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

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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 bridge design 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 structure, 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

ALCOSAN CSO Discharge Treats 200 million gallons of wastewater daily

The invisible city of infrastructure

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

Changing Perceptions

Steel Production

Regular sewage flow

Storm event

Steel Production

The strength of the bridge determines load.'
PROTOTYPING TOOLBOX: COUPLING WATER FEATURES

- Catchment
- Clarifying
- Large storage
- Small storage
- Filtration
- Release

A
B
C
D
E
F

1 2 3 4 5 6

A1 A2 A3 A4 A5 A6

B1 B2 B3 B4 B5 B6

C1 C2 C3 C4 C5 C6

D1 D2 D3 D4 D5 D6

E1 E2 E3 E4 E5 E6

F1 F2 F3 F4 F5 F6
EXHIBITION OF WATER FEATURES: Speculating Dynamics, Spatial and Programmatic Synergies

Transportation Modes

Water Features

Catch

Clarify

Large Storage

Small Storage

Filter

Release

Opportunities for New Water Habitats

Vertical Circulation

Absorption

Existing Structure

Zoning

Addressing/ W. Washington

Liberty Bridge

Downtown Pittsburgh

Pittsburgh Municipal Courthouse

Allegheny County Jail

Duquesne University

Concrete Manufacturing Facility

Three Rivers Trail

Urban Industrial District (UI)

Public Safety Complex

Specially Planned Districts (SP-3)

Allentown/Mt. Washington Downtown Pittsburgh

Aqua Center (Winter Bath, Pool)

Kayak launch area

Water plaza

Maintenance/Visitors Center

Vertical Circulation

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Zoning

# of.

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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...**

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

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

Hidden

**EXISTING**

Horizontal aggregation of vertical elements

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

**PROPOSED**

\[ ??? \]

Mimicking the existing trabeated pier spacing

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

(Maintains some horizontality for vehicular and pedestrian flow)

**OPTION 1**

Horizontal aggregation of vertical elements

Maximizes Surface Porosity, Minimizes Structural Footprint

(However, it dissolves horizontality, hails flow of people and cars)

**OPTION 2**

Utilize existing spacing of vertical superstructure to capture, convey, store, filter and release rainwater run-off
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.

**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.
STRUCTURE, POROSITY and FLOWS

The Pier: Grid Manipulations

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

Circulation Core + Water Cistern

Water Tank

Pier Types

Water Source

Circulation Core + Water Cistern

Frappé

Water Tank

Filter / Bioclimatic

Coupling Processes
(Water tank + Bio filtration swale)
Generating Porosity

Primary Structure  (Truss)

Secondary Structure  (Steel Frame)

Light Frame Structure  (Filigree)

Plan Grid

Water Year Map

Pier Zoning

Flexible Circulation

Basic Grid

High Basic Grid Low
URBAN STRATEGY: Expanding the bridge’s physical + virtual footprint

Lessons Learned from Water Towers

Virtual

Physical

Current

Process

Process

FOOTPRINT

Existing

Proposed

STORE

RELEASE/ RE-USE

City consumers storing supply

GPE to KE

Pump

Treatment plant

Bridge as Water Nexus

Process

+485

+100

A

B

+180

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.

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.

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

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

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 these partnering transformation organisations (i.e. urban agriculture, water plaza, a visitors center etc).

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.

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