Infections

Parametric patterning and material behavior

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Abstract. *This paper covers two workshops that are instances of a research on the feedbacks between parametric patterning and material behavior. Infection sets the conceptual background of these workshops utilizing pattern deformations as a generative technique. Gridal Infection workshop focus on real-time dynamic patterns while Reflex Patterning workshop integrates material performances to this exploration.*
Keywords. *Parametric patterning; material behavior; prototypes; fabrication; dataflow.*

INFECTIONS: GENERATIVE DEFORMATIONS VIA PATTERNING

Patterns have been instruments of analysis and research in various disciplines, from social sciences to computer science, mathematics and biology. Gleiniger and Vrachliotis (2009) state that the pattern concept previously defined as a structural system of order began to gain a new complexity and momentum in the light of cybernetics and system theory. Reflections of these studies with the triggering of computational tools have shifted the notion of pattern in architectural design realm. The classical notion of pattern as, formal, ornamental, decorative and geometric orders of repeating shapes has turned into the contemporary conception of pattern as *structural, sequential, distributed, or progressive* systems of repeating units or processes (Garcia, 2009). Meanwhile parametric design tools have become essential to think and act on this broader sense of patterning by accelerating and expanding space of possibilities through variation and diversity.

This paper covers two instances of a research that focus on the feedbacks between parametric patterning and material performances within a context. **Infections** is a series of workshops in which we study methods of interaction in-between digital and material to reveal the potentials of the context. The conceptual background of infection -even if sounds like an invasion- is a challenge and springboard for students to explore potentials via deformation processes. This concept provokes them with subthemes such as *immune system, recovery, metamorphosis and becoming. The* process begins with *pattern recognition*, an attempt to observe and perceive existing orders of *the context called host body*. Next, students are encouraged to manipulate the host body in a creative way utilizing *pattern deformation techniques.* Therefore, infection is both the metaphor and the method of these deformations, while the host body represents a pre-defined system and the physical context to be *infected*.

In the first workshop named **Gridal Infection,** this manipulation is studied by projecting *real-time dynamic patterns* on the glass-brick walls of the faculty building at YTU.

The second workshop, **Re-flex Patterning** is

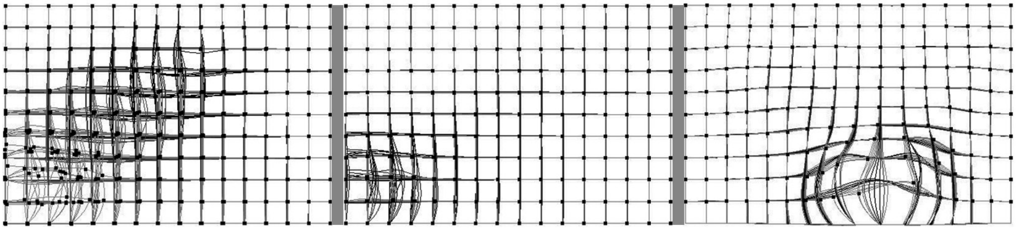


Figure 1
FiberGrid; Screenshots.

based on the correlation of the digital with the physical via parametric patterning techniques and a composite material system.

The third and last step in the ongoing research will be pushing the limits through the fabrication processes. Parametric patterning and CNC molded tiles will be explored as a case study for the future workshop.

In following sections, details of the first two workshops are explained, concluding with a discussion on outcomes.

WORKSHOP 1: GRIDAL INFECTION

This initial workshop focuses on the abstract notion of grid, sampled from an existing 16x11 unit glass brick wall, *the host body.* Students are asked to articulate its formal (*grid / pattern / tessellation / reference*), performative (*transparency / light / structure / function*) and tectonic (*ambient / kinetic / aural*) properties. On the early phase, three groups of students hunted concepts "lesion, plasma and fibergrid". Then, they are asked to develop their projects by creating *parametric deformations,* utilizing real-time interactions with the context. Students with no previous skill on parametric design are introduced with Grasshopper for dataflow parametric modeling and Firefly add-on for interaction design. They ended up with three dynamic patterns, superimposed to the existing wall. The semi-opaque material of the wall created a surreal-animate vision and an apopohenia kind of feeling for the viewers. As an educational goal, the attempt was not to create an eye catching media-wall but to introduce students with digital toolsets necessary to make them think of feedbacks in-between the digital and the physical during the design process.

In the final application, visual outputs are projected on the host body, aligned to its existing grid. Below are three student projects that are the products of this three day introductory workshop.

FiberGrid

Students considered the host body as a *dead tissue* of an organism, resembling the wall as a *standing idle* and *reckless* element to its environment. In order to *revitalize* it surrounding sound is considered as an *injection* that changes the inner structure of the organism and transforms the grid lines into curvilinear *fibers.*

Above concept of **FiberGrid** is realized by constructing a grid out of interpolated curves (Figure 1). Surrounding sound is captured and used as a real-time input that bends the curves. The change in sound level affects the process, creating temporal variations. Finally, a history enabled algorithm captures sequences of this process, creating *waves* of fibers (Figure 2). As it is a recursive algorithm, it responds concurrently, getting faster / slower and more / less fibrous while the surrounding sound level rises / lowers (Figure 3).

Lesion

In this project, the grid is considered as cellular forms packed together. The wall represents an absolute body, in which an infection causes various challenges, and activates an *immune system* as well. The struggle between infection and the immune system creates **lesions eventually** (Figure 4). This concept resembles infection as a distortion on the regularity of the wall. Irregularities of the surrounding factors,

Figure 2
FiberGrid; Dataflow diagram composed in Grasshopper. Cluster 1 captures surrounding sounds; Cluster 2 develops a square grid out of curves; and Cluster 3 generates force field deformations to the curves, based on the sound level.

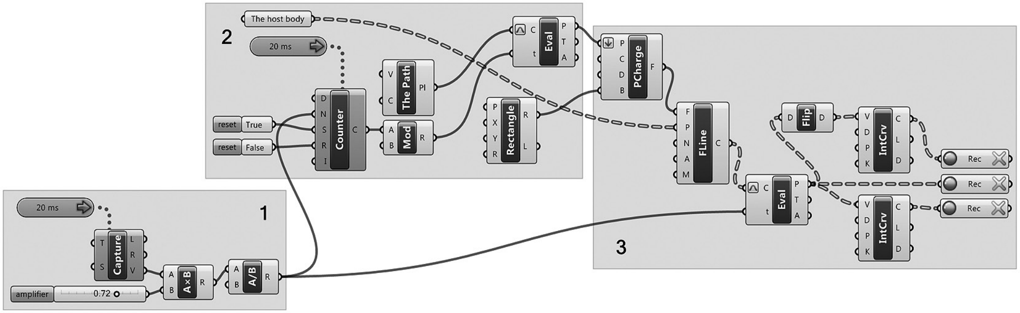
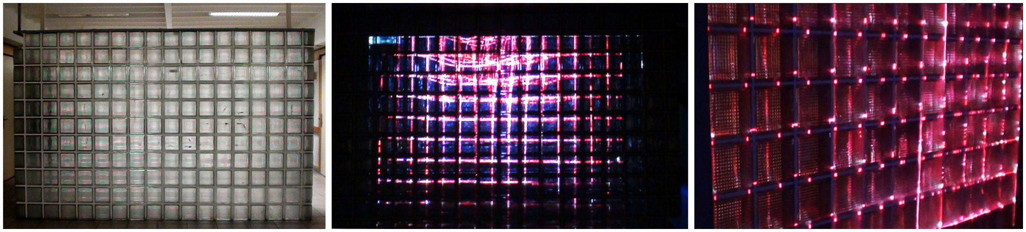


Figure 3
FiberGrid; Application photos. 'The Host Body' is on the left.



such as the movements of people around causes pattern deformations. The host body gets infected when someone gets closer to it, but eventually a time-based *recovery* process begins.

This concept is realized by implementing a history based truncation process on a regular grid (Figure 5). The truncation is associated with the vectors of surrounding motions, captured by a webcam in

Figure 4
Lesion; Student sketches.

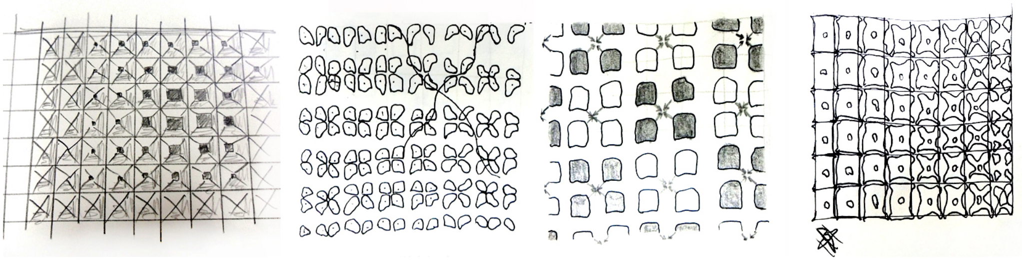
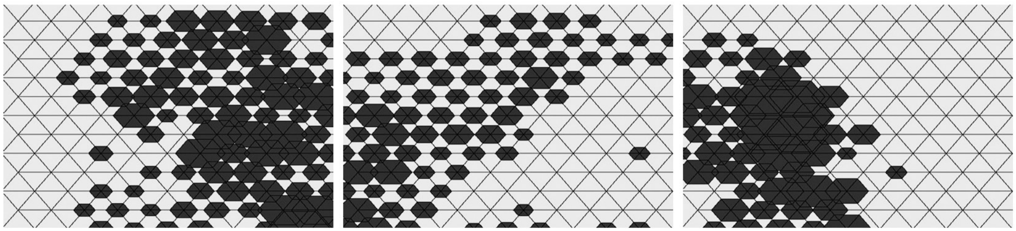


Figure 5
Lesion; Screenshots.



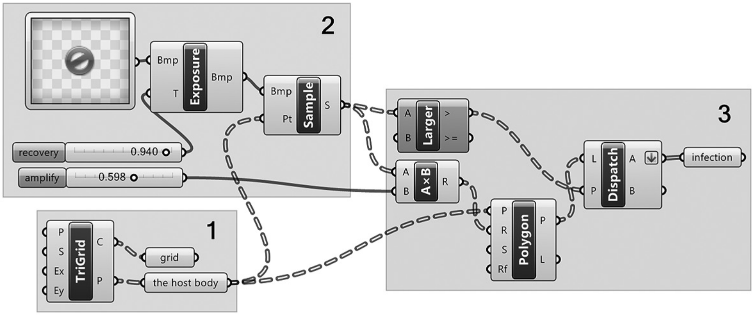


Figure 6
Lesion; Dataflow diagram composed in Grasshopper. Cluster 1 creates a regular grid to be infected; Cluster 2 captures the webcam input; and Cluster 3 processes this data according to the design intentions, creating polygonal shapes on the grid.

Figure 7
Lesion; Application photos. 'The Host Body' is on the left.

real-time. There are parameters such as recovery and immune system in the dataflow diagram (as seen in Figure 6) that function as a temporal deformation returning to its initial state progressively. In the final installation, various regular grids (square and hexagonal) are tested with an infection caused by people around (Figure 7).

Plasma
In this project, the host body is considered to be infected by high fever and pressure, changing its solid phase into plasma. The solid molecules represent the strict order of the grid on the wall, while the plasma represents a more flexible order, sensitive to its surroundings. The real-time deformation input was a similar one with Lesion, including a webcam capture. Distinctively, this project aims to capture not all of the small details of the surrounding, but the average motion, searching for focal points of movement. Students argued that this transformation of the glass brick wall to plasmatic body makes it more interactive with other bodies around it.

In this project, students' conception (Figure 8) is extended into a geometric solution based on metaballs (Figure 9). After various experiments on the reactions of metaballs, a grid-based deformation is chosen (Figures 10). When a person comes closer to the wall, its motion creates focal points. Eventu-

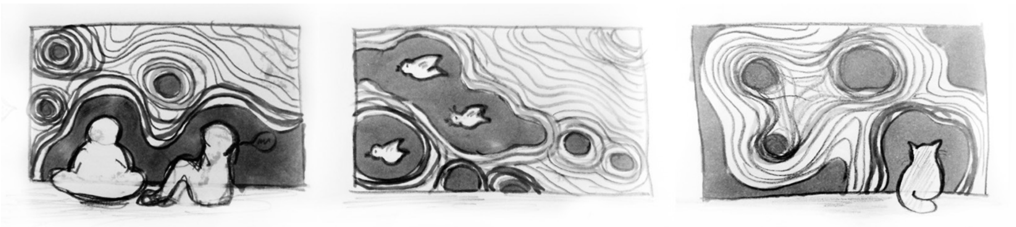


Figure 8
Plasma; Student sketches.

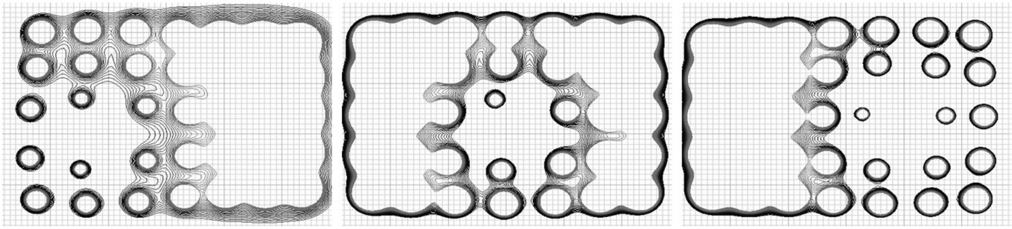


Figure 9
Plasma; Screenshots.

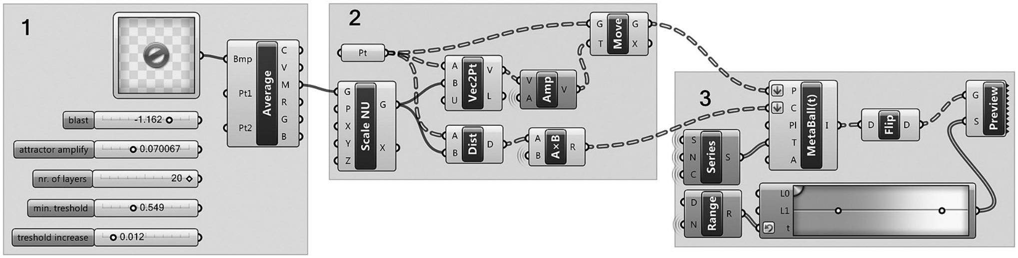


Figure 10
Plasma; Dataflow diagram composed in Grasshopper. Cluster 1 collects all necessary data including the webcam; Cluster 2 calculates a vector deformation on a regular grid; and Cluster 3 creates a serie of metaballs.

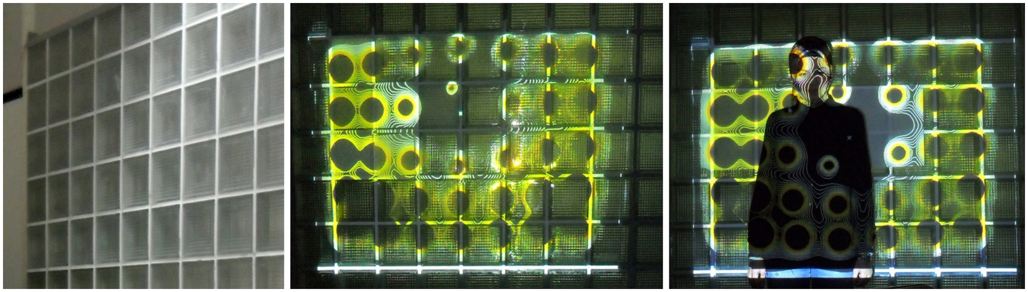


Figure 11
Plasma; Application photos. 'The Host Body' is on the left.

ally these points become blob centers that react and combine into larger blobs (Figure 11). A time-based algorithm captures sequences of this process, creating superimposed metaball variations.

WORKSHOP 2: RE-FLEX PATTERNING

In the second Infections workshop, the host body was the gallery hall of the faculty building at AİBU, a passive void waiting to be activated (Figure 12). The regular pattern dominating that body was the structural grid of columns and beams that is reference to all the details around it such as floor coverings, lightings etc. In this workshop students are encouraged to think on sub concepts of infection, recognize existing patterns of the hall and transform that inert void to a reacting body.

Within this three-day workshop, we worked with 30 students and introduced them with digital techniques of pattern-making and pattern deformation using Grasshopper. We discussed on how they could use parametric modelling to deform a grid based pattern.

The composite material system proposed for the workshop was a combination of flexible and soft materials (textile or bubble wrap) with a stiffer but lightweight plate material (5mm. foam boards). Soft material is to be covered with foam boards in both sides with nuts and bolts to explore its composite

Figure 12
Re_Flex Patterning; 'The Host Body'.

material behavior. Students were required to propose a patterning that controls the behavior of this composite material with the help of the re-flexing performances.

Prototypes

On the first day, we discussed on concepts of infection and the context. 5 groups of students presented their proposals via diagrams and drawings. They focused on changing parameters and dynamics such as daylight, circulations, gatherings, vistas and proposed concepts as molecules, fluid flows, colorizing etc. We wanted them to construct their first material prototypes by 2 m X 2 m via various methods of patterning. The next morning students installed their physical prototypes to the hall to observe the reflexes of the material and reactions of the host body. Each project was unique to explore various material behaviors using regular, irregular and associative patterning (Figure 13). Students chose the project that proposed a canopy formed by patterns of circulation .This project was able to control the macro-form as a self-regulating surface.

Final

The last step was working on patterning of the chosen project, and is developed with the guidance of instructors. At the application phase, 1600 individual polygonal elements are coded and laser-cut from foam boards, attached to the textile with nuts and bolts (Figure 14). The product of the workshop was two canopies of 1,5m. by 5m. in size. The emergent

Figure 13
Re_Flex Patterning; Initial prototypes, testing the composite material with various tessellations.

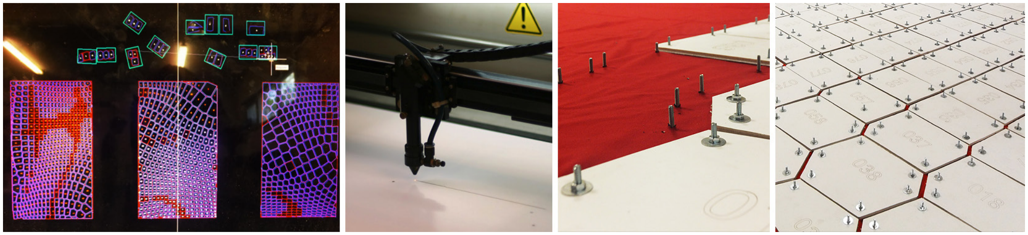


Figure 14
Re_Flex Patterning; Third and final day, fabrication.

performances of this product could only be experienced when these surfaces were installed in the gallery hall via *flexing* them with the help of steel cables (Figures 15, 16 and 17). Students were excited with a feeling of both familiarity and alienage of this product, mentioning that the passive void is becoming an-other living body.

CONCLUSION

Contemporary trend of the computational design education is grounded on an integration of domains such as fabrication technologies, material studies, and generative techniques. This requires not only an intuitive handling on digital tools and methods, but also an experience on material and production constraints simultaneously.

Patterning emphasizes a material shift in the generative side of the digital paradigm, and a geometric shift in the material side, as well. The study presented in this paper is an example of the integration between digital tools and material practices by implementing pattern deformation as a synthe-

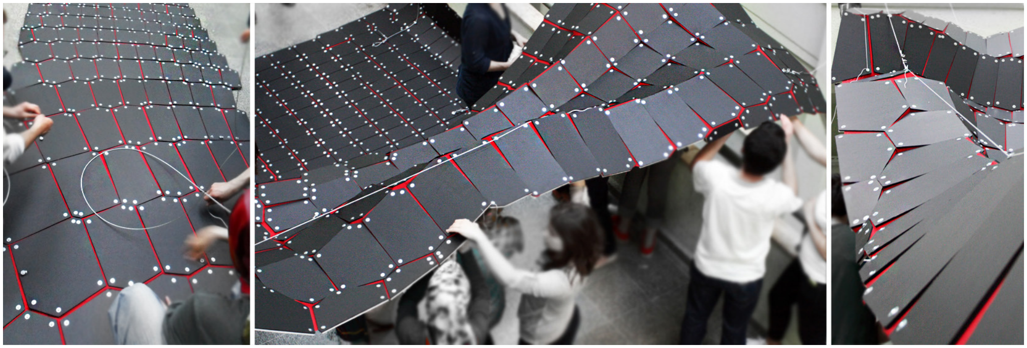


Figure 15
Re_Flex Patterning; Third and final day, installation.

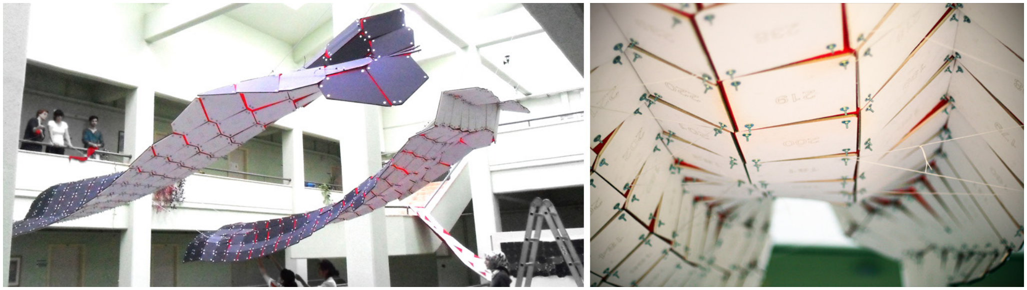


Figure 16
Re_Flex Patterning; Final project.

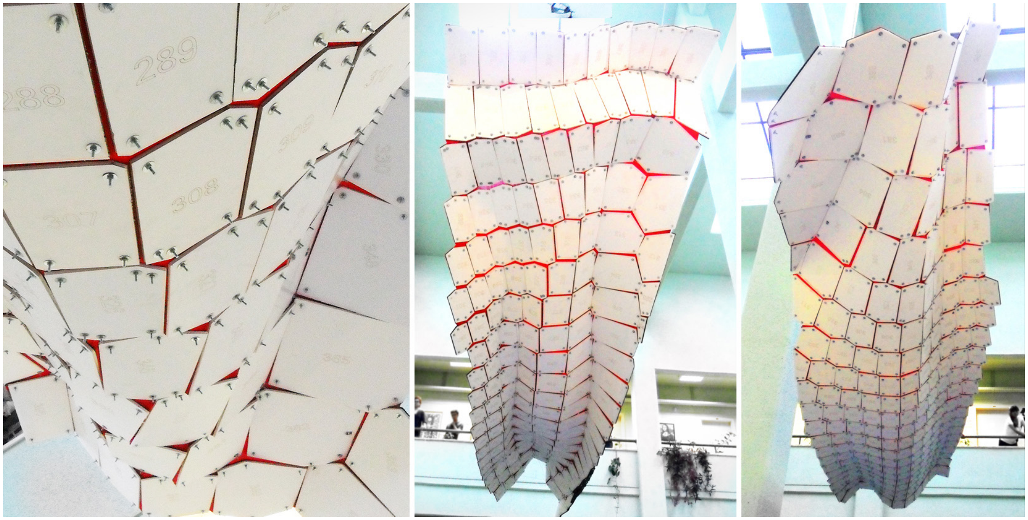


Figure 17
Re_Flex Patterning; Final project.

sizer. Such integration liberates students from passive and formal search of an on-screen parametric modeling, familiarizing them to a more practical and sophisticated body of knowledge about the physical becoming itself. Nevertheless, the articulation and reconstruction of patterns help pedagogical objectives as they promote temporal but instant, explicit but unstable nature of design exploration.

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REFERENCES

Garcia, M 2009, 'Prologue for a History, Theory and Future of Patterns of Architecture and Spatial Design', *Architectural Design: Patterns of Architecture*, vol 79, no 6, M Garcia (ed), Wiley, London, pp.6-18.

Gleiniger, A. and Vrachliotis, G. (2009), Pattern: Ornament, Structure and Behavior', Birkhauser, Berlin, pp.7.

[1] www.infections2.blogspot.com