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TIon oF one oF The 21 Main b ayoUS In hoUST on. The project seems perfectly aligned with the theme of
the issue because it examines the relationship between infrastructure, risk and urban design, and does so by
attempting to leverage diverse time scales and scales of intervention into the maintenance of this infrastruc-
ture, rethinking the legacy of its top-down 20th century planning logics. Moreover, it raises key questions
about new agencies and sites that may be available to architects that seek to engage the political ecologies
of the contemporary metropolis. Through research on the hydraulic urbanism of Houston and through three
speculative design proposals, hydrauli_city presents research about transforming Brays Bayou. The project
attempts to provide a figure for and foster the new forms of collectives and networks required to transform
the urban condition of Houston without resorting to unrealistic top-down planning infrastructures. We located
several scales and time-frames of operations, from micro-scaled interventions derived from ongoing mainte-
nance of the bayous to larger scale transformations now possible due to the programs to reduce the risk of
flooding in the bayou's watershed. hydrauli_city maps the confluences of interests and agencies invested in
Brays Bayou at this crucial moment in its history, and offers proposals of bold new civic spaces for the Green
Century. The project will be disseminated via an interactive website and a series of public presentations to
raise awareness and spark conversation. Flood risk management is a hybrid phenomenon, at once the object
of scientific knowledge, engineering practice, and political and economic forces, positioning the architect in a
prime-position to intervene.
1 Introducing the Bayou City

Houston has more bayous and major waterways than any other city in North America, with 21 main bayous and many dozens of tributaries which drain not just their immediate watersheds but also receive water from as far north as Dallas and Arkansas. In addition, three major ecological matrices meet where Houston now sprawls: the pine-woodlands of Appalachia, the coastal swamps from Louisiana, and the western grasslands. Prior to development in the early 20th century and suburban expansion since World War Two, all this water was processed through the resultant “moist prairie,” a grassy landscape that while unrelentingly flat at the macro-scale was in fact corrugated with micro topological features such as “hog-wallows” which along with dense grasses, marshlands ponds received the massive fluctuations of water flowing across the region while producing rich animal habitats. Development effectively smoothed this plane, turning it into parking lots, roads or lawns. Because the “gumbo soil” of the area is heavy in clays that close up when wet, the ground is relatively non-absorptive. This means that flooding was only prevented by the micro-topologies that had now been eradicated. Thus, as the city grew to become the fourth largest in the United States, massive infrastructures were required to manage flows of what would otherwise result in frequent catastrophes. This entire systems is a hierarchal branching structure that converges upon the 21 bayous. These are managed by Harris County Flood Control District (HCFCD), the largest such department in the country. Because of the non-absorptive soil and flat terrain, velocity of water flow, and its modulation, is the most important factor in managing flood risk in Houston; water must be slowed in upland areas, and accelerated in the downstream low-land areas around the Bayous. To achieve this, the HCFCD with the Army Core of Engineers has constructed many upstream detention basins to hold water while straitening and lining many of the bayous with concrete that allowed more rapid, and predictable, water flow. Water is then moved in underground culverts into these basins and channels. This system operates in the background of the city that has literally grown up with its back towards it, focused instead on the gleaming streams of automobiles along its freeways.

In 2001, Tropical Storm Allison formed just off the Gulf Coast and moved inland, stalling just north of Houston for days and inundating the area with up to thirty-seven inches of rain. The ground was already saturated from recent heavy rainfall and Houston’s and Harris’s county’s drainage infrastructures were overwhelmed with damages exceeding $4.88 billion. This raised to public concern the precarious relationship between systems of water management and natural processes upon which Houston—and many other cities—depend. It was suddenly apparent that the system was at its limits and could not cope with increased development or greater rainfall due to climate change. The HCFCD was commissioned to redraw the county’s flood planes, expanding the area within the 1% and 5% flood zone, much to the consternation of homeowners and developers. (Figure 1) Shrinking these areas required increasing capacity in the system; the city made larger culverts and the HCFD built new detention facilities and sought to widen the bayou channels.

These events and project coincided with a broader cultural shift that sought to reclaim the Bayous as a distinctive amenity for the City. Famously declared the “fattest” city in

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**Figure 1.** Houston and Harris County Floodplain

**Figure 2.** Brays Bayou and Tributary with Concrete Channel

(Photos by Natalia Beard)
America, Houston has fewer parks per resident than almost any of the cities with which it competes. Such amenities are seen as important to attracting new growth within a global economy. Nonprofit groups have been established and have worked with HCFD to beautify the long neglected bayous into green recreational corridors as they were once envisioned to be in a 1912 plan by Arthur Coleman Comey. While successful projects of this sort have already been constructed, such ambitions are thwarted when one attempts to deal with the channelized bayous. (Figure 2)

They not only have a concrete channel that is considered an eyesore, their banks have also been geometrically regularized to maximize flow. None of this can be altered because slowing the water by as little as 3% could cause catastrophic flooding farther upstream and upland because the bayou is the “trunk” upon which the entire drainage system converges. At the edge of the concrete bayou, cultural aspirations, technical requirements and ecological processes collide. The city and bayou have coevolved, with the former as a parasite. The task now was to refashion their relationship into a symbiotic interplay.

2 Houston, we have a problem

Hydrauli_city is a design research project commissioned by the Rice Building Institute (RBI) at the Rice School of Architecture to research this problem in collaboration with the civic stakeholders and the HCFC. Our site was the concrete-line mid-reach of Brays Bayou, the most urbanized watershed in the area, home to three-quarters of a million people with rapid growth This Bayou is also next to major cultural institutions (such as the Museum of Fine Arts) and economic generators such as the Texas Medical center, the largest in the world and which badly flooding in Tropical Storm Allison. Moreover, it runs through the part of Houston’s most important urban park, Hermann Park), the concrete channel creating a no-mans land. Thus, transforming Brays Bayou is very sensitive but key to the new
Proceedings 161

Differentiated Systems, Landscapes, and Cities

Hydraul_City

vision of the Bayous and the city. The initial problem we were commissioned to research was to design a series of weirs that could raise the nominal water level to cover the concrete channel and thus give the Bayou a more “natural” appearance. These weirs needed to be well-designed and promote programmatic uses. A morphogenetic design strategy that merged watergardens, weirs and bridges was pursued. Remote sensing would trigger the lowering of the weirs in a storm event, returning the Bayou to optimized performance. However, the more we examined the problem and the design, we became increasingly uncomfortable with employing tropes of complexity, emergence and morphogenesis as design tools when the design would still be deployed within a top-down, hylomorphic system and way of thinking. We realized it did not matter whether one was designing classical pavilions or complex geometry if one was still decorating the same cake. Such dissimulation seemed unethical.

Thus we came to think of the Concreted Bayou not as a design problem to solve but an invitation to rethink the terms of engagement of architectural design, one that could operate morphogenetically politically, urbanistically and programmatically. This opened entirely new sets of design research questions for us because it required shifting from research into the design of the object or system as more or less autonomous and instead focused the design’s performance in relation to contextual operativity. It was not enough to deploy models and metaphors of ecology to produce a design process; we needed to use design as way of fostering ecological complexity between the technical, natural and cultural agencies operating along the bayou’s length. This suggests a morphogenetic approach to urban form as the calcification of its various flows and processes immanent to it. Indeed, if one charts the visually flat terrain of Houston according to its hydrodynamic performance (speed of water flow across the surface), reveals a dramatically complex morphogenetic hydrological landscape. (Figures 3a, 3b)

Like any complex system the “Butterfly Effect” is in full play; operating upon material parameters like porosity, roughness, or detention, at small but crucial points can cause dramatic results at much larger scales.2 One blocked culvert, or slowing water flow the Bayou by 3%, can flood thousands of homes. This suggests that seriously confronting the problem of flooding in Houston requires fundamentally rethinking the built environment as a complex, highly interdependent dynamical system wherein design decisions made on the most local of scales can have emergent effect on global processes. At the same time, the design needed to offer a figure for these relationships in order to make these dynamics a matter available to the public and thus a point of political and civic engage-
ment. Can the top-down attempts to control flooding through massive infrastructure and administrative bureaucracies be transformed into bottom-up democratic responsibility for sustainable development? We needed to enrich the relationship between city, nature and infrastructure, to turn the edge of the concrete into an interface of entanglements between nature-culture.3

3 Engendering Life on the Edge

Having researched the hydrodynamic dynamics and politics involved in water flow management, we developed a few sympathetic design principles. First at the macro scale we sought to intensify the Bayou’s condition as urban motor of energy exchange. An ecologically rich Bayou was channelized into a drainage infrastructure designed to permit development. Now further infrastructure is required to produce ecological and urban transformation to the nature that has re-occupied the bayou in new and sometimes fantastic ways. The old model of infrastructure idea was based on an ethic of mechanical efficiency, which disrupted a natural homeostasis. (Figure 4) Our design assembles technical and programmatic strategies in different ways, populating the Bayou with many infrastructural “machines” designed to produce a diversity of synthetic atmospheres and uses.4 Secondly, to achieve this goal, we sought to produce the greatest possible differentiation along the length of the Bayou by concentrating redevelopment and resources at key nodes where roads traverse the bayou but need to be rebuilt due to the redrawn flood-maps. These crossings are redesigned to knot the strata of the city with the lower banks of the Bayou below, producing diverse programmatic attractors derived from the surroundings at each
Differentiated Systems, Landscapes, and Cities
Hydrauli_City

point. The space between these nodes operate as quiet connective tissue that can be slowly transformed through routine maintenance and replacement of the concrete liner. (Figure 5)

Through a combination of steady bottom-up refurbishment and pulses of concentrated intervention, over time the entire channel might be transformed without the need for a static master plan. Chronological phasing can be replaced by instants that extend into the past and future, much in the way of the temporal envelopes that characterize natural dynamical systems. Combined, this design approach deploys a discontinuous molecular “system” whose differentiation occurs at the scale, across the time-frame of urban development and which is adaptable to its unpredictable co-evolutions. (Figure 6a, 6b)

Shifting to the micro-scale, rather than attempting to return the Bayou to a more “natural” appearance, our design multiplies edges between hard (concrete) and soft (planted) landscapes and wet zones (remediation ponds, marshes, fountains, swimming pools) that commingle landscape and technologies of water flow management, remediation and leisure. These edges can also provide integrated steps, benches, plateaus and ramps that stitch together the level of the city and that of the bayou. In addition, multiple strategies of water retention, detention and remediation are used to produce complex programmatic and experiential relationships between water and land. Lastly, the spatial and formal language developed directly from the hydraulic performance of the Bayou and the interconnectedness of each building or parcel within its watershed to these dynamic flows. We also took into account the means of construction. For example the turning radius and blade size of the bulldozers that are used in such projects was a geometrical constraint as was a zero sum cut-and-fill criteria. The basic hydrological profile and technology of the channel and retaining walls are parametrically repeated, scaled and transformed to modulate the surfaces of the channel, interdigitating soft, hard and wet zones.

These design strategies were developed through three sites as case-studies. (Figure 7) The first intertwines the bayou and the immediately adjacent Texas Medical Center. A series of concrete retaining walls follow the geometry of a bend in the bayou, while large plateaus uncover the normally buried water systems upon which the city above depends. The steps link the city and water levels while the spatial qualities alter according to water level; when the water is low, sloping patterns leave spots of ponded water, when flooded only the ridge lines of the these slopes are dry. Gardens combine plants for phyto-remediation with phyto-pharmacology. (Figures 8, 9, 10)

The second node is set in the midst of the city’s most significant park. Houston’s flooding issues would be “solved” if every typical residential lot could detain ten inches of water that could slowly be released. Unlike the current system of top-down flood management, where as we saw in New Orleans during Hurricane Katrina, a small failure can cause massive flooding, local failures within such a distributed system of bottom-up micro detention...
would not result in massive catastrophe. Our proposal installs this idea by capturing all the water that runs off the Park’s golf course as a collective lawn, turning the banks of the bayou into a hydrologically terraced moire of blue, brown and grey water; detention and remediation ponds are set adjacent so swimming pools and fountains. The result is an emergent moiré pattern between natural processes and human use. Figure 11

In the last case study, a secondary channel is carved that modulates the flow and level of water to foster water-related recreational and commercial programs. New bridges formally and materially delaminate to link the bayou edge to the city fifty meters above and allow for programmatic activity. A structural system is developed that can allow for enclosed permanent program at levels above the flood-plain and open structures at the water’s edge amenable to changing use, for example as a market. (Figures 12, 13, 14)

4 Moirés of Nature-Culture
While Nature and its forms and processes are a rich and under-researched source for design, our research led us to become more interested in the entanglements between Nature and Culture, and the way these are linked through technical means as synthetic assemblages through which urban forms have “evolved” and which configure their distinctly hybrid conditions. Rather than seek to formally mimic or translate natural processes, we sought to understand the performances of these socio-technical-natural systems and intervene in accordance to their inherent logics in order to produce different outcomes. Without in any way opposing research into autonomous design ecologies, affiliative approaches that understand design not as the fashioning of objects but of the actualization of relationships and of the giving a public figure to non-anthropomorphic performances is crucial to operating in urban ecological domains. This is especially vital when design is mediating large scale infrastructural systems rather than discrete sites or closed systems. Urbanism, after all, can be understood ecologically as an emergent effect of the interaction between multiple open systems. The umwelt of the bayou is constructed out of these heterogeneous and often incommensurable positions of these systems and actants. It is questionable that any singularly autonomous geometry can effectively integrate the radical disjunctions of complex heterogeneity inherent to such overlapping systems and bring coherence. The problem is not to design one exquisite architectural animal nor even a population but to alter—through design—the relations between actants already at play. To do so we need further research into advanced design strategies that bring coherence while maintaining the necessity for radical differentiation. The richness of a morphogenetic and ecological sensibility can be deployed to research the messy Nature-Cultures that are being created around us but which we scarcely understand and to use our findings to actualize truly more complex terrains of interaction.

5 Credits
The project lives at: www.hydralicity.org
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Statistics according to NOAA: http://www.srh.noaa.gov/hgx/projects/allison01.htm;
1. This follows Deleuze and Guattari’s reading of the morphogenetic science of materials as the assemblage of singularities, traits of expression. One might characterize the dominant approach to flood mitigation as “hylo-morphic” in that it treats water as dumb matter that needs to be entrained into static forms (the concrete channel). Even though the hydrodynamical mathematics used to create such structures require morphogenetic approaches, these are appropriated into an apparatus of State-like control rather than nomad itineracy. Deleuze and Guattari, A Thousand Plateaus, (Minnesota: University of Minnesota Press, 1988).
2. The concept of “entanglements,” along with terms like “hybrids”, “nature-cultures,” “quasi-subject/object” (from Michel Serres) is a key trope of the work of Latour, Sloterdijk, studies of science and technology in society, and “animal studies.” Sloterdijk develops Callon’s concept of “entanglements” as a way of dealing with the heterogenous assemblages of nature-cultures.
4. Deleuze characterizes this as a contrast between the Aion, an instant that extends vectors into its past a futures and the Chronos, which chops the continuous flow of matter-energy into static measurable frames. Gilles Deleuze, The Logic of Sense (Columbia University Press, 1990 (1969), pp. 5-6; 64-65.