# DATAField
# Strategies for Technological RESILIENCE through URBAN PROTOTYPING

**MARCELLA DEL SIGNORE**
New York Institute of Technology

**CORDULA ROSER GRAY**
Tulane University, New Orleans

**The leveraging of digital technologies at the intersection of architecture and urbanism allows for imagining scenarios for the future of cities. In line with recent cross-disciplinary research, this paper aims at investigating how large-scale prototyping applied to urban space can generate impact and provide a working model for Resilient Strategies.**

**DATAField, a placemaking intervention developed in New Orleans, investigates how the synthetic integration of 'the making' of place, the importance of citizens' engagement and the incorporation of digital technologies can provide an operative framework for large scale urban prototyping. Introducing models for urban hydrology management, citizen-engaged science, visualization strategies of underlying infrastructural systems and resultant urban prototyping related to resiliency, DATAField demonstrates how digital technologies implemented through systemic approaches can be a powerful tool to design in soft-land and to strengthen citizens' awareness of 'how we can live with water' in vulnerable ecosystems.**

## INTRODUCTION

> If we can use information to make cities more mobile, accessible, sustainable, and resilient, then we must use the existing information to help shape the built environment, as well as direct the information of the future by determining what data should start being collected now.
> —Aaron Betsky[1]

The exponential growth of cities globally in conjunction with expanding social and ecological challenges and the increasing impact of digital technologies demands a renewed understanding of public space as a means to catalyze 'the making' of place in close relationship to the contextual urban conditions. The engagement of built space, cities and people not just as isolated entities but as parts of an extended network that encompasses the production of information, cultural and social infrastructures can be strengthened through inter-scalar placemaking strategies to foster resilience.

Many urban environments currently face the challenges of securing and maintaining natural and manmade systems and resources implemented to reduce the physical vulnerability of cities. Climate change and coastal erosion, subsidence, social transformation and absence of equity and equal opportunities generate weakened metropolitan scenarios while drawing attention to important regional and local issues such as water management related to long-term sustainability at the city scale. Megacities like Mexico City suffer from severe destabilization of water resources and subsequent subsidence due to extreme population growth and the over-exploitation of aquifers. [1] The city of New York after Hurricane Sandy faces the challenge to accommodate rapid population growth, aging infrastructure and the dangers of rising flood plains and adequate preparation of its coastal areas. New Orleans in the Mississippi Delta is especially strongly affected by its peculiar geographic location. Situated mostly below sea level, its infrastructural systems designed for protection and control over natural forces constantly struggle to accommodate existing contextual complexities. In order to direct attention towards long-term sustainability as well as underlying contextual challenges the connections between the physical, built urban eco- and infrastructural systems and the immediate user become increasingly relevant.

In New Orleans existing ecological, social and technological systems related to water management often remain buried and illegible, partially due to their physical disconnection and the neglect of the immediate site context as a valuable source of information. Pumping stations, crucial nodes within the infrastructural framework of New Orleans that have protected the virtually submerged city from the imminent danger of flooding for more than a century remain anonymous, their essence and effectiveness disguised behind thick walls. In an effort to educate citizens about the risks of living in the Mississippi Delta in a city below sea level, communities will benefit from legible, integrated water management systems to collectively formulate a viable urban identity.

In his definitions of 'Non-Place' Marc Auge draws a 'parallel between the place as an assembly of elements coexisting in a certain order and [the] space as an animation by the motion of a moving body'. [2] Similarly in 'Phenomenology of Perception' Merleau-Ponty delineates an important distinction between 'geometric' and 'anthropological space' to define 'existential' space as an important experience of hierarchies and relations. [3]

Smart technologies already inhabit major parts of society, directing information and forming ubiquitous network infrastructures. Rather than burdened by 'simplistic functionalism', interactive multi-layered design strategies can 'affect how each of us inhabits the physical world'. [4] Current surveys advocate that the "phenomenology of engagement"

is at the root of interactivity, this results in a shift of design values from, "objects to experiences, from performances to appropriateness, from procedure to situation, and from behavior to intent". [5]

Urban place-making that utilizes built space to abstract and visualize data and infrastructure networks should allow for human interaction and interpretation as they offer the opportunity to create context-conscious spatial connections within participatory environments amongst an engaged citizenry. The goal lies in the actuation of social structures in order for occupants to gain knowledge about the conditions of their context. In conjunction, how can we successfully develop multi-scalar strategies aimed at generating resilience through large scale prototyping and data collection and connect responsive systems with smart citizen participation to create a method for engaging users through interaction?

Resilience is now largely accepted as a concept that refers to the capacity of a system to maintain its function and withstand a disturbance, recover from it, and reorganize itself in response to it .[6] Recent literature focuses attention on urban competence as community-scale resilience, acting as a response to the belief that resilience is largely dependent on local action and on solutions dependent on micro-scale conditions .[7] At the same time, the concept of resilience has always been closely related to the general systems theory [8] as adaptive capacity to a positive trajectory that occurs when communal abilities such as information and communication, economic development, social capital, and community competence are achieved. [9]

As multiple definitions of resilience have been developed, a particular focus is placed on how large scale urban prototypes connected to place making, citizens' participation and technologically responsive processes can offer an integrated physical and virtual platforms for increased resiliency in communities through participation, awareness and communication while simultaneously creating a physical place. As working models, these kinds of prototypes can teach, learn and evolve while educating resilient communities. A vital community structure can be measured by the ability to provide habitable urban landscapes that embrace processes which can take on an agency of communication and connectivity. Design at every scale has to embrace an unpredictable and fluid context. Policy and governance have to adapt in equal measure to environmental, economic and social needs of a community, with the community genuinely being able to participate in this process.

## LARGE-SCALE URBAN PROTOTYPING AS A STRATEGY FOR RESILIENCE

A Prototype is defined as an "early sample, model, or release of a product built to test a concept or process or to act as a thing to be replicated or learned from". [10] The act of prototyping entails a process of testing a set of parameters through a synthetic whole that becomes a vehicle for further evaluation and exploration in the real world. It provides the capacity of developing a 'working system', a 'functional whole' for possible future formalization of an idea. Prototyping is a process that brings to reality a set of ideas or elements into a evolving working system. A prototype is a model that while being provisional in nature, as in-existence in the present moment, it has the embedded possibility of mutating, transforming and evolving into other forms. It is interim, partially temporary therefore highly responsive to change. As Diego Rodriguez states: "Similar to the scientific method, productive prototyping is about asking a single question at a time, and then constructing a model in the world which brings back evidence to answer your question. The goal of a prototype is not to be right, but to get an answer. That answer is what allows you to move forward with wisdom." [11]

While the process of prototyping can be applied to any field, the focus in this paper is placed on how the act of prototyping can be related to the urban scale to give responses to specific issues or test solutions in the real world. To establish the operating framework within which the case study is analyzed, the paper focuses on a particular question: How can large-scale prototyping applied to the urban space provide a working model for resilient strategies? To introduce the argument, two main themes need to be explored: how time influences the act of prototyping and how scale and scalability are important factors during the testing process.

In this context the term 'rapid prototyping' refers to methods that produce prototypes fast enough to leave a substantial amount of time for actual changes of the product, providing enough time for several iterations in the design life cycle during which the prototype can be refined based upon earlier evaluation steps. [12] In the last years, especially in the field of design thinking, rapid prototyping has become a form to quickly test ideas and move to the next phase by learning from the previous one. A prototype that usually tests one dimension of the particular issue is often called a 'low-fidelity prototype' as it has limited functionality, features and interaction, mostly used to depict concepts . [13]In contrast, if we start talking about the importance of increasing scale as an crucial factor in prototyping at the urban scale, we have to refer to a type of prototype that it is closer to the one defined as 'high-fidelity prototype', typically fully functional, interactive and taking into consideration the users' experience at full scale. [14]

Urban prototypes are fully-built physical working models that respond to a set of issues relevant at the urban scale while providing a platform for the evaluation of possible long-term solutions. [15] In this framework, why is the notion of large scale and inter-scalarity so relevant? Why is scale strongly connected to impact, especially in defining resilient strategies?

Prototyping at large scale allows for a set of integrated factors to come into play when we evaluate the synthetic working model and its potential impact for resiliency. In particular:

1. Large scale urban prototyping facilitates placemaking.

2. Large scale urban prototyping triggers citizens' response and engagement in catalyzing urban interaction.

3. Large scale urban prototyping facilitates technologically mediated processes that relate to larger urban systems.

In the context of this paper the three categories above are particularly relevant as a means of supporting the idea that large scale urban prototypes can offer coordinated strategies for resiliency while educating and bringing awareness to communities that are at-risk.

## LARGE SCALE URBAN PROTOTYPING FACILITATES PLACEMAKING

'PPS-Project for Public Spaces' states: "As both an overarching idea and a hands-on approach for improving a neighborhood, city, or region, Placemaking inspires people to collectively reimagine and reinvent public spaces as the heart of every community. Strengthening the connection between people and the places they share, Placemaking refers to a collaborative process by which we can shape our public realm in order to maximize shared value. More than just promoting better urban design, Placemaking facilitates creative patterns of use, paying particular attention to the physical, cultural, and social identities that define a place and support its ongoing evolution". [16]

The development of place is connected to essential elements that bring together physical, relational and symbolic/cultural space as a process that acknowledges the construction of the physical environment. Urban prototyping can support the making of place both as short and long-term public space while fostering placemaking. Again, according to 'PPS-Project for Public Spaces', "a community's connection to place is at the very heart of resilience. In fact, resilience on its own has limited value if residents feel little attachment to, or investment in, a place. Placemaking is the process of building and nurturing this relationship between people and their environment. Through a broad focus on creating quality places, Placemaking builds the shared value, community capacity, and cross-sector collaboration that is the bedrock of resilient cities and thriving communities. [17] As Jane Jacobs observed "Dull, inert cities, it is true, do contain the seeds of their own destruction and little else, (…) lively, diverse, intense cities contain the seeds of their own regeneration, with energy enough to carry over for problems and needs outside themselves." Indeed, what is often missed in top-down planning and policy—or upstaged by the loud voices and competing interests that generally dominate the discussion—is a community's own capacity to evolve and self-govern. [18]

## LARGE SCALE URBAN PROTOTYPING TRIGGERS CITIZENS' RESPONSE AND ENGAGEMENT

Due to their public and temporal nature, prototypes are meant to test out new ideas while the space generates visibility and dialog. Within this context, prototypes can be developed and displayed to solicit feedback from residents, city officials and stakeholders . [19] They generate a platform for citizens' to respond and participate while sharing awareness. The prototype itself provides a physical node to meet, share and communicate; a place where public interactions can be intensified to foster exchange.

Public participation is expected to increase legitimacy, quality, acceptance, and efficacy of decisions[20] and to foster empowerment of citizens. [21] Thus, citizen participation is even appraised as a key element towards sustainability and resilience on the local level. [22, 23]

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The embedment of technologically mediated systems within the urban prototype facilitates the inherent nature of the continuous working model. Technology implemented through systemic approaches can be a powerful tool to design in vulnerable ecosystems and support resiliency: from data harnessing, sensing technologies and citizens' tech engagement resilient communities can be fostered.

Figure 1: DATAField- View from Broad Streeet, New Orleans.

The framework provided above will be tested through a large scale urban prototype: DataField, a project developed in New Orleans that operates as a place maker combining citizens' engagement and mediated technologies to catalyze urban responses both from citizens and larger infrastructural systems to support resiliency. A set of sub-strategies, such data tracking, sensing technologies and citizens' participation arecombined to foster the civic awareness. The project is a prototype that acts both at the micro and macro scale creating a localized node while impacting the expanded urban context.

**DATAField: Urban Prototyping through Resiliency**

In New Orleans, a city that continuously faces the challenges of living with water and unstable conditions of soft-land, the DataField project aims at synthesizing strategies for resiliency through the development of a large scale inhabitable urban prototype (Fig.1).

Prototyping additionally can be defined as a 'concrete representation of part or all of an interactive system', [24] with prototypes viewed as both physical artifacts or as important components of the design process. As artifacts, prototypes can facilitate the manifestation and exploration of a design space and uncover relevant information about users, enabling communication and helping users interact with each other. [25]

McCullough states that we must move our design focus from "things to experiences."[26] Since its establishment on soft ground situated mostly below sea level, New Orleans has found itself inconstant battle with its chosen location. New Orleans' unfathomable proximity to water and natural systems as well as its vulnerable, dated, man-made water management infrastructure reminds us of the many threats as well as the opportunities that lie within this negotiated existence Its subtle topography, much unnoticed until the devastating effects of Hurricane Katrina, has provoked both ingenuity and hazardous decision making, leading to the implementation of successful protective measures as well as to failing strategies for resilience. New Orleans's interior drainage system, divided into several drainage sub-basins following topographic lines, mainly relies on storm sewers, outfall canals and pump stations, designed to work together to gather runoff released into nearby bodies of water. [27] Its siting on soft ground, together with negligence in recognizing the dangers of draining and building on swamp land led to the consequential failure of several flood protection systems, due to long-term subsidence of the ground and the lack of attention towards its weak geological configuration. The recently introduced New Orleans Water Plan proposes a new investment model for public works where streets, canals, pump stations and storm water systems make use of undervalued and illegible water management assets and principals for urban design as well as provide a better understanding of the opportunities managing fragile soil conditions.

Building on the rich history of the city's water management infrastructure, the DATAField project draws its inspiration from the desire to establish a connection between the city's life-defining topography and its intricate system of pumping stations essential to the continued existence of the

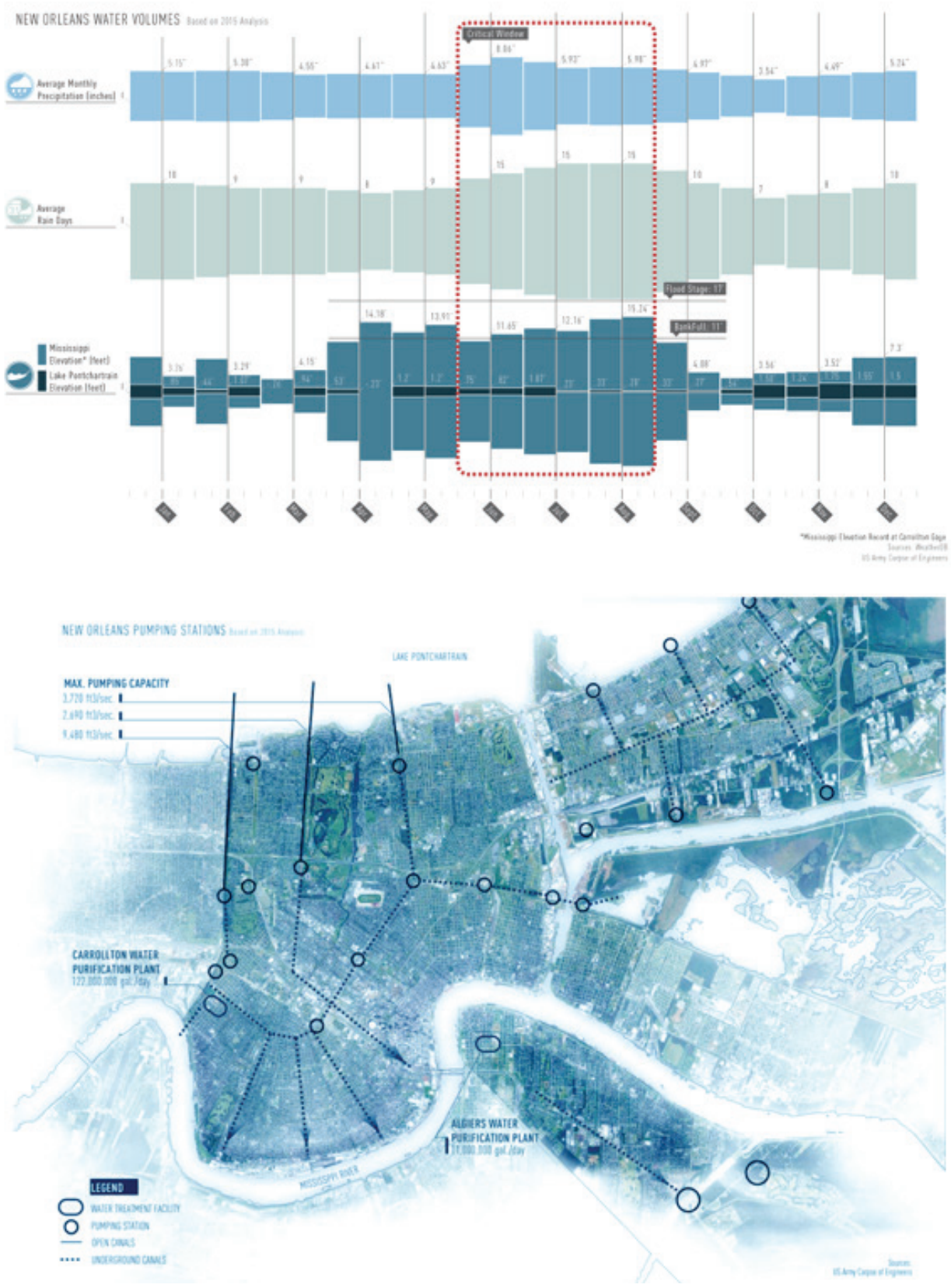


Figure 2: New Orleans Water Volumes and Pumping Stations

city within its current footprint (Fig.2). Using parametric modeling software as a means of generating the geometry, a network of macro and micro points is established based on the relationships between pumping stations and their respective capacities(Fig.3).

Designed as an exchange for citizens in accordance with Gordon Pask's Conversation Theory [28] about interpretation and behavior, DataField aims at providing the user with a dynamic multi-loop method for experiencing spatial conditions. Within the project the occupant is invited to take on a primary role in configuring 'the space s/he inhabits, a bottom-up approach which results in a more productive relationship to our spaces and to each other. It is about designing tools that people themselves may use to construct their environments and thus to build their own sense of agency.

It is about developing ways to make people themselves more engaged with, and ultimately responsible for, the spaces that they inhabit. It is about investing the production of architecture with the poetries of its inhabitants.' [29]

DataField consists of a dense field of data poles overlaid over an abstracted map of the existing New Orleans drainage network. Two different categories of poles are placed to index varying data streams in relation to water management activities (Fig.4).

The larger macro poles, steel poles with translucent plastic overlays are placed in a way that they directly relate to pumping station locations providing general user and systems capacity information. A field of medium poles record and display frequency and intensity of pumping activity at several New Orleans pumping stations, referencing real-life data. The experience is completed by densifying the field through the addition of micro poles, which physically allude to the configuration of the water network and spatially frame the pedestrian pathway leading through the space (Fig.5,6).

Overall the project focuses on the alteration of spatial conditions in favor of a successful place making strategy at different scales. The macro and medium poles respond to real time high- and low-end data transmission and processing (water moved by pumping stations at peak times) and incorporate vertical linear LED fixtures programmed through custom software connected to a light system manager registering the overall water fluctuation in the city and visibly translating it through light intensity. The installation organizes different invisible water-related data streams, specifically in relation to time and water flow quantities, aiming to apply integrated sensing technology and light responsive systems; as soon as the water flow at a pumping station fluctuates, an immediate response is displayed through a change in color and light intensity in the LED poles. The system can also be used to display past peak events, raising awareness about annual reoccurrences and their related outcomes (Fig.7).

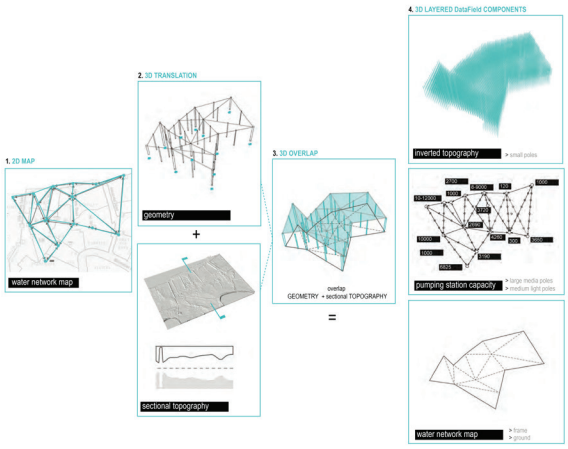


Figure 3 Above: Generative Process (3D Water Network Map).

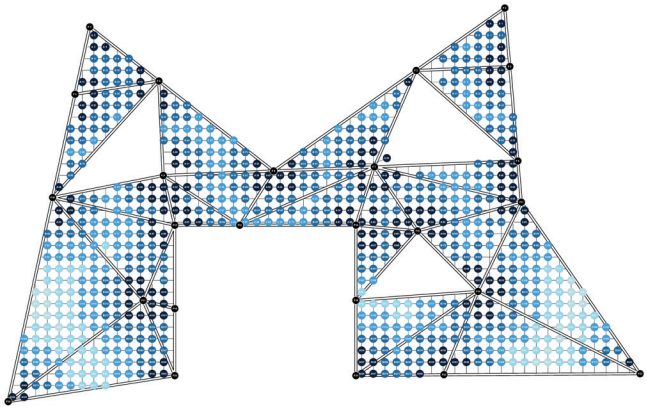

Figure 4: Components: Poles/ Gradient Map.

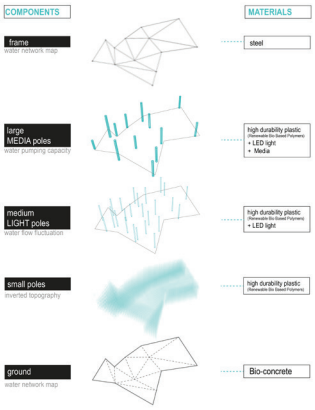


Figure 5: DATAField - Spatial components and material strategies

Simultaneously real time messages sent from APPs via smart devices communicate awareness and concern about infrastructural challenges around DataField at the local scale. Citizens have the opportunity to connect with each other at crucial times, exchanging information and drawing attention to extreme local conditions at the micro scale. These challenges can include issues related to water conservation, management and quality, threatening local flooding events and status and maintenance of local frameworks and if addressed appropriately can trigger new ways of urban solution finding. Recent unexpected flooding events in and around New Orleans revealed a lack in ability to effectively disseminate information amongst residents and missed opportunities regarding the prevention of harmful decision-making. Enhancing communication processes that connect the local with the urban scale would allow for people-based action that could lead to the achieving of larger goals.

Research in the field of cognitive science suggests that the making of concrete physical artifacts, prototyping, can be a useful cognitive strategy to debate a design approach and its possible solutions. Meaningful cognitive experiences often extend beyond the individual and engage the environment and also other people. [32] With DataField, through its approach to prototyping, the goal is to identify underlying deficiencies in communication systems and for citizens to become the primary actors in the construction of a public experience of space that disseminates information. The users have the opportunity to individually and collectively interpret DataField's physical space and alter their relationships with the surrounding environment (Fig.8).

Within the structure, topologically, a folded pervious concrete surface, in conjunction with the color-coded micro pole canopy above, formulate a spatial reading of the city's topography, initiating conversation, discussion and experimenting. Participants can experience the place, becoming active participants, with "...the individual himself is present, participating...most definitely participating.'[33] (Jan Gehl) Linking the data pole to a sectional representation of the topography establishes a visible network of nodes visualizing the underlying water management system and creating a three-dimensional map of the city.

The basic principles of 'urban interaction' provide citizens here with ways to make their urban experiences more productive and efficient in the long term. Smart communications strategies triggered by remote sensing and the visualization of underlying, hidden data streams, enable active citizen participation. At the same time they also stipulate interfaces that help citizens understand the layers in the networked city, and let them organize themselves around these to share awareness and control outcomes in conjunctions with other stakeholders.[34] Large-scale urban prototyping in this scenario interrupt, evaluate and equalize. Prototyping for resilience

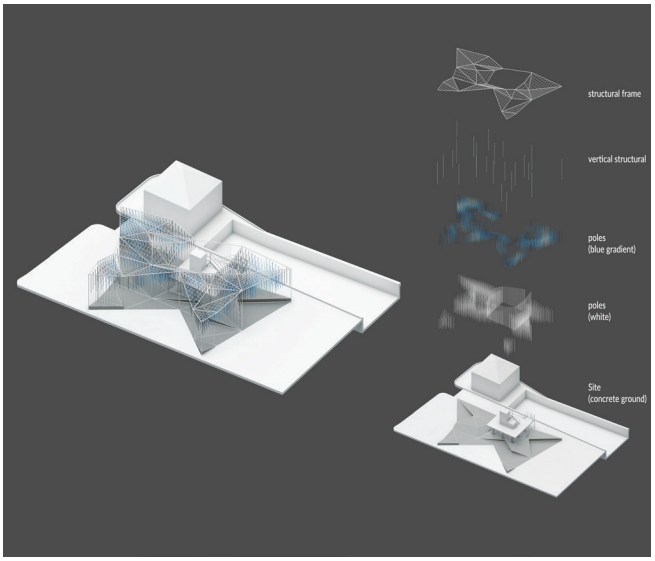


Figure 6 Above: Axon- Spatial components

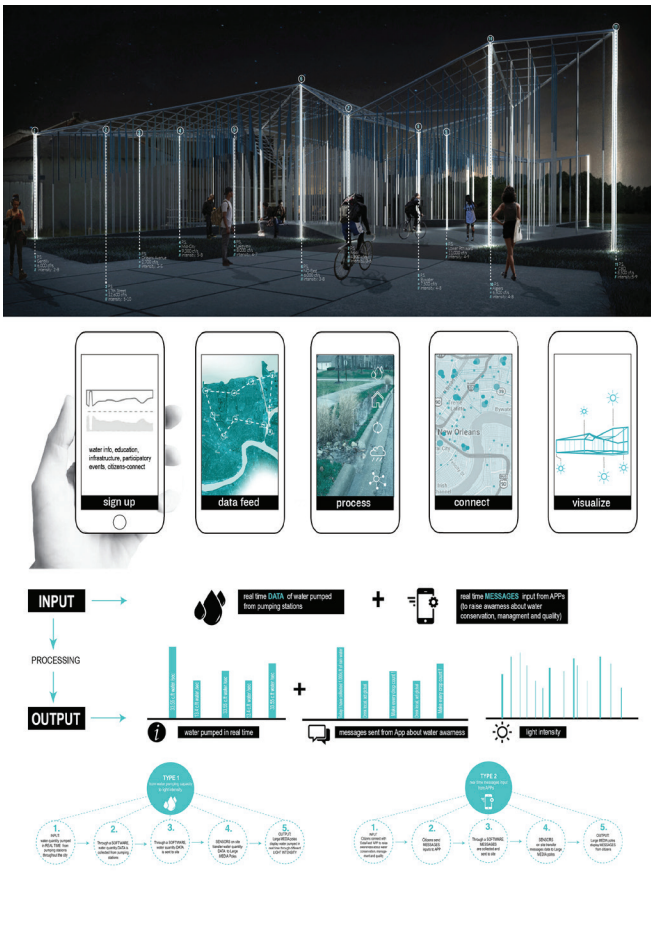


Figure 7: Media Concept and Narrative (Input - Processing - Output).

Figure 8: DATAField, View from Lafitte Corridor, New Orleans

requires proactive planning and a fact-based approach that communicates adaptive and ecologically-responsive design strategies as a response to multi-faceted and uncertain futures.

## CONCLUSIONS

DataField demonstrates as a series of strategies for resilience could be implemented through a large scale urban prototype that acts as a testing and working model. As the project has already been tested as small scale prototype during the Luna Fete event in New Orleans in December 2017 (Fig.9) and currently in the pre-prototyping phase (Fig.10), the project is already generating impact and engaging a series of institutions, organizations and city officials in the feedback loop process. Architecture and its symbiotic relationship with the urban scale has the opportunity to trigger immediate responses in observers and participants through indexing data streams in relation to the fluidity of water systems. The notation of these events in conjunction with the generation of successful public spaces enables a community-engaged environment, providing value to citizens through informing-about macro and micro issues relevant to real life data and existing infrastructures. At a time when city-wide planning strategies are failing due to a lack of governance and the widespread bankruptcy of communities, bottom-up models present themselves as an alternative approach to balancing public-private partnerships governed by corporate bodies .[3035] DATAField, through the embodiment of bottom-up approaches has the ambition of generating impact and large-scale transformation, eventually acting as mediator of top-down actions (Fig.11).

The emerging scenarios, especially at the community level, that this project will bring to the city of New Orleans is yet to be defined and will be completely rooted in the continuous cycle of mutual stewardship between communities and place. As stated in the 'Places in Making: How peacemaking builds places and communities' by DUSP at MIT:" In most successful cases, the "completion" of the project is far from the end of the placemaking effort. Success at identifying these ongoing "making " activities and engagement in the civic processes

Figure 9: DATAField small scale prototype exhibited at the Luna Fete event in New Orleans in December 2017.

Figure 10: DATAField, View from Lafitte Corridor, New Orleans

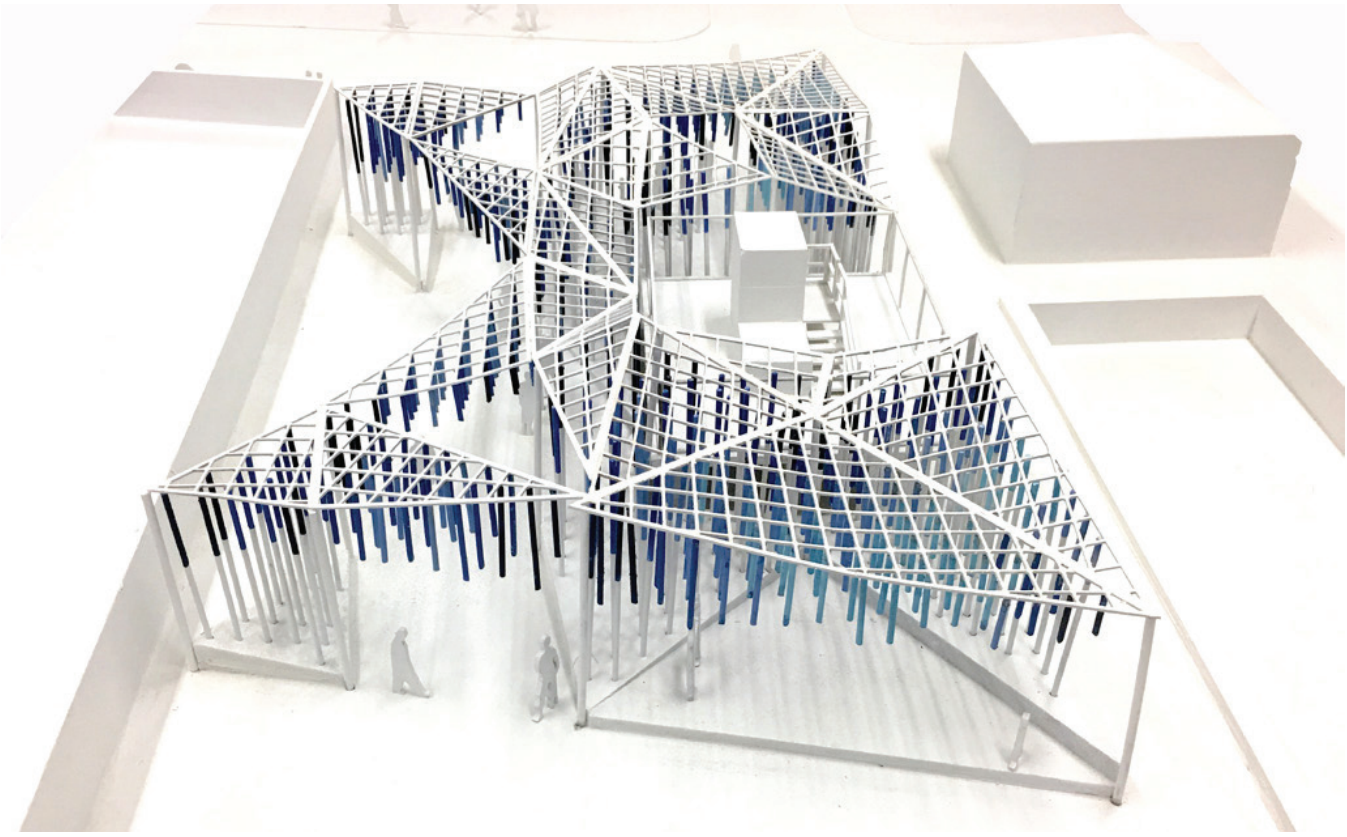

Figure 11: Arial View, Model- Field of Poles

that support them, creates the mutual relationship between community and place [3631] that lifts these placemaking projects above a simple sum of the parts (…)The virtuous cycle model can benefit the larger placemaking field. Each new step in each new project represents a learning opportunity not just for the project, but for the larger community of placemakers. The field has everything to gain from an open-source model, wherein information about tactics, obstacles, successes, and failures becomes a constantly-updating resource base for the placemaking community. [327] This continuous feedback loop is what will reinforce communities as they will learn to be more resilient and engaged in the process of 'making' places.

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**Keywords**: urban prototyping, water infrastructure, resiliency, place-making, sensing- actuating technologies.

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