INTRAVEIN – PARAMETRIC URBANISM

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Abstract

The paper is about a form of networked urbanism distributed in East London, consisting of a system of infrastructural and leisure clusters of cellular units, combining as a connective tissue of bridges and islands, adapting and negotiating as both a physical and informational network. Embedded with self-learning behavioural and responsive systems, it allows for an intelligent choreography of soft programmatic spaces to create new leisure experiences, negotiating the changing effects of time, weather, programmatic, and crowd dynamical inputs, extending parametric processes to drive urban performance.

1 Description of Thesis project

KNFRK propose a cellular form of networked urbanism, one where the large scale is made up of a series of differentiated elements distributed through the fabric of the city, where the urban parameters that feed the design are constantly indexed and used to drive the performance of the system. Through a neurological connection of these discrete elements the network gains the potential to constantly adapt to as well as itself adjust the dynamic conditions of the city.

This network consists of a system of infrastructural and leisure clusters of cellular units that combine as a connective tissue of bridges and islands negotiating the old and new Stratfords of east London as a physical and informational network. These clusters are embedded with self-learning behavioral and response systems, allowing for an intelligent choreography of soft programmatic spaces to create new leisure experiences that negotiate the index of changing effects of time, weather, programmatic, and crowd dynamical inputs.

At the intersection of the design systems – spatial, informational, and kinetic - responsive spaces converge as a cultural intervention that extends parametric processes to drive the dynamic performance of the urban. This is orchestrated as a system that allows person to thing interaction and communication from thing to thing while enhancing the experience of human to human interaction.

2 Networked Behaviours

2.1 Intelligent spaces

We are developing an intelligent infrastructure as a connective tissue to link the two poles of Stratford.

Given the extensive existing and proposed commercial development in the site, we propose to implement a series of cells of leisure uses along a bridge and within islands in Stratford City. These cellular units are injected with certain behaviors, allowing one cell to adapt to different uses depending on the information that is indexed by the system, as a cinema reorganizes into a series of karaoke rooms. The project is scenario-based, it cannot perform only in one way but rather must negotiate and reorganize according to the incoming information, taking on multi-state behavior.

The bridge at its most basic functions as a piece of urban infrastructure connecting the two sides, but this typology is expanded to offer differing pathways, opportunities, and situations to the users as they inhabit the ever adjusting bridgescape. This logic is then extended into the surrounding neighborhood fabric to develop a physically discontinuous but informationally linked archipelago of behavior spaces.

Thus, we have to be looking for a mechanism that reflects the criteria of the system. A mechanism of this kind can be considered a control mechanism of the entire procedure that should be built around a managerial intelligence that concerns the management of spaces during and after the design of parametric spaces. Is it possible to generate spaces based on algorithmic design and the logic of DNA so that the autonomy of forms and spaces wouldn't be related with a predefined or even an autonomous system? On the other hand what is the potential of a relationship (exclusively or not) with a system that implies the active participation of users that interact and drive the system? This managerial intelligence could be found within the society itself instead of being left at the discretion of managers-creators.

In this hypothesis, a collective intelligence could reciprocate with the genetic material of architectural objects - abstract machines. "Once knowledge becomes the prime mover, an unknown social landscape unfolds before our eyes in which the rules of social interaction and the identities of the players are redefined."[1] In this social landscape humans participate in a dynamic, intelligence based relationship with their environment (either artificial or natural). In a way we assume that management of machinic architectural objects could be realized by collectivities. Of course this scheme could not guarantee a harmonic evolutionary model based on total control and guidance of a system. Rather the development of individual responsibility to navigate and communicate inside our broader social eco-system is necessary. "Fuzzy aggregate, a synthesis of disparate elements, is defined only by a degree of consistency that makes it possible to distinguish the disparate elements constituting the aggregate."[2]

2.2 System networking

The proposal is structured around a system of networking different scales and behaviours of elements that are seeded and grow in Stratford city as our case study. Urban leisure (entertainment, commerce, community activities and infrastructure) as the main urban intervention is decodified through input parameters that evolve from the initial spacial unit of the single cell to the urban scale of Stratford (cell > cluster > island > urban network) while allowing for human-to-space interaction.

2.3 Networked Urbanism

Based on a fractalized logic of evolution the system consists of cells as spatial units, of clusters as aggregation of cells, of islands as synthesis of clusters and finally as an urban archipelago of networked islands. All these components are interconnected through specific scalar formal and informational relationships, but also through a shared negotiation of adaptivity and interaction, offering in this way a rhizomatic evolutionary perspective. Unpredictability becomes a basic factor of networked urbanism that parametrically enhances the urban experience and creates an ecosystem where cells, clusters, and islands always interact without a linear dialog with their environment and users.

3 Informational experiments

3.1 Crowd dynamics

Crowd dynamics are used as a simulation technique in order to explore organizational behaviors that evolve in time. The generation of organizational models is based on various parameters (number, cohesion, separation, alignment of direction and speed, type and number of targets) that take specific values according to time (day/week/season). Time and space criteria are merged as time based parameters feed the behavior of agents through attraction points. The attributes of these targets are differentiated following various desire properties that are then translated to local spatial conditions and crowd desires.

These studies suggest that optimum organization of space varies in time and that parametric tools can simulate and reorganize qualitative-quantitative spatial and temporal characteristics.

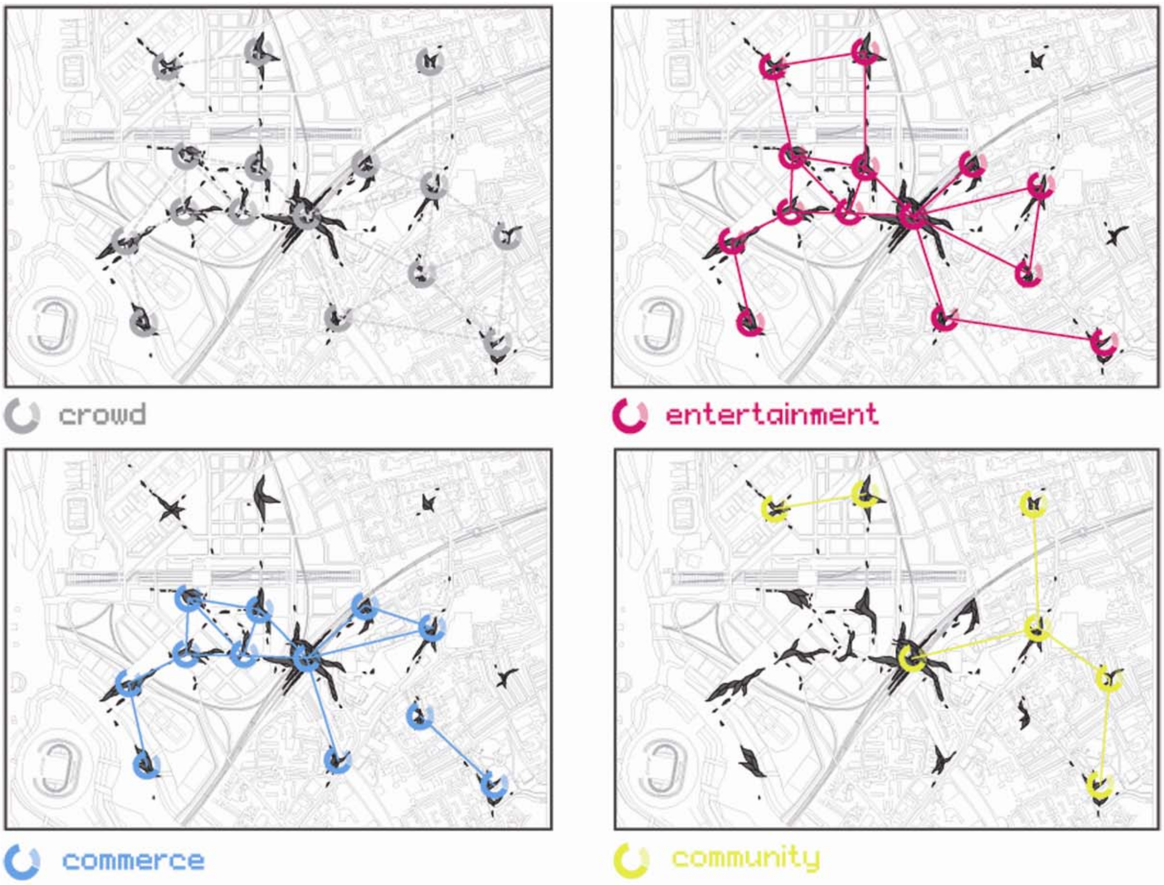
3.2 Human Interface

Interfaces play an important role within the scheme. Actually it is about a man-machine interaction whose center is activated inside the system, a mediator-linkage. Through my choices inside an informational structure made using an interface, I participate in a collectivity that altogether informs a system with data. This data affects not only the performance of a space, but affect primarily the algorithm-code that controls the space. So being aware of my input, i contribute to an intelligent collectivity that deals with the system as a collective input.

“Similar to vernacular archetypes and prototypes that have been developed and adapted for different sites, environments and individual requirements” [3], intelligent collectivities can interact in the complex context of contemporary urban life. In this way a decentralization of the system follows, implicating loss of control by the author. Actually it “removes the architect from the design process: giving the environment the ability to design itself and to have autogenetic existence…..is about a new kind of architecture without architects (and even without surrogate architects)” [4].The triptych intelligent collectivity-reorganized space-interface can be reduced to the primal triptych human-machine-interface.

The idea of an interface as part of an urban network becomes important, constantly feeding the parametric behavior of the system with data. The digital extension is an integral part of urban activity and merges intensively with spatial urban experience. The code of the system becomes open, culling feedback from people’s desires. This could be translated to become conscious of taking responsibility about our social relations parallel to deep embodiment of technology. A parametric space managed by collective intelligence implies a complex system and an abstract communication relationship between user and interface. “As clusters of tools, procedures, and metaphors, technologies configure a platform for discourse and ideology. Such a technical-discursive ensemble is modifiable through politics, yet it has political orientations built into it system” [5]. The potential all of these references is related to a collective organizational logic that accelerates social connections. Offering open procedures to users is not a risky decision, but on the contrary it is necessary to deal with specific existing conditions and to create new ones as well. “The architecture of the exodus will give rise to a nomadic cosmos that travels the universe of expanding signs; it will bring about endless metamorphoses of bodies; Far from engendering a theater of representation, the architecture of the future will assemble rafts of icons to help us cross the seas of chaos.” [6]

3.3 User input indexing


crowd
entertainment
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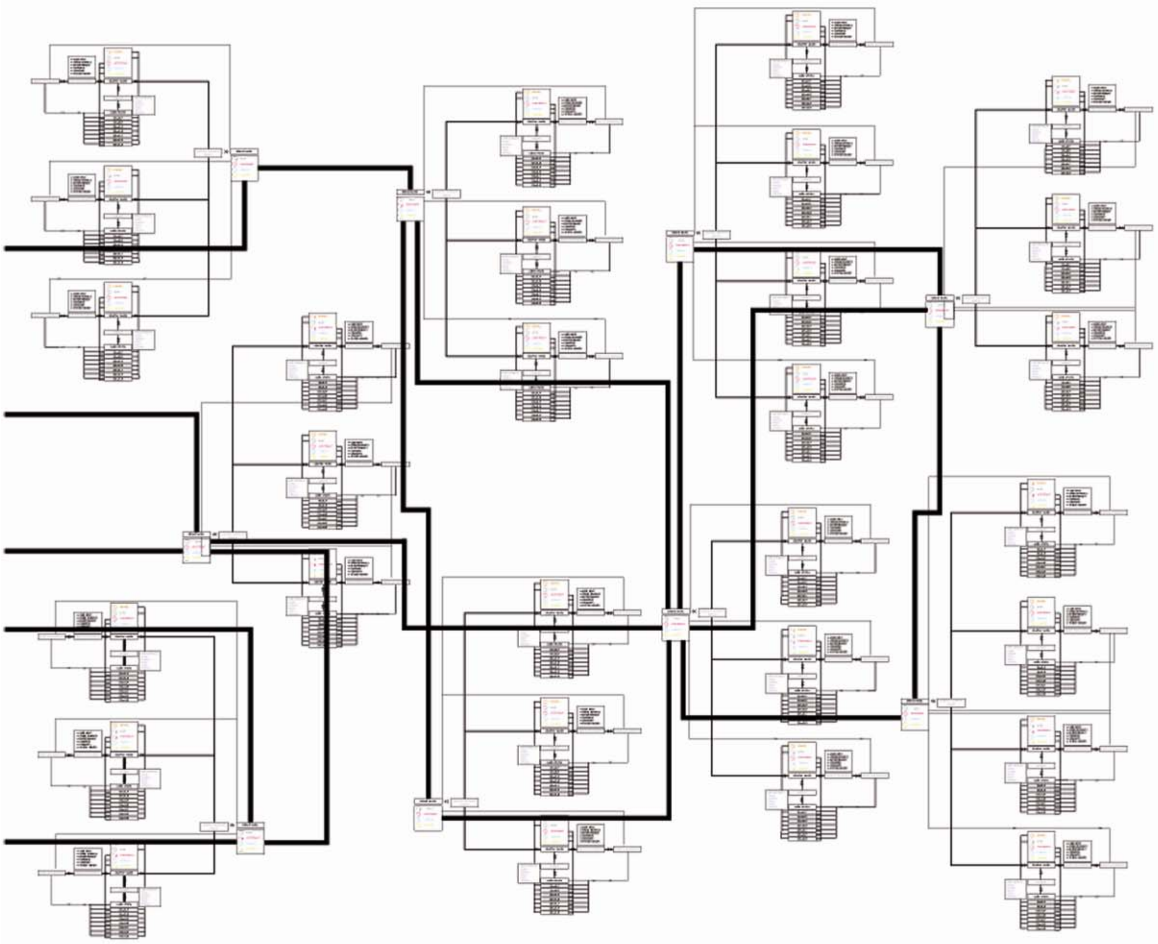
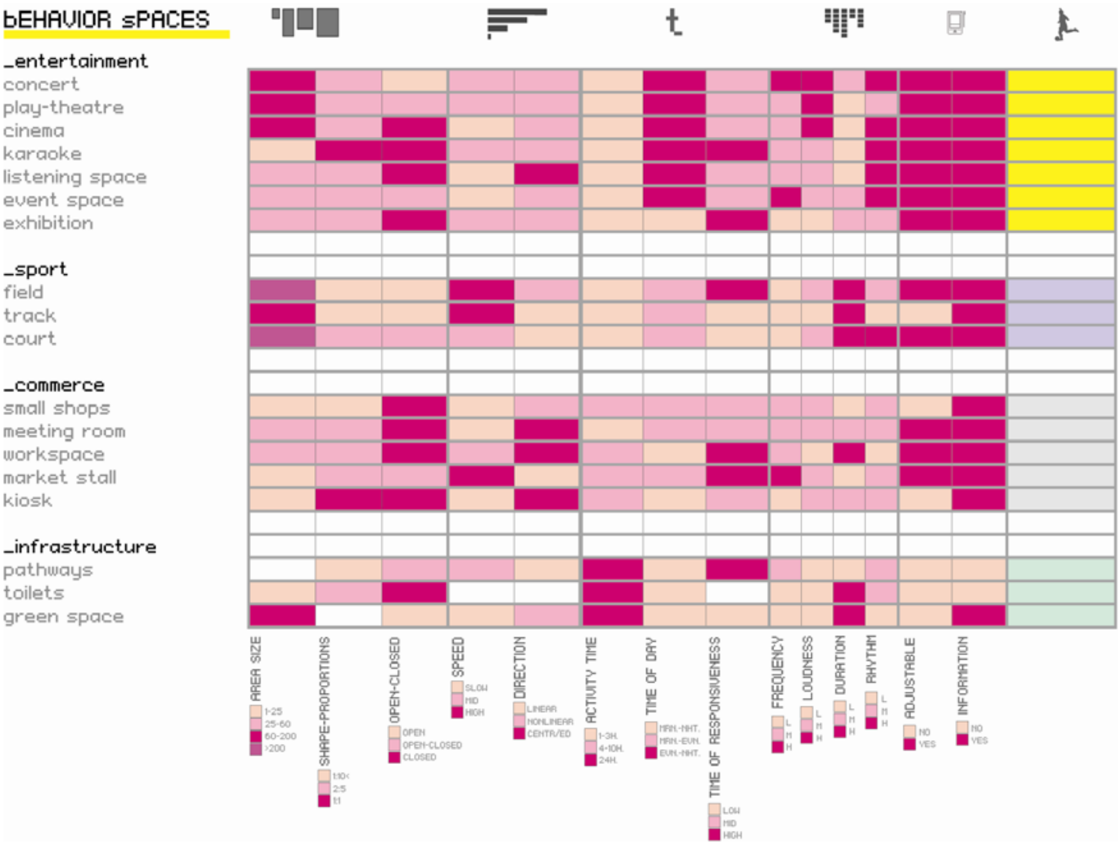




Connection between MAX/MSP and Flash through a user interface allows the adjustment of global parameters concerning physical space from the users ubiquitously and at the same time enhances urban experience as an information visualization medium.
“Consumer becomes producer in an automated system“ *Marshall McLuhan*

Personal involvement inside a networked urban field functions similarly to Internet online communities that share desires, but in this case they share desire about their space, their activities and therefore their actual urban experience and interaction. This attachment emerges between user and system that exchange information by sharing the strata of space and time.

The User Interface offers the navigation through information that deals with space, activities and time. This structure allows human interaction to have an impact on physical experience as user interface input is connected with the adjustment of physical space.
The access to information is categorized in three levels of navigation and interaction. Firstly user receives information through location based navigation. Secondly, user participates in the system by inputting his or her desires and thirdly, user initiates the response of system behavior by triggering new activities.

3.4 Information distribution

Inside a complex system of networking different locations, scales and times, the organization of information is the first crucial subject. In order to connect information with space the basic categories become the foundation of the system. It is not about reducing complexity, but about simplifying the understanding of complexity through setting fundamental driving forces. The selected information categories mix space parameters such as crowd behavior, activity intensity, or programmatic uses (entertainment, commerce, community) with relevant information parameters.

Urban, island and cluster choreography of information distribution are based on the above information categories and are applied as group of parameters of specific locators and at the same time as group of parameters of the relationships between the locators themselves.

3.5 Programmatic parameters

The parametrization of program is realized through the codification of spatial programmatic uses with selected main parameters. Area of space, motion of users inside that space, sound in that space, use in that space, time factors of that space and the potential of interacting with an interface become distinct as main parameters. The next step is the analysis to sub parameters in order to proceed to measurable spatial qualities. Area concerns the area size, its shape and proportions, and the open, semi-open or closed state of the space. Motion refers to the speed of movement through space and directionality of the crowd. Sound concerns frequency, loudness, duration and rhythm of the environment. Use is categorized to entertainment, commerce, community-sport and infrastructure. Time is analyzed as the duration and time of day of the activity in the space and the time of responsiveness that is needed. Interface involvement is about the adjustability of that space and the potential of offering information to users through an interface.

3.6 Fluid movements and pulses

Our visual indexing records the past events in memory, but the current view is set to the present moment. By implementing a motion tracking system we are able to translate present movement into visualization with an increased lifespan. As the camera records the motion within the frame, zones of change birth sets of particles in the system who are encoded with behaviors of growth, atrophy, and a finite lifespan. The reactive system allows traces of recent events to be left behind, extending the moment of the past present.

The complex flows of bodies through a city carry embedded information within their patterns of movement. Fluid algorithms and particle physics are used here to simulate the dynamic conditions of the crowd. Seeing crowds as fluids allows for us to conduct digital research into the interactions between certain user types, focusing on the laminar and turbulent flows generated by the system and on the crowd as a whole, adding a layer of understanding to the neighborhood conditions of the agent based crowd dynamic simulations.

Parametric adjustment of the conditions of the simulation allows for time-variant conditions to be taken into account and the results studied relative to individual output. Here trajectories and points of attraction set up the simulation where fluid bodies interact according to the implanted values.

3.7 Density driven

Fluid algorithms provide a system in which local change in reflected through the global whole. Each voxel [volume pixel] that makes up the digital fluid reads the parameters of its neighbors and adjusts its condition accordingly, generating gradient flows across the fluid container. These fluid motions and their adjustment to local conditions provide a way to translate characteristics of crowds into a system that allows for the simulation to be adapted to drive other parameters of the design. Here the density values of the voxels are connected to corresponding cells with a discrete range of possible motion. Higher density values correspond to higher crowd densities and cause the cells to open in response, revealing the activation, speed , and trajectories of the users.

4 Space (in) formation

4.1 Negotiating behaviours

Multi state behaviors emerge from a system in constant negotiation, adjusting between present and future conditions while progressing away from previous states. This dynamic equilibrium allows for low level changes in the system to have global

effects, maintaining a partial memory of past events and allowing for a conversation to occur between the states.

4.2 Splinal logic

The splinal logic of constructing and merging splines of beams together was developed by creating specific properties that a cellular formation should follow. Bundling is the integral method of creating the infrastructure of the beam, where depth through accumulation is achieved. When a beam needs to split into different directions, the diverting property of the splines will allow the bundles of the beam to follow a specific trajectory. Because of the bundling ability, even if a beam splits into two parts, structural integrity can still be retained due to the redundant density of splines that the beam started with. Twisting in the system was used to create specific directional flexibility on the bundles created. With the twisting property, a vertical bundle can transition to a horizontal bundle that would allow the beam to flex and move in a different way. Depending on structural requirements, a spline can blend into other splines when a lesser amount of support is needed on a certain area, thus, material optimization is achieved.

4.3 Cellular system

A more coherent cellular element was derived based on the splinal logic studies. Following a straight trajectory of lines, the 1CELL unit is formed, its horizontal elements merging with diagonal splines enclosing a space. With the directionality of the cellular design, a simple rule of addition was followed to produce the next three sets of cells. Starting with a single cell, a second one is added at a 45 degree angle on any of its four edges so as to merge the two by sharing similar splines. With the addition of a third and fourth cell, the 3CELL and 4CELL can be derived respectively. To create transitional spaces from enclosed to open both the upper and lower splines of the enclosed cell are merged with the lower splines of an open cellular space.

With the use of singular units, deformation can occur in a more local scale that ripples through neighboring elements. The flexibility of the system is seen with the ability of the cells to nest within larger cells, providing for a system of adjustability and easy deployability. Given a specific large cell to fill, the four types of cells can be easily paired up to give the best possible formation for the given space.

4.4 Parametric relationships

Catia software was used to catalog the static and kinetic programmatic cells that then are applied with localized programmatic criteria to form clusters nested into infrastructural cells. The semi enclosed interior of the resulting space is defined by the placement of floor and canopy cells. Each cell type follows specific rules controlled by relationships that allow for a range of adjustment to fit the cells to specific formations. The cells stay within a defined range of possible values of dimensional parameters, allowing them to share similar geometries but provide differentiated spatial outputs.

4.5 Cells

There are four main types of programmatic cells:
A) Single programmatic cell: a simple structure that is able to define small semi-enclosed spaces within the larger array, it is embedded with kinetic behaviors that allow it to adjust the height and position of its structure to accommodate various configurations.
B) Double programmatic cell: defined as two subtypes, one semi-enclosed and able to adjust by vertical motion alone, the second begins completely enclosed but is able to open to surrounding spaces with a combination of vertical movement and rotation.
C) Triple programmatic cell: also developed into two subtypes, the first semi-enclosed and able to adjust the upper portion of the cell, while the second is able to perform as a walkable ramped connection to an upper level or as component in a varied landscape.
D) Quattro programmatic cell: entirely enclosed, these larger cells remain static in their structure to allow for more spatially demanding uses to coexist in the clustering formations

4.6 Canopy cells

Where the programmatic cells' states are determined by the cluster to cluster relationships within the network, the canopy cells respond to their immediate conditions providing a less hierarchical system of response to changing conditions. By reading the states of their neighbors as well as the movements and requirements of the fluctuating crowds, single cells are able to adjust their position accordingly, constantly adjusting the conditions and experience of the space below. These variations transfer across the global level of the system by passing information at the local level, resulting in an ability to adjust ambient spatial conditions through the resulting patterns of porosity.

The catalog of static and kinetic programmatic cells is applied according to localized criteria to form clusters that act as nodes within the system. The individual cells within these clusters respond to the positioning of their neighbors, allowing the cluster to take on varied formations. These clusters are then nested into the larger infrastructural cells, with the semi enclosed interior of the resulting space defined by the placement of floor and porosity of canopy cells.

4.7 Robotic prototypes

A series of manual and robotic prototypes were developed in order to explore the possible configurations of the kinetic cells in parallel with inverse kinetic digital animations. The digital and physical prototyping processes were explored such that the results were fed back into the corresponding development of the next prototype version. Initial prototypes attempted to replicate the initial behavior and range of movement of the animated typical programmatic double cell. In order to achieve this motion a simple linear pull mechanism was implemented to control the position of the structural arms of the cell, and with a short adjustment a far greater change was achieved. Adjusting the balance between stiffness and suppleness of the members allowed for the prototypes to be fine tuned to desired behaviors.

4.8 Prototype double cellv.1- cellv.2

This first manual prototype 2CELLv.1 brought about some interesting developments in the design of the kinetic cells as the performance of the model was now related to the properties of its material. Through this material computation a twisting motion was added to the repertoire of kneeling / opening initially proposed through digital animation. The states of the cells are linked to the index of incoming information within the network. As the clusters communicate the relevant data of time, crowds, desires, program, and weather they determine the current state of the individual cells.

The supple robotic prototype 2CELLv.2 developed as a way to link the digital indexing of data to the physical manifestation of the cell state. Attraction points within the network are adjusted to the varying activation scenarios, and the localized conditions are then fed to an Arduino microcontroller via an interface developed in Max/MSP. Density within the digital diagram is translated to the position values of the servo motors that take over control of the linear pull, allowing for precise control and relationship of the pair of double cells. This state data is then fed back into the system through communication with the other clusters within the network and at an interface level to distant users within the urban network.

4.9 Prototype canopyv.1

This prototype explored the possible configurations of a single canopy cell and its relation to the overall organization of the prototype array. Using similar materials as the previous cellular prototypes, the motions of the canopy cell are explored in a physical manner in order to bring out certain tendencies in the system to inform further development of the cellular type. Each cell is able to act independently, but the position taken is relative to the neighboring cells, working with the same principles that were used to initially study the fluid movement of the canopy array. These variations transfer across the global level of the system by passing information at the local level.

5 Distributed responsive leisure

5.1 Stratford

East London is preparing for an explosion of development in coming years, the time frame of which has been accelerated by London's successful bid to host the 2012 Olympic Games, whose site sits adjacent to the proposal.

Stratford Town Center is a major transportation hub for east London, currently providing connection between northeast England and London, with trains, buses, and the underground converging at Stratford Station, and London City Airport a short DLR ride away. This is about to be expanded as the new International Train Station is constructed, extending Stratford's reach directly to mainland Europe.

5.2 Urban network of negotiation and leisure

The addition of an urban leisure park at the point of connection between the two Stratfords would augment the existing and proposed development, offering an intelligent infrastructure that adapts to constantly changing scenarios.
Set up as a parametric urban filter, this connection is unpredictable and follows economic, social and cultural dynamics. A bridge could be a continuously responding structure to these changing trends. It adapts, creates space and even takes part in the negotiation between the two Stratfords. Leisure activities are proposed as an urban enhancement

of the centralized commerce poles of old and new Stratford.

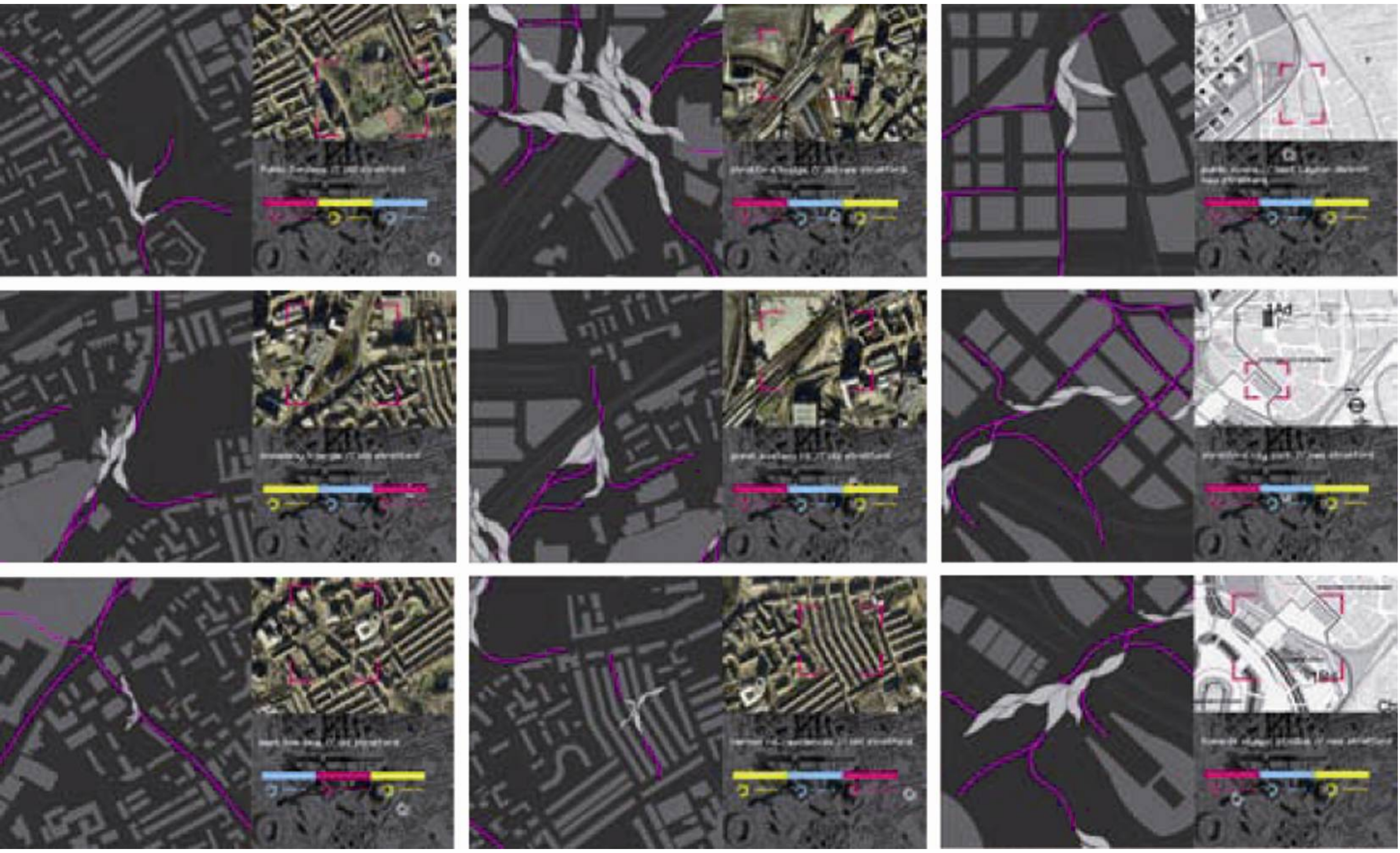
This response to parametric urbanism is a network that spreads through the old and new Stratfords. Instead of a centralized mega intervention, a flexible urban network is articulated around the central station of Stratford that connects the two local poles. Urban islands are proposed in strategically important locations of the area, following the logic of system networking that in urban scale is realized as both a circulation and a digital network.

5.3 Circulation network

The proposed urban network of Stratford is first of all a circulation network. Its islands are located in proximity to each other in order to allow the movement between them. The old area of Stratford (east), the main bridge area, the new Stratford City (west) and the new Olympic site are connected in a common urban environment. The logic of dispersed urban intervention enhances the in between places as well and circulation becomes vital, allowing a degree of freedom to users in contradiction to a centralized urban masterplan.

In addition, the placement of the network's nodes takes in consideration the existing and future main circulation directions, creating a "bridge" between existing space experience and the proposed adaptive urbanism.

5.4 Digital network



On the other hand, a digital network is developed concerns more translocality than locality. The urban islands are interconnected in terms of information. The flow of information between them is based on specific information categories derived from (crowd behavior, entertainment, commerce and community activities) that translate the existing urban activities to the network's nodes. The digital network apart from the information characterization of the urban islands and the information distribution between them, extends also to ubiquitous human interfaces that provide to users access and interaction with the system's networking.

"Interaction, between the users and the pieces of information they handle, may become information itself. It is the automatic translation of these interactions that is taken over in the fuzzy interfaces. Accordingly, it is not only the interface graphic design that has to be conceived, but also the design of the structure of information itself."[7]

5.5 Localized programmatic hierarchy

The connection between global information parameters with the various areas involves the specific local conditions that differentiate each zone among the network. The daily urban experience within the network is not a homogeneous one. Therefore the formation of the islands takes into consideration the local conditions and becomes the extension and the augmentation of the existing urban environment. The islands of the proposal are placed in old Stratford (Great Eastern rd, Broadway triangle, High St., West Ham lane, Public Gardens, Vernon rd), in new Stratford (South Station square, Stratford City park, Retail square, Central spine, Olympic village, West Leyton public space, towards and by Olympic stadium) and in the bridge that connects both Stratford's (Stratford bridge). An island is also placed on Maryland St. in the neighboring area of Leyton, exploring in this way the potential of a further expansion of the network into greater London.
Each island feeds and interfaces differently with the digital networks producing its own localized programmatic hierarchy of entertainment, commerce and community activities.

5.6 _Stratford Bridge

The Stratford bridge island is the interface of social, economic and cultural forces of old and new Stratford. Additionally, as an architectural proposal it combines all the spatial qualities that could be faced across the urban network. Apart from being a physical connection that facilitates the movement of vast amounts of people, it is a leisure park that hosts entertainment, soft commerce and community activities in a larger scale than the other islands of the proposed network. It also extends organically to the proximal bus and train stations. The programmatic cells are the spatial units that cluster together to host human scale activities. The clusters are then attached to larger infrastructural bridge cells, the synthesis of which forms the urban island.

5.7 Cluster networking

The information distribution is gradated to different spatial scales. Each island is itself another network of interconnected clusters of cells. The clusters are linked to each other according to basic information categories (intensity of crowd activity, crowd behavior, programmatic activities), based on interrelations that take into account local and spatial criteria. Proximity, location, programmatic tendencies, scale, proportions are properties that differentiate clusters from each other and build their networking that triggers the performance of the total system further in the human-experience scale.

5.8 Scenarios

The performance of the system as a consistent multi-scalar network is simulated concerning three different scenarios (carnival, weekend evening and morning rush) while networking triggers bottom-up and top-down reactions at the same time. Space behaves in a different way responding to each scenario. Information flow brings adaptation in urban, island, cluster and cell scales. The mechanism involves a continuous interaction between networked spatial organizations: a network of cells generating clusters, a network of clusters generating islands, a network of islands generating the urban proposal. Clusters have the ability to adjust to various scenarios as they are formed by programmatic kinetic cells and responsive canopies. The proper response to each scenario is choreographed according to the input parameters of clusters. Cells through their movements allow the change in the spatial environment that facilitates the development of variable scenarios.

A) Weekend evening at the main clusters of Stratford bridge: the majority of the programmatic cells are activated creating a landscape for urban leisure.
The human interface input is high as users have participated in the creation of their spaces. Crowd activity is intensive and entertainment with community activities prevails while commerce activity is also present on a smaller scale. The self-learning of the system contributes as weekend activities follow repeating patterns.

B) Morning rush at the main clusters of Stratford bridge: most of the programmatic cells are in their rest state, few are activated in order to provide a quick morning passage for the crowd.
The human interface input is extremely low. Crowd movement is high. The need for commerce activity is present, while entertainment and community activities are absent. The self-learning of the system partly contributes, recognizing tendencies in the flux of crowds.

C) Carnival festival at the main clusters of Stratford bridge: nearly every programmatic cell is activated creating the infrastructure for a large scale event.
The human interface input is partly activated as some users trigger discrete local events. Crowd activity and movement are high and mostly entertainment with some community activities prevail while commerce activity is absent. The self-learning of the system also contributes as it responds to the need for temporary big scale events.

Each island within the urban network is linked together allowing for certain activities to be choreographed among specific groups of islands. Depending on location and input parameters, an island or series of islands can simultaneously provide the same desired activities of a given community.

5.9 Stratford Interface

The understanding of the urban proposal is communicated through the human interface which gives access to users to receive information about what the current state of the network across different scales and in parallel input their information (desires of participating and initiating). The networked system becomes open and flexible to accept as further
parameters the users' active involvement. The user
parameters the users' active involvement. The user
has an overview of scales, spaces and time. The urban network behaves like a living organism that shares different information and experiences with users in time and space.

The synopsis of the proposal appears at the interface, as each urban island, cluster and programmatic cell provides the proper information. Navigation through different days of the week and time of the day reveal the flexibility of space and each potential to change. Additionally, information about other users' initiations and preferences could form collective activities and enhance the performance of a networked parametric urbanism.

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