strategically infuse infrastructure with public agency and diverse utility. Such an approach has the potential to yield greater systemic outputs and a more productive lifespan, allowing future infrastructures to be positioned both as a collective good and a resilient service.

Infrastructures are inextricably linked to the development of cities and the delivery of improved living standards. These ideals are embedded within the typology of the bridge—a structure critical to the efficacy of transportation networks. Optimized to facilitate the continuous flow of people and goods, the present state of the United States forecasts a future of urban dysfunction. Over the last decade, bridges in the United States have become a significant feature in the growing crisis of public infrastructure. Built during the post-war era when the growth of transportation networks was less of an expansion and more of an explosion, many bridges have now exceeded their 50-year lifespan.

Via the prototyping and design of a new Liberty Bridge in Pittsburgh, Pennsylvania, this thesis aims to demonstrate how infrastructural thickening might enable the next generation of public works to perform as resilient systems rather than standalone structures.

**Infrastructural Thickening** is the term I propose to describe a strategy that aims to modify the spatial, systemic and experiential utility of infrastructure—a strategy that works towards shifting the understanding of infrastructure from line to volume. This shift is achieved by virtue of de-optimization, a design technique that seeks to augment engineered specifications into scenarios for inhabitation, participation and added value.

In pursuit of infrastructural thickening, this thesis explores relationships between bridging, space and form as a means to generate redundancies that have the capacity to address issues beyond the bridge’s physical footprint. Topics such as storm water run-off, waste management, and public space are central to the design agenda. In response to these urgent issues, a system of structural cones is deployed that mediate flows of water, cars and people into a unified, heterogeneous interface.

This thesis envisions the next generation of infrastructure as **thick matter**—a new public territory that provides people the opportunity to engage and participate in mutually productive dialogues with issues of urban, spatial and environmental urgency.
The Bridge Problem

The present solution is by far the most burdened. The solution is in place for the next 50 years. The cost of the CSO is burdened by 36 inches of annual rainfall.

Treats 200 million gallons of wastewater daily.

(1800s) Lewis Mumford’s Invisible City (note: The hidden pipes and conduits at the junction of Gay and Lombard Streets in Baltimore, 1908).

Liberty Bridge is being prepped by an advertising campaign to pressure congress to increase its investment for infrastructure.

If every bridge in the city could collect/capture the volume produced by a 1-inch storm event, how much water would they be able to keep out of the CSO?

Bridge Crisis in the U.S.

If the bridge fails, the system fails.

3) If the bridge fails, the system fails.

Bridges are a technology both for mobility within the interior of cities and also for the modern city’s expansion, its reach deep into rural nodes. The purpose is to facilitate the continuous flow of vectors (people and cars) and processes (mobility) two linear surface. The bridge is a constructed from a planar interlace of a series of segments and planar processes. Typically, every two planar manipulations a bridge crisis would occur.

A bridge is a planar surface constructed on a repetitive assembly of structural components. In urban contexts, structural components feature a series of pipes and related processes, typically in river transport.

The strength of the bridge determines the magnitude of allowable ‘live load’.

Volume of vehicles crossing the bridge.

Number of lanes constricts the bridge.

Could a bridge go beyond its physical footprint and address issues that have urban, ecological and spatial implications?

Bridges as resilient system, not standalone structures.

Volume of storm water run-off, waste management, and public space.

Design Technique: De-Optimization.

Designing the Chunnel.

System, Resource, Object.

WHAT IF

The bridge is a technology enabling multiple modes of mobility.

The bridge is a technology enabling multiple modes of transportation.

Sectional difference or ‘double-deck’.

Rather than a stand-alone structure, can the bridge become an infrastructural key element in a transportation system?

System and by extension part of an urban strategy?

System, Resource, Object.

Volume

Volume

IF we...
PROTOTYPING TOOLBOX: COUPLING WATER FEATURES

HORIZONTAL/LATERAL

VERTICAL

CATCHMENT
CLARIFYING
LARGE STORAGE
SMALL STORAGE
FILTRATION
RELEASE

A
B B1
C1
D1
E1
F1

C2
D2
E2
F2

B3
C3
D3
E3
F3

B4
C4
D4
E4
F4

B5
C5
D5
E5
F5

B6
C6
D6
E6
F6
Since a bridge is fundamentally an aggregate of structural modules, how can we utilize structure to maximize surface porosity and also facilitate rainwater flow?

**WHAT RAINWATER WANTS TO DO...**

Horizontal aggregation of vertical elements

Maximizes Surface Porosity, Minimizes Structural Footprint

**WHAT RAINWATER IS FORCED TO DO...**

Percolate vertically and re-enter the hydrological system in order to recharge the aquifer

**PROPOSED**

**OPTION 1**

Approach: Mimicking the existing trabeated pier spacing

Increases Surface Porosity **BUT** forces the Structural footprint to Increase

(Maintain some horizontality for vehicular and people)

**OPTION 2**

Utilize existing spacing of vertical superstructure to capture, convey, store, filter and release rainwater run-off
Shifting from Line to Volume

The structure is no longer distinguished by its basic subdivisions. Instead, through the process of infrastructrural thickening, the bridge begins to express a whole-to-whole relationship; a fine grained structural lattice that enables people, water and cars to participate in the issue of volume.

If water is the space for water, where do cars and people emerge?

Structure, Water and Porosity

Linear Volume

Vertical aggregation of horizontal planes allows for infrastructure to shift from a line to a volume.

Unified Interface

Multiplicity of horizontal planes allows for various flows to weave and traverse both in plan and in section.

Composite Structure

Merging cones with horizontal structure

Structural Gradation (x, y, z)

Add structure where needed, remove where not needed

The structure is no longer distinguished by its basic subdivisions. Instead, through the process of infrastructural thickening, the bridge begins to express a whole-to-whole relationship; a fine grained structural lattice that enables people, water and cars to participate in the issue of volume.
Water Generator

STRUCTURE, POROSITY and FLOWS

Pier Types

Filter / Absorption Coupling Processes
(Water tank + Bio filtration swale)

Circulation Core + Water Cistern

The Pier: Grid Manipulations

Water Tank

Program

Circle

Ellipse

Frustum
Generating Porosity

- Primary Structure (Truss)
- Secondary Structure (Steel Frame)
- Light Frame Structure (Filigree)
- Pier Grid
- Water Year Heat Map
- Pier Zoning
- Flexible Circulation
URBAN STRATEGY: Expanding the bridge’s physical + virtual footprint

LESSONS LEARNED FROM WATER TOWERS

1. The site of old 28-acre Mellon Area has been proposed to be transformed into a mixed-use development. Utilizing the elevation of the site, rainwater run-off could be channeled to the bridge for collection and processing.

2. This convergence of highway ramps is bounded between Duquesne University and the Downtown area. Further accumulation of rainwater can be guided to the bridge structure for storing and processing.

3. This underutilized and crucial public space nested between the Municipal Courthouse and the county jail has the potential to become part of the systematic logic of the bridge. Water-based activities and habitats can be introduced in order to create a more productive space for public engagement.

4. The 14-acre “East Parcel” of Station Square is proposed to be transformed into a mixed-use residential and office development. Utilizing the elevation of the Mt. Washington Neighborhood

5. Housing the headquarters for "Friends of the River" and "Just Harvest", the Terminal Warehouse next to the bridge sets the tone for the kinds of activities that could complement those preferred transformational organizations (e.g., urban agriculture, water plaza, a visitors center etc).

6. Utilizing the 485’ elevation of Mt. Washington, rainwater run-off can converge on the bridge where it can be stored, processed, re-used and/or released.

BRIDGE AS WATER NEXUS

A shift from stand-alone structure to infrastructural system

The convergence of these areas provides an opportunity for water-based activities and habitats to complement the kinds of organizations that could benefit from the transformation of the bridge into a water nexus.