pneuSENSE

Transcoding social ecologies

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Cities are continuously produced through entropic processes that mediate between complex networked systems and the immediacy urban life. Emergent media technologies inform new relationships between information and matter, code and space to redefine new urban ecosystems. Modes of perceiving, experiencing and inhabiting cities are radically changing along with a radical transformation of the tools that we use to design. Cities as complex and systemic organisms require approaches that engage new multi-scalar strategies to connect the physical layer with the system of networked ecologies. This paper aims at investigating emerging and novel forms of reading and producing urban spaces reimagining the physical city through intelligent and mediated processes.

Through data agency and responsive urban processes, the design methodology explored the materialization of a temporary pneumatic structure and membrane that tested material performance through fabrication and sensing practices through the pneuSENSE project developed in July 2016 in New York at the Brooklyn Navy Yard during the ‘HyperCities’ IaaC- Institute for Advanced Architecture of Catalonia - Global Summer School.

Keywords: responsive urban processes, data agency, reciprocity between micro (body) and macro (environment), dynamics of social ecologies, mapped-environment

INTRODUCTION

PneuSENSE is collaborative project that takes the form of a responsive, interactive and inhabitable pavilion space (see Figure 1) The pavilion embodies the dynamic relationships of interdependence and reciprocity, between micro (body) and macro (environment) systems, within a diverse range of urban conditions found within New York City. Through the use of sensing and actuation technologies, biometric and environmental data was collected from individuals within a range of specific urban sites, and was translated into a responsive inhabitable space, a ‘mapped-environment’ that renders the dynamics of social ecologies. The design methodology of this project disrupts conventional digital design processes by using computational tools, GPS, and sensing technologies to rethink the complex relationships and interdependencies between bodies, build-
ings, urban spaces, and environments, as intercon-
ected, multi-scalar, ecological systems.

CONCEPTUAL FRAMEWORK: INTERDE-
PENDENCE AND RECIPROCITY THROUGH
SYNTHETIC MACHINIC SYSTEMS
The notion of social ecologies intended as the in-
teraction between social and environmental systems
and adaptations triggered by their co-evolution is
the overarching project framework. As Henri Lefeb-
vre’s already suggested in his book ‘The Production
of Space’, social space is a dynamic space in which in-
teraction and exchange at multiple levels produce the
urban space itself. The production of such a space
can therefore be understood as a collective experi-
ence in a broader context and in continuous ten-
sion between the collective and the individual, the
imagination of shared scenarios between the macro
and micro scales. The project aims at investigating
dynamic relationships of interdependence and reci-
procity between the macro (environment) and micro
(body) scale through prototypical macro-contexts in
New York. In particular, the notion of ‘Urban Ma-
chines’ represents the underlying conceptual scaf-
olding of the pneuSENSE project.

As emergent technologies have brought into
question the role of the material city in represent-
ing the public and the collective experience of ur-
ban space, Information and matter, code and space
collapse into a new system, and mediated spaces
become an architectural problem. In this new sce-
nario, the role of machines is intended as a set of de-
vices that become relevant to the experience of ur-
ban space and the public realm.
A device can be defined as an apparatus, instrument or tool designed for a specific purpose. Devices perform, inform and continually transform the environment and our perception. They can manipulate data by seeking performative spatial relationships. Accordingly a machine can be defined for its inherent meaning of being a system of devices able to communicate and perform within a certain environment. A machine implies the notion of “something that has been constructed” and “function with a specific purpose” while being composed by parts that respond to a “functioning whole.” The notion of assemblage developed by Deleuze and Guattari is intended as a composition of heterogeneous elements that give rise to a new system. In Deleuze’s book A Thousand Plateaus the concept of machine can be understood as a more complex formulation of the concept of assemblage. In Guattari’s terms, a machine is a composition of heterogeneous elements-subjective, social, technical, spatial, physical and process-related-that delimits a series of conditions for the production of the real. This entails that the notion of machine is directly connected to the concept of agency as it has the capacity or potential for an action within an environment. Rather than seeing those interventions only as objects or installations, they are seen as assemblages whose spatial parameters merge with information, networks, devices, media and users to create a public space that is more responsive, participatory and collective. The inhabitants are a dynamic part of the assemblage and become active producers of the public space. Space in this scenario emerges as a social product, and citizens are empowered in the production of it. Those interventions can be seen as tools to produce hybrid public spaces that in the temporary, interim or permanent phase are active, networked and responsive. Urban Machines in that way provide an alternative scenario to the production of physical public space.

From this conceptual context, Urban Machines are interventions in the physical urban public space that function as a system or set of devices, and through information technology, mediate the relationship between the urban environment and the user. In this framework the spatial practitioner is designing and programming these machines to promote, test and prototype the relation between city, technology and the human scale. The machines have the potential to generate a new type of either permanent or temporal urban geography operating as large-scale plug-in systems. CJ Lim, in his book Devices, argues that a technological or abstract understanding of such machines and their construction can influence and redefine the potential for architecture and spatial thinking. Urban Machines are a family of projects designed and developed to mutually enrich relationships between people, the space they inhabit and the urban environment. As the city is more and more produced through entropic processes, Urban Machines could operate as synthetic systems determined by the recombination of multiple parameters into one performative spatial form. Those systems perform differently based on how and where they are situated, their scale and their relationship to the environment. Urban Machines could help to intensify the interaction between urban space, people, objects, architecture and media devices. They have the potential to test and prototype models for future urban scenarios.

CONTEXT: BODIES AND CITIES

Within the systemic machinic system framework, the dynamic conditions of the users and their body in space/environment reflect constantly on the reciprocal approach to the production of space itself. Hybrid public space refers to collectively inhabited urban space that is traversed by digital flows of data and images that enhance and alter the traditional interaction between the body and its physical, social and symbolic environment. In the mix of people, flows, networks, data and electronics, new relationships between humans and machines, time and space can be found. An urban space that embraces technologies changes everyday rituals and how social interactions are mediated. At the same time, the importance of the physical encounter must be rec-
ognized. Those interventions embody the capacity of bridging the physical and non-physical into a hybrid condition. They merge the hardware (space, tectonics, materials) and software (information, systems, networks). Synthetic machinic systems produce new ecologies in the way Guattari theorizes: environmental or technical ecology, social ecology and mental ecology. Urban Machines are an urban heterotopia, a public space that emerges between environmental conditions, ambient conditions and situations, an urban manifestation of event and memory, a space that is temporary but leaves a permanent transformation in its urban context. Experimenting at the intersection of information technology, urban space and architecture, Urban Machines emphasize hybridity over mono-functionality. Environment, space, technology and different forms of use are intertwined to produce a space that encourages new modes of urbanity and the emergence of new forms of public life. As a space-environment Urban Machines allow for multiple conditions to exist simultaneously. Urban Machines promote a continuous hybridization and exchange between the city and its citizens, place and technology.

To test the dynamic relationships between bodies and cities through the lens of Urban Machinic approach, four prototypical macro-contexts in New York City are the extended sites of investigation, sampling a variety of urban characteristics, including green spaces, dense urban conditions, public transportation systems, and spaces of extreme verticality. They are experienced through the simultaneous overlap of micro-condition (body) and macro-condition (environment) in order to understand the

Figure 2
Customized sensing device that incorporates biometric and environmental sensors, and a map of the various sites where data was collected.
multi-scalar, temporal, and dynamic complexities that form urban spaces. Through sensing platforms, agents are able to record both biometric and environmental data, in order to evaluate and translate collected information and metrics into data-driven design strategies.

DATA SETS: BIOMETRIC AND ENVIRONMENTAL

The project engages simultaneously two sets of data and sensing devices: environmental sensors (sound, light, temperature, humidity, and CO2) and body sensors (heart rate, stress sensor, skin conductivity). The data is collected from sensing platforms, stored, and organized into quantifiable sets, which are translated and parsed using computational processes to visualize information and relationships, into patterns and geometry.

The first step of this phase was to build the ‘Data Acquisition Unit’ (see Figure 2) as a portable device able to be attached to the body to record and store in real time to data-set at each of the four macro-contexts. The customized sensing device incorporated simultaneously biometric and environmental sensors to understand the level and degree of co-dependence of the data sets and how they affect each other in relation to context.

After the collection of data, the subsequent step required a system to interpret and select data able to reveal the interdependence between the environment and body. Through evaluation and direct comparative translation, patterns of reciprocal data behaviors started to emerge and guide the data parsing phase.

Visualization of Data into quantifiable sets provided a platform for testing strategies for form-finding and geometric recurrence. Through Grasshopper and generative processes, the interdependent data sets were mapped through geometries that visualized tri-dimensionally the dynamic and relational fluctuation of the environment and biometric data sets. In particular, three inhabitable units were mapped and geometrically translated; each unit represented one specific prototypical site in New York City: The Brooklyn bridge, Grand Central Station and Top of the Rock (see Figure 3).

MATERIAL FABRICATION: CODING AND PROTOTYPING

The patterns and geometry derived through the data were used to design a physical construct. A pneumatic structure made out of a reflective mylar material, was used to express the dynamic and temporal qualities of the body and environmental phenomena. The project explored the potential for pneumatic structures, through the generation of inflatable components, assembly methods, and the performance of aggregate systems.

Geometry was first tested into small prototyped units to understand the inflation capacity relative to structural performance. From small components, the macro-modules were developed acting as independent and self-stable unit to then be aggregated into the larger map/spatial system. A series of non-linear testing were performed to evaluate the relationship between air supply, the system of interconnected inflation tubes and the form-finding process in relation to structural stability. Once stable form was achieved, the system was aggregated in its final configuration.
and ready to receive the biometric real-time responsive mechanism.

**FEEDBACK: RESPONSE AND INTERACTION**

As the nature of the public environment has changed dramatically, responsive and systemic machinic systems seek to create atmospheres that embody this negotiated status, engaging the public in constructed agencies. The same perspective was theorized by Henri Lefebvre who pointed out that the city is both a product and a medium created by social praxis and socio-spatial processes. Lefebvre decodes the urban space in three dimensions: 1) the perceived space: space produced by the collective activities in the urban space; 2) the imagined space: space constructed by urban planners and architects as a “representational space” projected onto the reality; 3) the experienced and suffered space: space experienced by users and mediated through images and symbols of everyday life. Urban Machines are systems able to extend material space into space for action. Action is a generating mechanism to express form and space. Those interventions have an inherent relational nature and the ability to set up a public system for interactions and events to occur. Urban Machines construct scenarios in which the public is invited to enter a manifold space where the experience is multilayered and set in motion by a series of spatial, ephemeral and technological mediated devices. They intervene in the public realm as systems that are socially, technologically and physically integrated. (see Figure 4)

The machinic responsive condition of PneuSENSE is performed through feed-back loops of input-processing-output (see Figure 5). Each individual spatial responsive unit assembled in a continuous macro-spatial map was layered with embedded biometric sensors to provide real-time responses and feedback: the first unit (Grand Central Station) sensed in real-time the heart rate, the second (Top of the Rock) CO2 in the breath and the third (Brooklyn Bridge) the skin conductance.

This provides new opportunities for body/architecture and individual/social interactions. Users can ‘plug-in’ to the physical prototype, which reads various biometric data and provides actuated feedback through breathing (inflating/deflating) and pulsating (lighting) effects (see Figures 6 and 7).
Figure 6
User interacting with the architecture to receive a real-time response. Carbon dioxide sensors were used to measure air quality to actuate lighting.

Figure 7
LCD screens that communicate information to users in text format, instructing the user to ‘see your heart beat’.
The testing of those interdependent actuated conditions can be the accelerator of ways in which we understand urban space and its multiple forms of operations. They provide agencies that could potentially influence urban configurations and narratives yet to come. The generative potential of these interventions is the capacity to catalyze processes of creation of the “open city,” a city that is in constant evolution and that can be transformed through bottom-up and overlapping of functions, while initiating processes that start the dialogue about urban scenarios.

CONCLUSIONS
This paper aims at providing a trajectory and a step-by-step design methodology to understand dynamic relationships of interdependence and reciprocity between micro (body) and macro (environment) systems and how they could inform forms of projecting design scenario in public spaces. The pavilion (see Figure 8) developed within the two-weeks of the IaaC Global Summer School represent a prototype that negotiates between “process” and “product” to test a system of relationships. Functioning in this case as a prototype, it seeks to engage the public or a specific urban condition. Once a strategy has been proven successful the prototype might inform long-term implementations. This has a strong potential to replicate the same intervention in other urban contexts as a testing device. The process of prototyping, replicating and adopting can promote urban innovation. Urban prototyping as a movement is exploring those processes demonstrating that participatory design, art, and technology can improve cities.

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