Materially driven approach to design

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ABSTRACT: This paper describes and assesses an approach to teaching an architectural design studio grounded in exploration of materials, their inherent properties and behaviors, and the performative capacities of material constructs. The goal of the studio was twofold: to blur the boundary between form generation and materialization of an architectural construct, and to examine the capacity of a materially driven approach to redefine traditional notions of function, context, and design methodology. The underlying ambition was to engage making as intrinsic to the design process. The resulting products of the material- and making-driven processes were then tested by projecting and engaging them in the public realm. In conclusion, this paper discusses possibilities brought forward by the emergence of an "intelligent" material – possibilities that relate not only to a change of a design methodology and process, but to the change in architect's attitude that may arise from better understanding of material possibilities and how to work with them.

Conference theme: Innovative approaches to architectural education
Keywords: materials, technology, design process, materially driven approaches to design.

INTRODUCTION

Recent research and advances in material science have opened previously unimagined possibilities for architects and designers. However, it isn't only the new properties and performative capacities of materials that trigger imagination. Like material scientists, architects and designers are increasingly interested in biological models and the way organisms use (i.e. make) materials and create structures. A possibility to tap into the growing knowledge base of how nature builds is truly fascinating. But it is not necessarily the beauty and elegance of the forms in nature that is most fascinating; it is a grasp of underlining processes which bring these forms into being that truly opens new possibilities into how we could design.

Fascination with biology is not new. Throughout the history of architecture this interest has taken various forms, but it is only in the past century that the understanding of underlining natural and biological processes (as opposed to figurative interpretation) has started to infiltrate architectural thinking. It is perhaps only in the past decade that this thinking has found its performative manifestation in architectural research.

At the beginning of 20th century chemists and physicists become interested in biology. Discovery such as double-helix structure of DNA provided an insight into a molecular structure and enabled manipulation of biological structure and function at the scale of the molecule. Alongside this and similar discoveries, building upon D'Arcy Thompson's seminal text "On Growth and Form" showed that physical forces of the environment influence the form of an organism over long periods of time (Thompson 1917). The natural form and function of the organism were linked to the adaptation to the environment. The idea that form is not given or predetermined, but is the result of the process, influenced the technologically inclined architects, artists, and thinkers of the early 20th century. This influence is found in the works of Lissitzky, Moholy-Nagy, Kiesler, as well as Le Ricolais, Buckminster Fuller and others. The new understanding of indeterminacy of form opened the door to the question of what kind of processes or means are involved in the making of form (Mertins 2007).

Today, advances in science and technology continue to open new horizons for architects and designers, triggering their imagination and informing their thinking. Capacity to design materials with specific properties, design material behavior, along with tools and techniques to visualize and fabricate infinitely small and to simulate emergent behaviors are opening previously unimagined possibilities. Architects such as Lars Spuybroek, and engineers such as Cecil Balmond and others, are demonstrating that this is a very important area of architectural research that potentially can change the way architects think and design buildings.

It is important to mention that architecture as a profession is slow to embrace new horizons and a change in thinking. Historically, the capacity of material (matter) to inform the form (by means of its adaptation to the environment) has rarely been employed. Materialization and formation of an imagined construct have rarely followed each other. Form, as a representation of meaning, has been prioritized over material (matter). This has led to the subjugation of

material to form, and subsequently to viewing material as an inert matter that has to be organized through various kinds of assembly. Assembling materials to achieve a form became a way of materializing layered and complicated representations. But the logic of collage and montage is quite different from the "logic" of a biological model; the seamlessness of execution, the evolving adaptability, the inherent responsiveness to the internal and external influences, awareness of the interconnectivity to the surroundings is an aspiration that would require the change of (collage) logic and sensibility. What would the focus on material, its operational capacity, its behavior, and its innate properties bring to a designer? Are we ready to begin to unmask, redirect, and reframe the concept of representation, shortcut the mediation of an image, and engage making more directly, seeking fluid alliances between conception and realization?

In the past, architects have occasionally used the inherent "intelligence" of material as an active design tool. For example, Frei Otto worked with form finding experiments using soap film and stretched fabric to develop minimal surface geometries that later served as a basis for the Munich Olympic Stadium. Heinz Isler, a Swiss engineer built doubly-curved concrete shell based on suspension method where the forms for shells are found by hanging and fixating cloth. Antonio Gaudi, a Spanish architect worked with upside down wire models that traced the flow of forces within a complex structure to expose the week structural condition. These materially driven experiments were simultaneously material, structural, and geometric (Spuybroek 2004). They drew upon the material's capacity for self-organization under the influence of the external and internal forces. However, in these experiments material's behavior was used only to visualize complex structures and the way forces interact to produce stable and optimized organizations.

In the studio described in this paper, we used material behavior not only as a model for exploring materials' organizational potential, but also as a way to explore formal and structural qualities emerging from those organizations. We were intrigued by their variability and complexity but also by a discovery. The intention of the material studies in the studio was to extend the inquiry into the materially-based process and recognize the capacity of the organizational logic of material distribution, so that this information can be perpetuated in the quest for form, structure, and space that emerge from the inner logic and workings of the material system itself. Also, the intention was to pose a question whether form can emerge from an engagement of the material and whether such an engagement can bring forward new possibilities in architecture where architectonic imagination relates more fluidly with the urban and cultural one (imagination). This link was further explored through the agency of the body and its capacity to experience, inhabit, and appropriate.

1. LEARNING FROM MATERIAL ORGANIZATION

> Increasingly, I think of a project as a distribution of material in space, not as the assemblage of preformed elements. We are moving from collage to morphology, looking to deploy material as material for its spatial and surface effects … (Goulthorpe M. 2005)

The studio began by studying forming processes in nature and biology, and then focused on material experimentation. Students were encouraged to use wide range of materials that have properties of distribution and deformation under stress (plaster, glue, sugar, rice paper, wood, paper, metal). Material experiments were conducted to focus on the properties of deformation / distribution / behavior in order to explore the materials' organizational potential. In these experiments materialization and formation were viewed as intrinsically and inseparably related. In other words, an attempt was made to preserve an intimate relationship between matter and form (Hensel and Menges 2007).

Generally, there were two groups of projects. One explored the emergence of a construct through the processes of accumulation and organization of the individual elements. The other group of projects explored the emergence of a construct through the manipulation of material properties.

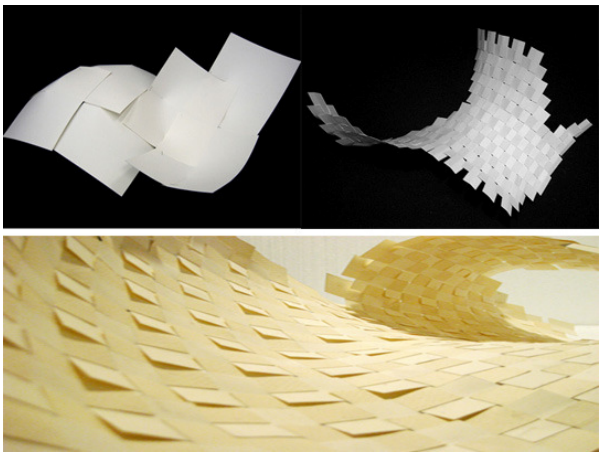

Figure 1: Experiments: Structuring Through Cut and Aggregation (Ji-Young Soulliere 2008).

Structuring through Cut and Aggregation experiment started by examining a capacity of an individual element to generate a spatial construct by modulating its local geometry. Local geometry of a sheet material (in this case paper) can be altered by cutting and gathering a material. The length and direction of the cut controlled the geometry of the sheet, making it more or less curved. Combination of elements with the slight variation in the curvature enabled an emergence of the construct that was capable of finding its own spatial distribution and structure (Fig. 1). In other words, the

emerging form could be directed into particular spatial or structural configuration by choosing elements with the particular local geometry. Through the choice of these local geometries the global geometry of the construct could be choreographed. This simple technique generated variable and complex material system (made up of simple uniform elements) that exhibited a degree of adaptability to various external and internal conditions. Design of a material system with embodied behavior (and a built in technique to direct that behavior) raised a question whether this approach could be used to seek and to design alternative ways of spatial or urban occupation. Could these adaptabilities be further explored by examining the behavior of the system under the restrictions of physical context, scale, materiality, programmatic requirements, occupation of space, its relationship to a human body, and variety of other issues that are involved in thinking architecture?

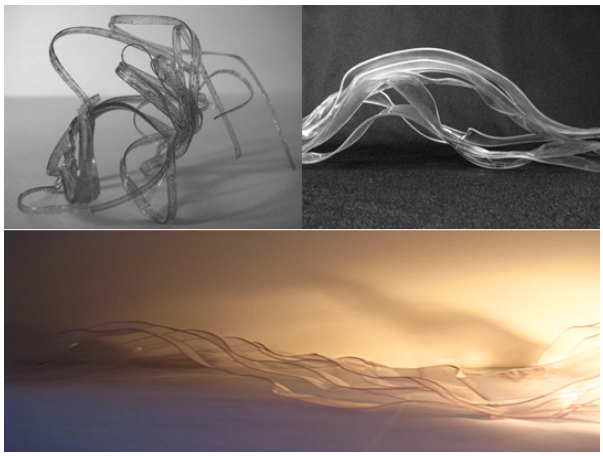

Figure 2: Experiments: From Sugar to Plastics (Gabriel Garcia 2008).

From Caramelized Sugar to Heating Plastics experiment started by studying the emergence of form and structure by manipulating a material property – in this case by the hardening of caramelized sugar. The process of extruding shapes by slowly pouring the hot sugar mass was suggestive of "drawing in space" and indicated the significance of movement in the emergence and structuring of the construct. The fragility of the material required the regions of strength that could serve as main supporting areas from which the construct could expand. The movement allowed an immediate attendance to the regions of structural weakness, enabling the construct to grow quite organically. The second part of the experiment looked into ways of structuring a plastic ribbon by heating it. The process demonstrated a capacity of a construct to renegotiate and adjust its form, balance, configuration, and structure under the influence of constantly changing conditions of the growth of the structure and heating process. Both experiments exposed movement of a "tool" as an important aspect of the formation process (Fig. 2). Taking this idea further into the full scale project would open a question of a role of the body's movement as a direct "tool" in making the construct. Could this way of making blur the boundary between the tool and the craftsman? Could this be a way to engage making more directly and blur the boundary between conception and realization? When craft depends on the fluidity of movement of the entire body can we "dance" our buildings into existence? In this model, the physical work of the act of making embodies its own dynamic and constraints. The intuitive and gestural economies and limits of the body movement meet the limits, economies, optimization, and efficiencies of the material itself. The product of this process would certainly not be a representation of a form imagined in advance. The product would be a result of the interplay between the strength and resilience. It would emerge from the new sensibility that acknowledges and works with several strengths simultaneously.

2. DEPLOYING THE MATERIAL BASED APPROACH

In the first part of the studio the students were involved in designing a "material system" that embodied behavior and had a capacity to adapt under external influences. In the second part of the studio they were asked to project this material system into the public realm and use it to seek and to design alternative ways of urban occupation. Students were expected to design an urban interface that mediates between the body and the city. They were expected to engage through this materially driven approach a body and a city in order to establish distinct and productive interface between the two.

The initial material systems that students produced could "grow;" they could renegotiate and adjust their form, structure, balance, and configuration. The rigorous studies of the material and material systems laid out a logic by which the system works, but it is always a challenge to extend the discipline of the initial technique throughout the design process. It is difficult not to lose open-endedness and experimental quality of those techniques and at the same time integrate many dimensions that make architecture work. Architecture is experienced through its occupation, performance, and perception. Architectonic imagination has to be extended through the urban and cultural one. The challenge is to think and develop habits of design and making that are inclusive of many dimensions that make architecture work.

One of the first steps in an attempt to appropriate the material system was to project the ways in which it can be inhabited or engaged by the body (Fig. 3). The material system was also projected across the scales and through the variety of spatial occupations. Nevertheless the question of engaging the behavior of a material system through design and extending the influence of such behavior into the more defined articulation of the future construct remained a challenge. The organizational logic of material distribution speaks about form, structure, and space

more easily than of the ways of occupying the space. But the question whether the way of occupying the space could emerge from the inner logic and workings of the material system itself was readily engaged by the students. Could the nature of the urban interface be informed by that logic? Can programming of the space emerge from the crossbreeding of the material construct, appropriation of the construct by the body and the context? Could entirely new ways of inhabiting an urban space emerge?

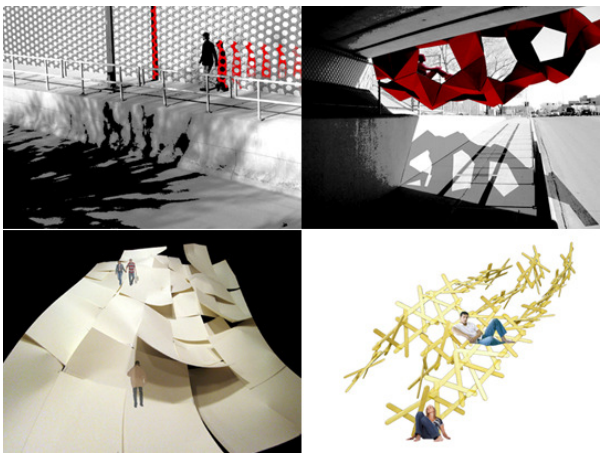

Figure 3: Inhabiting the material system (Dion Lassu, Ji-Young Soulliere, Roy Kuo 2008).

What follows is the description of two proposals for the urban interface that fully engage in its design the agency of the human body, embrace a dynamic quality inherent to the material system, and bring closer cultural and urban imagination to the architectonic one.
The context for the project is a Calgary neighborhood of Inglewood and its mixed-use medium-scale main street. This is one of the Calgary's oldest communities with the number of historic buildings undergoing a restoration. It is among Calgary's most trendy shopping and arts districts. It is also home to the Inglewood Bird Sanctuary, an urban wildlife refuge. It has the city's largest collection of antique and home decorating shops. The main street is surrounded by a thick belt of family homes and is one of the major roads leading to downtown Calgary, frequented by both the residents of Inglewood and the wider Calgary population. Even though there are number of conditions that could make this street a vibrant urban area it is not so. The students saw an opportunity to provide a catalyst for a public occupation of space by designing an urban interface that would activate public realm of the street. In this project there was an opportunity to work and think in two scales: the scale of a body and the scale of a city, and to establish distinct and productive interfaces between the two scales. The inhabitable urban interface was meant to mediate between the body and the city, and have capacity to position a wandering body and initiate spatial or temporal processes (urban activators) that can give rise to alternative ways of urban occupation.

The initial material study opened a possibility of facilitating form creation as opposed to creating a form. This possibility initiated an attitude that allowed a designer, at least partially, a role of a facilitator of a design process. In other words a designer had an opportunity to design conditions that would give rise to an intervention, and not an intervention alone. This initiated a process of working that was constantly modified, negotiated, and adjusted unlike any prescribed set of standardized procedures. This attitude, in addition to a focus on the agency of human body, significantly altered the relationship between a designer and a construct, and affected positions towards function and context. Form creation slipped away and the sense of space and occupation – and most importantly desire to activate the space through occupation and use – took a primary role. This process was a process of discovery and not a premeditated manipulation; it fostered intimacy with the material, site, function, and processes of making. This intimacy translated into a search that enabled a designer to incorporate materiality and form into a construct, and engage the construct with the context in a very direct way.

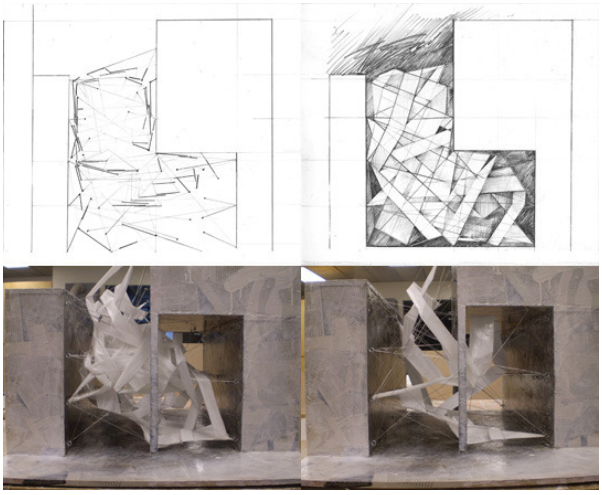

Figure 4: The Cocoon (Kate Anderson 2008).

The Cocoon (Fig. 4 and 5) is an urban interface that changes with use can be built in-between the adjacent buildings. It is highly adaptive, formally and programmatically, and therefore can accommodate variety of sites and uses. Initially it was conceived as an extension of a domestic space. This was motivated by a desire to reveal existing qualities of the street and the neighborhood that stayed hidden from the public eye. But its main use evolved to be an artists' place of work, as well as an exhibition space and a public gathering space. As such, the place could accommodate a group of artists or a single artist; it can be rented or public. The very structure consists of a tensile wire, enclosed and enveloped by hard and soft surfaces that would allow movement through and at the same time be the surfaces for work. Through use, the structure would change and gradually disappear as

artists take away the surfaces on which the work has been created, eventually leaving only hard surfaces to walk on; afterwards, the structure would be wrapped again. This structure cannot be finished; its components are brought together but begin to change through occupation and weathering. This urban interface is a story, not a thing. It is a living system, a narrative that is always in process and incomplete.

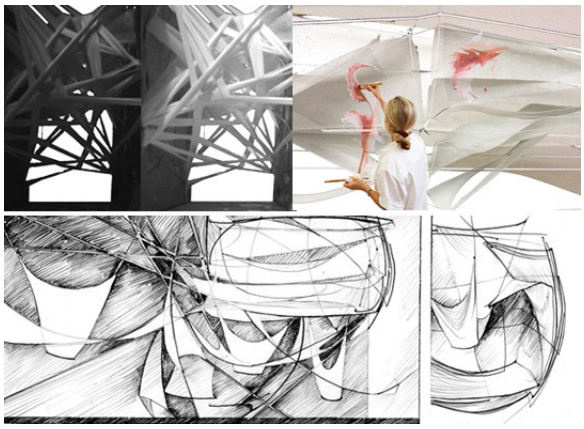

Figure 5: The Cocoon (Kate Anderson 2008).

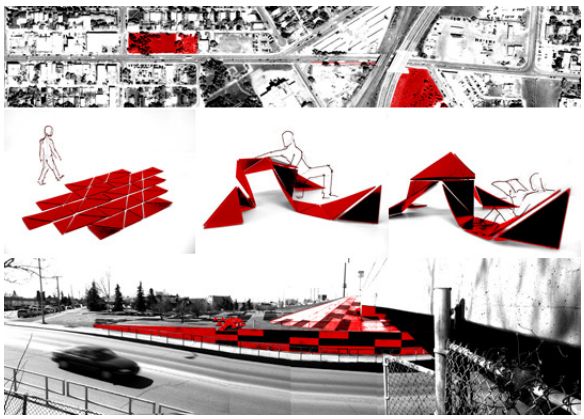

Figure 6: Migrating Folding Plane (Dion Lassu 2008).

Migrating Folding Plane (Fig 6) is an urban interface conceived to connect two neighborhood parks divided by some distance and the highway overpass. The connection was achieved by the proliferation and concentration of folding planes along the site. This was another highly adaptive proposal. Formally and programmatically, combination of the folding planes could accommodate variety of uses.

The element (folding plane) was made out of galvanized steel and coated with rubber. Powerful magnets at every fold of the plane made attaching possible, so that many planes could be clustered together in variety of formations. Through use, the rearranging planes would constantly change the landscape of the park. Each reiteration would hold a memory of the previous occupation.

CONCLUSION

The projects in their final articulation occupied perhaps the threshold between architecture and installation. The scale of the intervention was purposefully chosen to allow the intimacy between the body and its immediate environment. In this way the body, as the medium of experiencing and making, could more directly inform the process of design as well as the process of making. Perhaps the only way for us to explore the possibility of dissolving a traditional approach to making architecture is to dissolve its traditional placement. This potentially translates into alternative ways of occupying space of the building or a city and opens a way to alternative ways of living that might not necessarily require permanency, stability, or defined occupation, yet could productively participate in the cultural and anthropological unfolding of life.

In the initial studies of the material, the material behavior was a model for exploring materials' organizational potential. Understanding this behavior enabled students to manipulate the material by changing internal and external influences. The realization that form and structure could emerge from such process was very important. This possibility, that an architect could set up and facilitate a process of an emergence of the form as opposed to willfully participating in a production of objects, held an intriguing promise. In this context, the architectonic imagination began to reflect inclusiveness and interactivity characteristic of other, more complex systems. This enabled students to engage the questions of context and program more fluidly.

In an interview, titled "Where Architecture Meets Biology," Detlef Mertins comments that architecture requires an anthropological and cultural imagination as much as architectonic one (Mertins 2007). These imaginations occupy very different territories; the willfulness of the architectonic one stands apart from the anthropological and cultural ones which emerge through working of highly complex forces. Could they share the territory where form and space have to be inhabited and appropriated? Could one perpetuate the notion of emergence (imbued by the materially driven process and thinking) and allow it to inform and influence programmatic and urban participation of the architectural intervention?

It is also suggested in the student work that followed material experiments that a certain change in attitude is possible. Once we understand aspects and inner workings of matter we might be better equipped to intervene in the environment and redefine our zone of influence by being more keenly aware of the cross-influences that any intervention triggers. A more direct work with the material brings forward a new awareness of the material's capacity to behave and perform beyond the visible surface modulation. This "intelligence" offers an opportunity to conceive of material and construction systems from the system's intrinsic logics and constraints of making. This is a very exciting opportunity. But perhaps even more exiting is to speculate to what extent this awareness can refocus

a “depth” of making. Creativity that can emerge from this awareness can potentially transform the act of making. If material’s “intelligence” is fully deployed aren’t we obliged then to make and think about our environments differently?

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