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Non-edited transcript of workshop talk

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Waterloo Architecture Beesley NEST studio

Background: the foundation for what I am engaged in started roughly eleven years ago. I will speak about the 'nonlinear systems' organization, working with Cecil Balmond. Teaching at Penn, fourth year. NSO intersections between science, computation, and interest in forming bridge between complexity and production of form. Series of conferences, different disciplines, there are a number of interesting discussions, writings, exhibitions. Self-critique: we were being a bit too opportunistic, fitting a time what we were engaging- emergence, non linear systems, complexity, DNA. Could we be more rigorous? Peter Lloyd Jones, formerly at Penn- matrix biologist. Year-long conversation trying to figure out how to communicate. Investment of time early on, 2005-6- transdisciplinary collaborations,

Protagonists: Buckminster Fuller

Robert LeRicolais, attempting to understand dynamic of form. Father of the space frame, corrugated sheet metal. Obsessed with radiolarian. Cecil Balmond teacher, mentor, influential in my thinking.

Over the course of the year that Peter and I spent together, I joined in weekly lab meetings. Like terms, but different definitions of those terms. Different deliverables, funding figures. At end of that year we felt we had enough ground covered to stard design studio: 'LabStudio:

Dynamic Complex Systems

Environmental Context

Shared space for exchange

Abundant Information

Methodologies and Metrics

Visualization

Course together in graduate architecture department. Intent to pair post-docs and graduate architecture students. Three areas of inquiry, closely aligned with Peter's expertise as matrix biologist. Networking behaviour within human lung. Motility. Environmental cues. Surface design- multi-cellular

- Design Trajectories: New Tools and forms, novel methodologies
- Architectural Protoyping: huan-scale, material systems, data scapes

- Buildings: ecological building design

What Peter introduced to me early on: the Extracellular Matrix: a dynamic protein network

A repository of biochemical and biophysical information

A historical document, it records events

Master regulator of function.

This notion of dynamic reciprocity, constant feedback of context with the production of form- presented a very powerful ecological model for architecture.

On biomedical end, Peter and colleagues: Nina Bissel, pioneer of matrix biology- as early as 1980s she was being shunned, dogma focused on DNA and code. She put on the table, and Peter did postdoc, was that secret of life lies outside the cell. Architecture of the cell- not only do we have code, but that cell is acted upon within dynamic architectural textile. Some of the successful research included how changes in extracellular matrix could alter diseased elements into healthy things! You don't attack the cell, instead you address the environment to bring cell back into harmony.

I believe we have it all wrong. How buildings can act more like organisms. Developing a reciprocity. You have PB as teacher, exemplifies that. How would we start.

So, how do we start?

Frequently we work with technology coming from colleague's labs.

Extract conditions forming pseudocode, acting on through iteration.

Generative components: components embedded in them. Simulated within orange tessellation.

Sometiems we work directly withdata: connectivity and clustering.

Pseudo code developing algorithmic tools. Ideas of network, connection, context defined as a translational surface defined as manipulation. Reciprocity and feedback loops. A few outputs---

A way of approaching subdivision. Dynamic components relative to scaffold that had its own resilience that could change over time. Prototypes turned to architecture. Starting points for methods and tools.

Generative Fabrication:

Surface design, one of the research tracks. Context of peter's research, looking at breat cancer. Data working with: basically, a series of confocal stacks, through multicellular structures. Brought into simple Quicktime format: practical pixel-based raster information. We need to work with vector information in CAD format. Immediately: parameterize these as three-dimensional models. More specifically, same types of cells. Epithelial cells- in this movie it is undergoing tumerogenesis. Architecture of the two:

Basement membrane stained in green. This will look simplistic: we simply started to work with each image. We passed a smooth NURBS space to define external constraints. We worked with a series of relationships- voronoi filter was useful for site relationships, delany. Geometric duals. Compex field conditions. These geometric filters allow extraction of quantitative relationships. They had never been able to mdoel in this way before. It was incredibly useful to Peter. In Sciences there is a strict format for information- new diagrams that we were offering became a point of contention early on. We worked with a 3d printer early on. I was interested less as representational device and more as rapid manufacturing method. We'll look at a project that explores that.

Another project: deployable structures:

Contaminating data. Simple scissor. Off-centred. Probing the connection logic between cells. Multicellular structure: see nucleus, actin filaments binding two cells together. Actual view of what that is- in a disease scenario the actin filaments don't work properly. The scissoring behaviour when they come together is undermined. Rethink how one engages mechanisms. Beyond regularity, three-dimensional/two-dimensional systems. Developing a robust kit of physical parts. Physical models—prototype where surface of cell rendered as hexagon.

Sophisticated models, distal effects, variegated performances. Linear deployable systems we are familiar with. Brought into a studio- moving some of these prototypes into a brief. Pavilion and folly for a site in Philadelphia. Liminal zone between site. A provocative way of addressing sites at scale of architecture. You can see the system engaging parasitically with a bridge. Series of surface studies on exterior. Digital space and through much larger prototypes. Final prototypes water-jet cut aluminum with struts.

Rolantd snooks, Peter Lloyed Jones. We were quite excited by the prototype. Active set of connections. Healthy scenario and disease scenario. The disease scenario can tell us a lot about the potential situation.

Grount substance, 2009: Design and Substance. Maximize build-bed size, print multiple parts. We started with a multicellular structure and began to scale up. Designed nonstandard components coming together in a coherent organization. Along that time, perhaps in next day and a half, splinter and parallel investigations start to occur. We were using z-corp printer. I have a background in ceramics. I started to think about powder based media, alternate powders. Greenware clay parts, sugar and fibre printing process. Digital ceramics, simple concept of brick, hasn't changed for many years. Nonstandard biological systems could impact built environment. Unfired parts cleaned up, constraints to deal with-proprietary media and bisque fired, clay fired. Views of final prototype with interstitial stand network of steel cable.

We were also working on a paper related to the epithelial architecture. Featuerd on Americal Journal of Pathology. Series of abstractions provided very useful

Motility- pulmonary hypertension

Behaviours rendered into architecture. Another trajectory was that of motility. Disease: motility looks at how cells move. Could changes in ECM influence motile behaviour. Golgi apparatus, and philippodia, attempting to nework. Cell becoming confluent and sick. Biometical end: hypothesizing: we were interested in extracting a set of choreographies. Signatures cuing whether or not someone had pulmonary hypertension. Smooth muscle cel.s

We started with dance, point of departure. Ice dancing. Tool palate, looking at extents of body. Developing a set of signatures initially looking at single path, commingling path, environmental boundary. Setting up a series of tools bringing into context of cell motility.

Final suite of signatures.

That then influenced a series of custom-written algorithms. Motile behaviour mapped as continuum. Looked at single cell, choreography. Ice dancing, specific waltzes. Signatures resulting from that. Here, the problem was reversed- extract choreography from motility and generate coherent behaviours. Field conditions and individual acts. Early diagrams being produced- focus on sinle cell. Time represented in Z dimension. Morphology through time. Polar filters attempting to extract. Unraveled, to look at landscape. Native environment- healthy normal environment. Each one is an edge of a cell, overall landscape. In a denatured, unhealthy environment, you can see it is much more turbulent. More differentiated.

This was one of the more mature diagrams. Exciting—Eric Assadic accepted into Stanford as cancer biology. Noone had done this before: specific motile behaviours

Translating relationships into behaviours. Finding new behaviours ***[hope to get this lexicon!]

Is information gained, lost?

Datascape: body as extended network. A set of methods, prototypical relationships.

Blood Vesel Development

Simulating dynamic biological systems via design. Pulmonary hypertension- endothelial cells, forming vascular lining of your lung. Smooth muscle cells.

Design computation gallery at Siggraph. We didn’t have a budget. This was a first set of data: stacked jpgs.Pixel-based information, crude information. Crude information: we see endothelial cells, dynamic protein-rich silica gel. Networking, signaling through ECM, pulling up onto matrix. Transferring forces, attempting to network. That is how the lung forms. Cells start to network, form sheets, tubes, organs, bodies.

With a single cell, taken out of extracellular environment, it becomes a perfect sphere. Drop a bit of matrigel into it it will flatten out immediately. Incredible to observe that. Without that environment the cell will behave differently. They would attempt to network. They would try to lay down their own ECM- they are kind of like loms, they make their own. If they don'thave that they will become sick and die.

Four roules:

1. Cells seeded within matrix.
2. Cells locate matrix attachment
3. Initialize attraction via other matrix
4. Tension network generated across entire field.

Slow down process of visualization: in that slowness, how might we move into an analogue mode of material production? How might we begin to navigate and scale up this environment? Human data- a data scape.

Applets done in processing. Attachment points.

Force-changes within network. Components.

We are less interested in objects and more interested in matrix itself. Diagrams- we settled on moments in time. Series of templates. In these templates, the density shifts are delineated by colour. Ingenious

We worked with 75000 zipties

We settled on three different sizes of loops. Zip ties are amazing: adjust locally, regional and local conditions. For about a month and a half we worked like this. Printed tempates at 1:1 scale. Produced sheets. Then, the densest areas of sheets connected with tubes. Wormholes through timescape. Visitors invited to meander through installation. 18' x 12' x 15'

Ziptie played an important role: everyone understands that. Obsession: they were impressed by mass. Trhough that entry, allowed people to engage some new questions. One of the most important moments happened about a third ogf the way through: Director of Medicine and Engineering, impressed by the idea that each one fo the cells represented a data point. The fact that this allowed for different readings. Projective reading: hypothesis-fundamental research, going back to the benchside with a new set of questions. The most important deliverable was to set up a way of thinking.

Ars electronica: I was quite pleased that they put this between live MRI station and another station visulaized through optics. Questioning perhaps an installation of zipties could tell us about body. 2009 visualization challenge. Scientists getting heat. Visualizing science recognition.

Antoher project: workshop ran in 2010, Smartgeometry. Networking. Cells and influence of ECM. 25 students from around the world, prep work with students. Read papers, key texts, building up a robust understanding of scientific underpinnings of content. Tasked with developing series of nodes.

Component family—those nodes needed to have connective intelligence. 3d printing arrived to Iaac in Barcelona. We arrived with several large boxes of preprinted nodes. Zcorp wasa partner. Groups worked back and forth between digital production and simulation of possible analogue networks. Seeding possible sites. You can see: each one provides a seed allowing for vectors of movement and connectivity. Andrew Lucia and myself maniplulated the field, striking new line of tension within the warehouse space, with intention of developing an active diagram constantly shifting behaviour: to get students:

Rule sets. Deploying systems. bEtween each node, possibilities of compliance. Stiff, midrange, very floppy. Running throughout this: stainless steel cable. Starting a sprout of the network. Tension. Dynamics: influence of form. Started to take shape: filigree started to form. Day two. Final day: structural engineer referred to Catenary networks by Gaudi…

'the great book, always open, and which we must make an attempt to read,  is that of nature- other books are taken from him/her, in them are the errors and misinterpretation of men and women…' Gaudi

Matrix architecture: the embedding of material systems with biological relationships at once natural and artificial. It is about breaking pedagogical boundaries.

Questions: Mark Kim: such a departure from typical architecture. Rigour deeply appreciated. Few projects are formal representation of microscopic qualities enlarged. How does this move into architecture, do they replicate?

Georgiana: what is the equivalent of the ECM in the built environment?

Jenny: at urban scale, there are a lot of flows that have their own agency

PB: Michelle Addington: perception

Jenny: Susan Yelavich: a feminine set of meshworks, interesting to think of interiorities, liminal zones. I obsess over the ECM. Looking at models that exist, a provocative question. My interest

PB: making things deliberately sensitive.

Jenny: one model that might exist in material world is weaving. Textiles at large. Weaving: connection with computation. Mechanization of the Jacquard loom. Jessop Jacquard invented the punchcard, flow through warp and weft. Common friend, Ada loveless, friends with Babbage. She is credited with being the first computer programmer. First IBM computer titled Ada. Profound: model of the ECM as a dynamic woven construct.

Image: a decellularized ECM. Washed away through chemical processes: took over Peter's lab. Her images: she's running a lab but spends time at the bench. Both of these are ECM's decellularized. Top one is undergoing tumerogenesis. Bottom is healthy: wonderful bundels, braids. Fray, flts, things broken. Continuity of strands are undermined. Human lung, interesting to look at architecture at scale: cellular scale, hierarchical conditions.

Cells plated in matrigel E-skin project. Challenging architecture of ECM environment. Differentiated geometries, changes in compliance. Border of the environment: why is no one questioning the circular nature of the Petri dish?

Smooth muscles plated onto a wrinkled environment. Contrast this to a flat one: philippodia reach: slight differentiation and a wrinkled one: why this might be important. Think about how changes in geometry and compliance might change changes in finer-scale performances. This is the foundation for thinking for passively responsive building skins.

Here, one substrate changes the wrinkeles and pillars. Behaviour is quite different. Within pilar and wrinke: cells care able to, cells able to dance on top, lassoing each and around, riding on top.

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Getting started tonight:

Take your material constructs that you've developed already. Use that as a starting point for integrating with these rule-sets. There are a set of rules. A 'polymorph': there is a top surface, a bottom surface, and two manifolds. Everything is governed by two bounding conditions: isosceles triangle and equilateral triangle. The red dashed lines delineate connections. Diagrams: there is a three dimensional morphology. I would like you to follow rules:

All of the edges connect. Take your material constructs and develop a simple component family that has to integrate with this active ground. I'd like you to have a few swaths—

I've organized this with seeds, forming parts, creating larger holes.

Naket edge, stay clear

MT: Manifold to top surcae

B: bottom

T: top

Differentiated colours

Dashed lines conections across parts. The intelligence of these conditions. Sites: this will influence how this behaves. Tomorrow we'll spend about three hours doing a scripting tutorial where you can start to develop your own templates.