

DIAGRAM AS MEDIA OF DESIGN SPECULATION

Maria Loreto Flores Reyes
 Universidad de Chile- Architectural Association School of Architecture
 March Design Research Laboratory. AAD[R]L
 130 High Holborn, London WC1V 6PS, UK.
 mloretoflores@yahoo.com

Abstract

Diagram as media of design speculation. The productive ambiguity of Voronoi diagram.

In contrast to the traditional models of design processes based on the abstract manipulation of objects, the new digital media arena provides to architecture an interesting territory of experimentation characterized by non-linear design processes capable to articulate spatial requirements and social organizations on time. In this sense, the speculation through a diagrammatic system proposes a change focused on design as a network of processes. According to this, this paper purpose is to investigate the validity of these arguments through the use of Voronoi Diagram as design tool into the context of Create_Space research agenda of the AAD[R]L 2004-2005.(1)

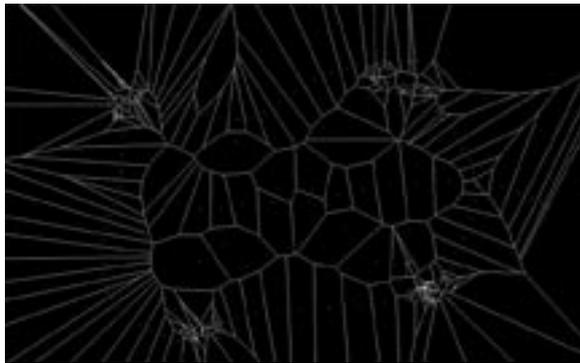


Image 1

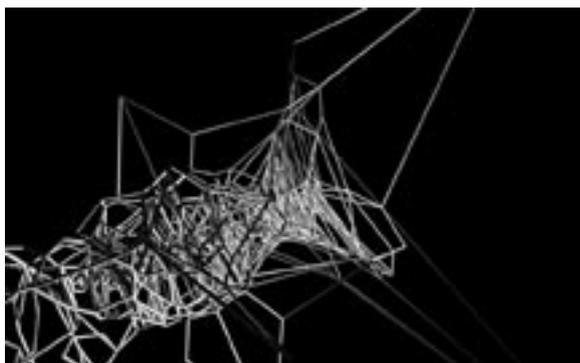


Image 2

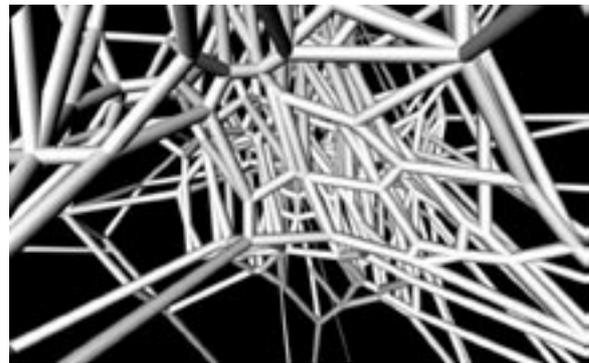


Image 3

Image 1, Image 2, Image 3: Bubble Harp. Scott Snibbe 1998. Digital representation of Voronoi diagram construction through a set of points. As points

1. Diagram as design device

Today's architectural design discourses have as main objective to seek for a new relationship between space and information. Likewise the traditional notion of

Cartesian space is changing increasingly toward a new definition of space conceived as an *environment* which includes multiple forces and more complex social programs.

This approach emphasises the role of architecture in the development of a language capable to articulate dynamic processes within a spatial scenario with different scales and needs.

In this sense, the proliferation of media tools and their application into design process has stimulated a systematic development of new formal repertoires and its mode of representation or rather diagram, which has played an interesting role as device to produce a more flexible architectural language. Moreover, the

diagram has become in a fertile instance to develop the architectural project in a non-hierarchical way: a diagram can be considered as a creative event produced not only when the project is already conceived, but rather during the entire conception of this one. In consequence, the diagram is a generative tool more than a representational one.

Nevertheless, the question is in the effectiveness that a mode of representation or diagram can offer to develop an architectural project, because how we develop an architectural project according the influence of any kind of diagram we have to reflect at least on three aspects that can affect the mentioned process: *First the formal imposition of a diagram into the project and its relationship with the final form*

2. The mediator or the project itself

The clearest arguments to analyze the previous question come from the *Abstract Machine* conceptualization established by Deleuze and Guattari, which define a

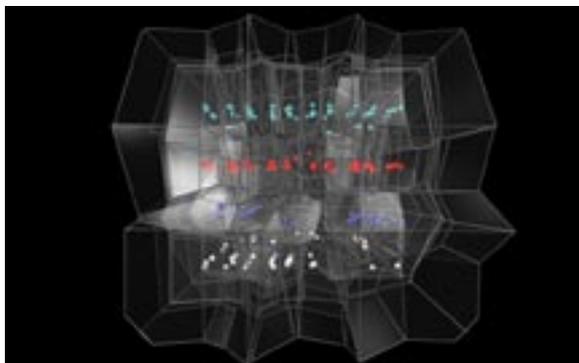


Image 4: Generation of a polygonal mesh through the Voronoi Software.

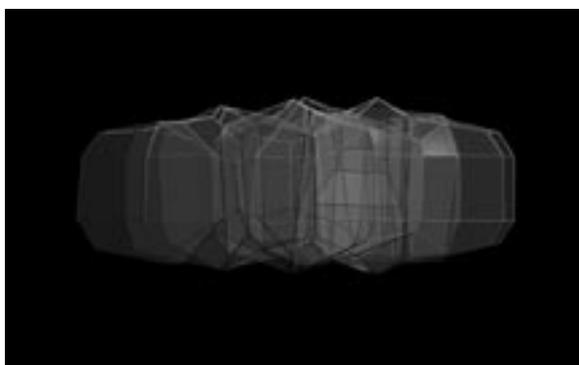


Image 5: View of a Voronoi Diagram with random coordinates.

diagram as an instance that is “not physical or corporeal, any more than it is semiotic; it does not function to represent, even something real, but rather constructs a reality that is yet to come, a new type of reality” (Deleuze and Guattari 1998)

According to this statement, it is possible to say that *a diagram has a language capable of determining the design issues* through the selection of an operational mode and its related set of rules and digital expansions as well. However, it means that a diagram can establish certain limits in relation to the design process rather than in the designed product itself.

In second instance, about *the relationship with the final form*, it is possible to say that this tool can formalize contents in different strata of a project without a deep correspondence with the final result. “This is a critical difference, as diagrams do not have a linear or casual relationship with form. Used in their most radical way diagrams are exploratory devices that are guided by an experimental systematic intuition” (Lynn 1995). As applied examples of these arguments, we can mention Peter Eisenman and UN Studio practices. In the first case, the early Eisenman’s experiment to move architectural projects into new territories of production and economic integration where the diagram operates as “intermediary in the process of generation of real space and time” (Eisenman 1999). In second place, the UN Studio implementation of diagram to incorporate external information into a shape obtaining a sort of catalogue of options and transformations for a specific project.

However, it still remains the question about *the diagram as end itself*. In relation to this, Andrew Benjamin mentions that a diagram is an exploratory tool that must always be incomplete. This is the fundamental factor to remain as mediator element. (Benjamin 2000). This characteristic is especially present in Zaha Hadid’s projects, which manifest an interesting incompleteness that maintain a productive and constant reinterpretation of the project over time, “ where the compositional techniques still share some of the productive under-determination of the experimental drawing” (Schumacher 2004).

3. Diagrammatic-architectural translation

Based on deleuzian definition, it has obtained general premises to use the diagram as design device: The presence

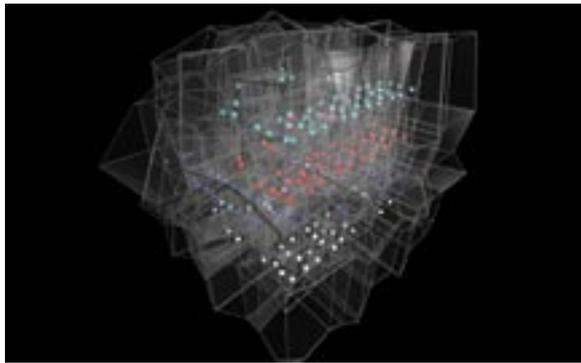


Image 6: Voronoi as diagrammatic tool. 3D diagram of ARUP workspace organization, London Office.

of a particular language, a non-linear relationship with the final form and its condition exploratory tool. However, before visualizing a concrete experiment, it is important to understand the process through which a diagrama allow us to obtain a defined architectural form from a representational diagram. In this sense, it considered interesting to analyze the diagram under the “Design World” concept developed by William Mitchell.

‘Design World’ defines the collection of primitive formal elements (points, lines and polygons) that a designer chooses to establish his universe of formal speculation. This one constitutes the initial information that can be transformed into objects or transitory spatial relations according specifics design operations. Each one of these operations can modify a Design World from one state to another: “Translation from a surface world to three-dimensional physical reality usually involves producing specified surfaces shapes (by such methods as bending, lofting, milling and so on) (Mitchell 1996). In this context, the modelling operations can occur in a non-chronological succession and each of them can be considered an individual experiment.

If we understand the diagram under the previous argument, we can say that this one can represent every transitory state of transformation of a defined design process, independently of the final result of

this one: we can observe an initial state, intermediate states and possible solutions or rather the ‘universe of possible solutions’ for the specific project. Likewise, it is possible that a diagram becomes in an entity itself, not as an architectural project but rather *as a state of transformation* with exploratory value itself, a snapshot into the whole process. Mitchell has represented this idea as a tree, where the root is the initial state of the process, the nodes are the intermediate states and the branches represent the possible solutions for a project

4. Speculating through Voronoi diagram

Voronoi Diagram is a representational technique with interesting characteristics: a specific set of rules because is an algorithm whose formal expression is represented as a network of areas of influence and dynamics boundaries.

Basically, to construct a *Voronoi Diagram*, we have to establish initial values or a set of coordinates, then to calculate the distance between these coordinates through

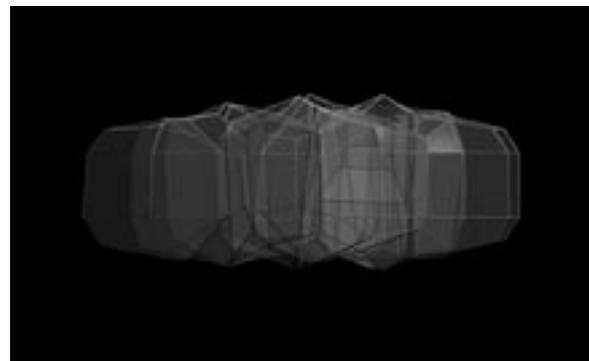


Image 7

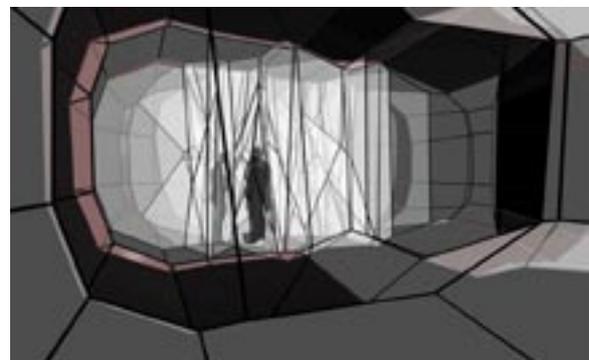


Image 8

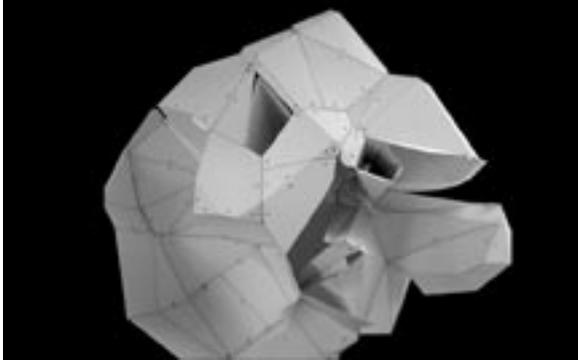


Image 9

Image 7, Image 8, Image 9: Voronoi as architectural tool. Design of a workspace through numerical information about amount of square meters, activities distribution, number of users and real time internal movement of the people in the space.

the algorithm and finally to generate the *Voronoi geometric structure*, which can be understood as 2D or 3D system. This simple mathematical principle was considered an adequate platform to test how a representational tool can be turned into a design device based on the *Abstract Machine* and *Design World* conceptualization.

For this purpose, it was established an experimental design process, which includes the definition of three basic aspects for its implementation:

- *Scenario*. It represents the associated application to each transformational state or transitory outcome of the process.
- *Platform*. It represents the digital platform or software chosen to work according to specific requirements of the process.
- *Language*. It represents the collection of primitive formal elements used as initial information to design.

Scenario 1 _ Voronoi as organizational diagram

The first scenario was testing Voronoi as representational tool. For this aim, we chose a real workspace (ARUP London office) where to analyse the influence of the people movements into the existent spatial configuration in terms of patterns of distribution and aggregation for

individuals and groups. The platform was the ‘Voronoi Software’ developed at MIT specifically to generate the Voronoi structure through the application of the algorithm into a set of coordinates. According to this, the first operation was mapping the internal organization of the workspace (the position of people (x,y,z)) and the second, to enter this information into the software. The outcome was a polygonal net that expresses the area of influence of each individual and the relationships among them. The most important point about this diagram is that the definition of each area of influence and its boundaries has been built in dynamic relation with the whole; hence if one coordinate changes, all the diagram is modified.

Scenario 2 _ Voronoi as volume

The second scenario was applying Voronoi in order to obtain a basic volumetric expression through the creation of an experimental workspace. This proposal included a specific amount of square meters, people per activity and different schedules, whose mathematical relationship would allow us to obtain the suitable coordinates to produce diversity and spatial quality into the volume. For this purpose was necessary to modify the procedure and the platform and to translate the Voronoi software outcome into AutoCAD. The final result was a volume constituted by several polygons with different dimensions and an interesting pattern of distribution in terms of density of aggregation and structural potential. This volume was considered as an architectural space with the potential to be used as starting point to design more than a basic representation.

Scenario 3 _ Voronoi as architectural environment

The third scenario suggested the need of testing Voronoi as design tool able to generate an architectural environment integrating the dynamic organizational principle of the first diagram and the structural potential of the second one. In this case, there was a real brief, with concrete architectural program and defined site and users, whose information was translated in a series of layers with coordinates, which were understood as initial state to develop the architectural space. Later, these

layers would receive more information from the site and the users like weather conditions, infrastructural and transport requirements, and people movements (interior and exterior of the new space). Likewise, it would be possible to create a collaborative network through the spatial link among several buildings into a central area. According to this aim, the platform was modified to include 3D softwares and the Voronoi language was translated from Python script to Rhinoceros allowing the real time manipulation of the variables. The outcome was a complex spatial system, subdivided in relation to the density of points and the movements in each area of activity (information in coordinates). In relation to the urban proposal, the final result was an interesting semipublic space but with not yet appropriate proportions according to the scale and role of the site. Finally, the new space does not recognize the formal diversity manifested in its initial state, its aesthetical expression is homogeneous and predictable as well.

5. The productive ambiguity

The diagram has the potential to combine the complexity of a design brief, the dynamic information of the social structures and the organizational capacity of the mathematical systems. Therefore Voronoi Diagram was used as an informational network capable to map the fundamental variables to organize a specific space, to process the information algorithmically and to generate a concrete architectural environment..

Nevertheless the complexity and constraints of its diagrammatic constitution made difficult the negotiation among the emergent computerized output, the contextual parameters and the will of the designer. The organizational principle of the algorithm reduced many of the functional requirements of the design, specifically in relation to circulations and interstitial spaces. This tool works basically with closed areas, which limits also, the aesthetical expression of the space

Although the previous critics, this experiment opened up a clear opportunity to apply a diagrammatic tool as an architectural device, misusing its language and modifying its basic rules in order to develop a concrete

3D expression for the Voronoi Diagram. Until now, the majority of applications of Voronoi had been related to the description of positions, relationships and polygonal areas of influence in flat surfaces. In this sense, the present experiment represents a starting point to analyze the formal transformations of a diagram and to determine the suitable information to produce the change.

Finally, Voronoi Diagram is an ambiguous tool, but is this condition which confirms its effectiveness to be used as experimental platform able to be constantly modified to as part of an evolutive process more than an automatic formalization.

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Architectural Association School of Architecture. G_ nome AAD[R]L team

Faculty of Architecture and Urbanism, Universidad de Chile

References

- Atsuyuki O, Barry B, Kokichi S. 2000. *Spatial Tessellations : Concepts and Applications of Voronoi Diagrams*. Chichester: Wiley.
- Benjamin, A. 2000. *Architectural Philosophy*. London: The Athlone Press.
- Deleuze, G and Guattari, F. 1998. *A Thousand Plateaus. Capitalism & Schizophrenia*, translation and foreword by Brian Massumi. London: The Athlone Press.
- Eisenman, P. 1999. *Diagram Diaries*. London: Thames & Hudson.
- Lynn, G. 1995. Form of Expressions: The proto-functional potential of diagram in architectural design. *El Croquis*, N 72/73, 16-30
- Mitchell, W. 1996. Chapter 3: Design Worlds. *The Logic of Architecture, design computation and cognition*. London: MIT Press.
- Schumacher, P. 2004. *Digital Hadid: Landscapes in Motion*. Basel: Birkhauser.

Van Berkel, B & Bos, C. 2002. Chapter 7: Diagrams. Interactive Instruments in operation. *This is not architecture: media constructions*. Ed. Rattenbury, Kester. London: Spon. 99-109

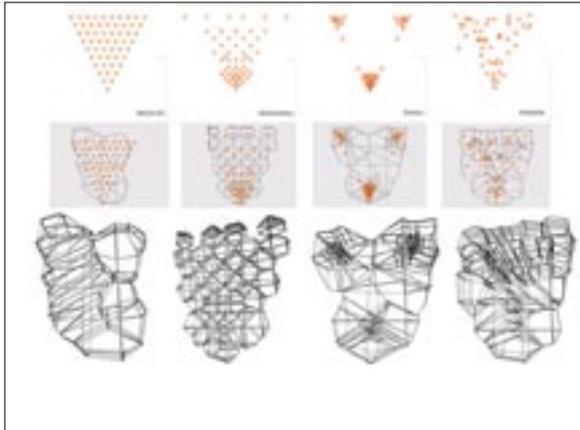


Image 10: Patterns of distribution and structural outcomes for a Voronoi-based space.

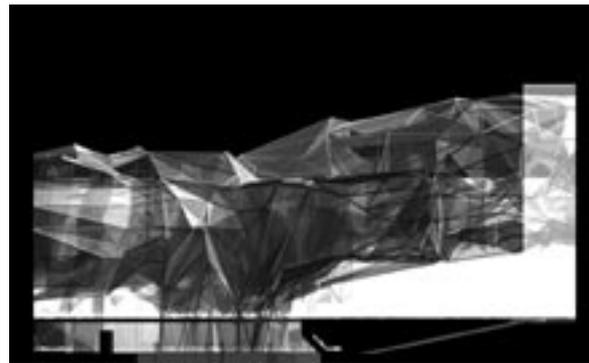
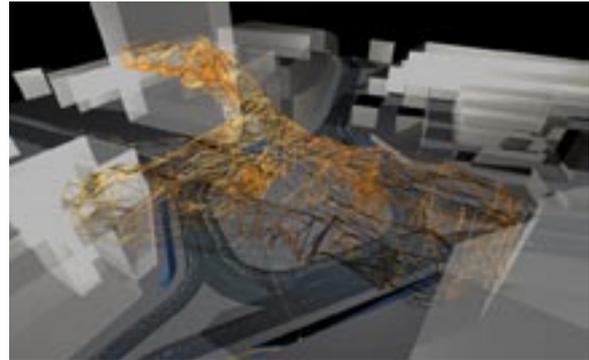


Image 12 and Image 13: Overview of a workspace of Old Street, London



Image 11: Architectural application of the Voronoi algorithm at Old Street, London.



Maria Loreto Flores Reyes,

Architect Universidad de Chile (2002), Master in Urbanism (c) Universidad de Chile (2003). Teacher Assistant of the Faculty of Architecture and Urbanism, Universidad de Chile. Currently developing the March Design Research Laboratory D[R]L in the Architectural Association School of Architecture in London. Key words: design research, network process, diagram, rule-based system, cellular organization, Voronoi diagram.