A Form-Based Study: Integrating the Manhattan Bridge into the Urban Fabric

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ABSTRACT
Physical, functional and socio-cultural boundaries can emerge in cities over the course of time, and which can be strengthened or weakened by external forces. Since these boundaries affect the integrity of city circulation in a negative manner, correct design should be introduced to reduce their effect. In this study, such qualities as mutualism, porosity, permeability and connectivity have been considered as design principles for integration, the subject of which is The Manhattan Bridge. The networks between the meshworks are weak in the area where the Manhattan Bridge meets ground level, but continuity can be provided by strengthening connections between these existing nodes (meshworks). Creating interfaces (or apparatus) and strengthening the existing functions would reduce the physical boundary effect created by the bridge. Accordingly, in the study, during the creation of this apparatus via the synthesis of tectonic and organic infrastructures, the polygon modeling techniques were used within the Maya software and projects were modeled by means of a morphodynamical approach. Thus, the form-finding process began by addressing an urban problem and was based on a theoretical infrastructure.

KEYWORDS: computer-aided design; conceptual design; built environment; urban boundaries

INTRODUCTION
Bridges are built to provide connections across rivers, which are natural boundaries. However, when connections are provided by building bridges, some borders can be created on a micro scale. For example, the areas where bridges meet the ground in Manhattan can be thought of as physical borders in the city. Mostly, these areas and their environments lack any specific function, while additionally they create borders which interrupt continuity in the city.

Two objects which are functionally, physically or culturally distinct from one other may have some points of connection. An interface can be a transition area or threshold which can provide this connection. Boundaries are critical to classical thinking, while The Modernists attempt to subvert them while creating new ones. The Postmodernists, unlike those in the Modernist era, have produced discourses that intersect with complexity theory, such as 'doubling' (Foucault, 2003) and 'double-articulation' (Deleuze and Guattari, 1988). In these discourses, the 'boundaries' are blurred. As De Landa (2000) notes, a complex system is mentioned instead of a hierarchy. In summary, when we view the discourses in relation to the boundaries, from the past to the present, we see that the boundaries are inclined to disappear. In other words, the boundary is transformed from a limit to a frontier and finally to an interface (Islami, 2009).

Integration of different spaces via interfaces can reduce a boundary effect between them. Different spaces (functional, physical and socio-cultural), different urban pattern intersections, public-private intersections, open space-buildings (solid & voids in the urban pattern), natural edges, and different demographics can all be given as examples of spaces with boundaries. An integration process through interfaces will gradually affect the whole urban system. Thus morphogenesis in the boundary will start at a single point, and then cause its environment to change. With the successful creation of interfaces, the boundaries will become not only transition areas but they will additionally be places where benefits to the urban structure can be provided. Hence, the form of the entire urban system will begin to change as a result of these particular factors.

METHODS

As fluid urban conditions change the direction of how architects view the links that establish themselves between objects and buildings, their interest in infrastructures is naturally enforced. In the case of urban projects with an infrastructural significance, they attempted to integrate the urban fabric, on the basis not only of the specific dimensions involved, but also as a result of larger-scale forces. Hence it is apparent that the discipline of architecture is now shifting toward the field of infrastructure. Indeed, Delalex (2006) mentions that, according to Stan Allen, architects have started to focus on infrastructures. Allen called this approach infrastructural urbanism, since the architecture began to deal with territorial scales. By questioning scale, use, movement, flow and exchange, architects are led in the direction of infrastructural design. Since design allows us to channel, distribute, orientate, or diffuse flows (Delalex, 2006), this study was undertaken on a regional basis and form-finding paths were explored for within the infrastructural urbanism.

At the end of 19th century, the first opposition to the classical drawing method was derived from the perspective of form-finding, which appeared from the resulting complex relationships between structure, form and materials and arose for the purpose of examining the optimized structures. The pioneers of this perspective -Gaudi (1852-1926), Isler (1926-2009), Otto (1925-2015) and Musmeci (1926-1981) rejected typology and tried to identify the self-formation processes that occur in nature, which they tried to reflect in architecture (Tedeschi, 2014; Pugnale, 2014). Accordingly, the pioneers of the form-finding methods began to make physical models, and so rather than using the drawing as a tool for research, they preferred to produce of physical form using analog methods. This method provided the means to demonstrate dynamic power in architectural forms, which was self-optimizing. In the past 10 years, a rapid increase of complex forms in architecture has arisen, in which form-finding has become an important strategy for the determination of these particular forms. Thus, digital form-finding methods are in a phase of rapid development. In this project, set in an urban context, we tried to achieve the particular form-finding as a research exercise which attempts to reduce the border effect, created by the bridge.

Since the form-finding studies were carried out in this city (Manhattan), we used the tectonic structure of the existing infrastructure in the process. According to Schmidt (2007), the tectonic movement in the mid nineteenth century attempted to explain architecture and arts in a meaningful manner, although it appears less so from the rational point of view. However, the tectonic practice in architecture has changed spatially and organizationally as a result of the new technological paradigm. If the tectonics are defined as being the strategic usage of an element’s technically induced morphology, in order to address social functions in the articulatory dimension, then tectonics can be redeemed and integrated within contemporary concepts of handling form-function relations. We may call this strategy of using technical details as *tectonic articulation* (Schumacher, 2012). The dominance in the 20th century of the rectilinear, orthogonal mode is a reflection of the materialist values of an industrially driven age. The post-industrial age is awakening to a new world, but which also reflects an older and wiser vision. The reappearance of organic design displays a new freedom of thought; an expression of hope for the future. This affects most fields of design, ranging from products and furniture, lighting and textile design to architecture, landscape architecture, and interior design. As this occurs, organic design becomes more popular than the mainstream design trend. Modern information technology and the rapid spread of computer-aided design (CAD) across all fields of architecture and design, has made the design and designers' creative processes independent. The latest three-dimensional design software makes it much easier to create designs, sophisticated models, complex shapes and forms, such that the straight line, right angle and cube are no longer necessary as dominant features (Pearson, 2001).

Hence, in this study, an infrastructure of these interfaces (or apparatus) (Agamben, 2009) was formed by using a combination of tectonic and organic forms. Since, until recently, the city was developed on the basis of tectonic ideas, its infrastructure and structures are tectonic in nature. Thus, the system of the same tectonic structures as bridge structures, pedestrian paths, bicycle paths, rooftops and building structures were used to create both the starting and finishing points of a new infrastructural system. Through this new infrastructural system, a new type of organic structure has been created at certain points (determined nodes), and so a principal of composite identity has been achieved for new infrastructure by means of a combination of organic and tectonic forms (Figure 1).

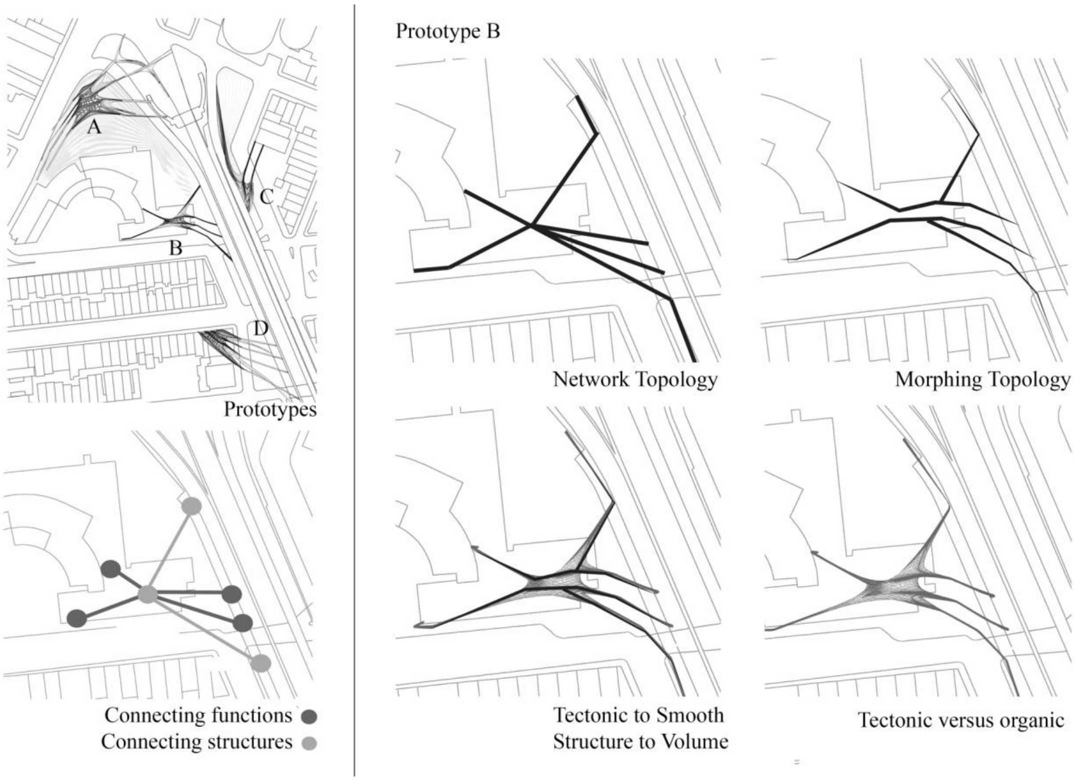

Figure 1: Morphing topology.

In the built environment, the entire system in the city is interconnected, which is defined by De Landa (2000) as meshwork. In the meshwork, each unit (from the smallest to the largest) interacts to build a collective network. Thus, we see the gradual formation of meshwork in the city, from the past to the present. For example, De Landa mentions that the formation of meshwork between the innovative systems in the city resulted in the industrial revolution. This, he argues, is because, as the formation of the links between the materials such as coal, iron and cotton increased, the network became stronger. Later, with the meshwork created by electricity, fuel, steel and synthetic materials, a self-supporting system began to be formed. The integration of railways and telegraphic technology with these existing units has enlarged the network and ensured the formation of the urban structure and road system in Europe (De Landa, 2000). When we look at the built environment in physical terms, we see that it grows gradually in time, matures slowly but surely, and forms a meshwork. De Landa (2000) notes that the nodes in the meshwork must be very well and mutually catalyzed. It is necessary for the units to be parts of the whole system, to form a meshwork and to function together, and thus a self-supporting system finally emerges. As mentioned by Deleuze and Guattari (1988), this situation is analogous to 'double articulation', which refers to the process in which a final object is actually made up of other objects. However, in some cases, such as the area where the Manhattan Bridge meets the level of the ground, this meshwork may be weakened. In order to avoid the emergence of urban boundaries in the city, this weakened meshwork should be supported. In the present work, we propose that this can be done by strengthening the network formed by the nodes in the meshwork. We consider that it is possible to strengthen this network by creating an interface, which can be formed according to the morphology of the existing network. Modern computer aided design methods are powerful tools in helping to create such complex morphologies.

RESULTS

To develop this composite system, first, *meshwork*s (De Landa, 2000) were identified in the area. Nodes of the meshworks, which were present as isolated from each other in the featureless area (caused by the bridge), were determined. For example, in one model, in order to strengthen the pedestrian paths, the pedestrian paths over the bridge and the closest bus-stop nodes, were considered (as functions) to be connected to each other. In the other model, for the strengthening of the bike path on the bridge, the functions of shops under the bridge, pedestrian path and the market place, were considered to be connected. However, the nodes were viewed as being connected to one other using the tectonic of existing structures. At this point, the combination of tectonics that were in the traditional Euclidean geometry, was made and from this, 3D modeling was began.

Since the 3D modeling was initiated from the tectonic of existing structures, it was begun using the Euclidean geometry for the new creation of an infrastructural urban design proposal. This led the designer to follow a morphodynamical (Chu, 2006) design process. In contrast to the morphogenetic approach (where the designer can obtain unpredictable emergent forms in the design process), in the morphodynamic approach, the designer can directly intervene in the design process and can manipulate the forms accordingly. In this work, while the morphodynamic process was followed, polygonal objects in Euclidean geometry in Maya were created using the trace of the network as determined with the help of nodes. All of these created objects have been combined (using the *combine* command under the *mesh* heading) so that they can give a holistic result in the smooth operation (using the *smooth* command under the *mesh* heading). The objects were combined and made into a single mesh object. To achieve this, the properties under the *edit mesh* heading (*merge, merge to center, add divisions, bridge*, etc.) were used in Maya. Next, smooth operations were carried out in order to make this tectonic model (modeled in Maya by polygonal modeling) become organic over the possible combination points, and the subdivision values were adjusted (Figure 2). Although the designer generally predicts the geometry to be formed, as a result of the smoothing operation, the transformation of the mesh in the Euclidean geometry into an organic form sometimes provides unexpected outcomes for the designer terms of the morphogenesis of the form. This is because the different organic forms can occur by giving different subdivision values to the mesh object. Accordingly, many alternatives in the form-finding process may be created. Smoothing operations made the form-finding process so to select the appropriate form with the desired criteria. In some areas, to get the exactly desired form, the face, edge or vertex of the polygon were combined or separated as required. Although this process is time-consuming, it does give designers the possibility to intervene in the form down to the thinnest point. The same method was then used to create solid & void structures of the resulting interfaces.

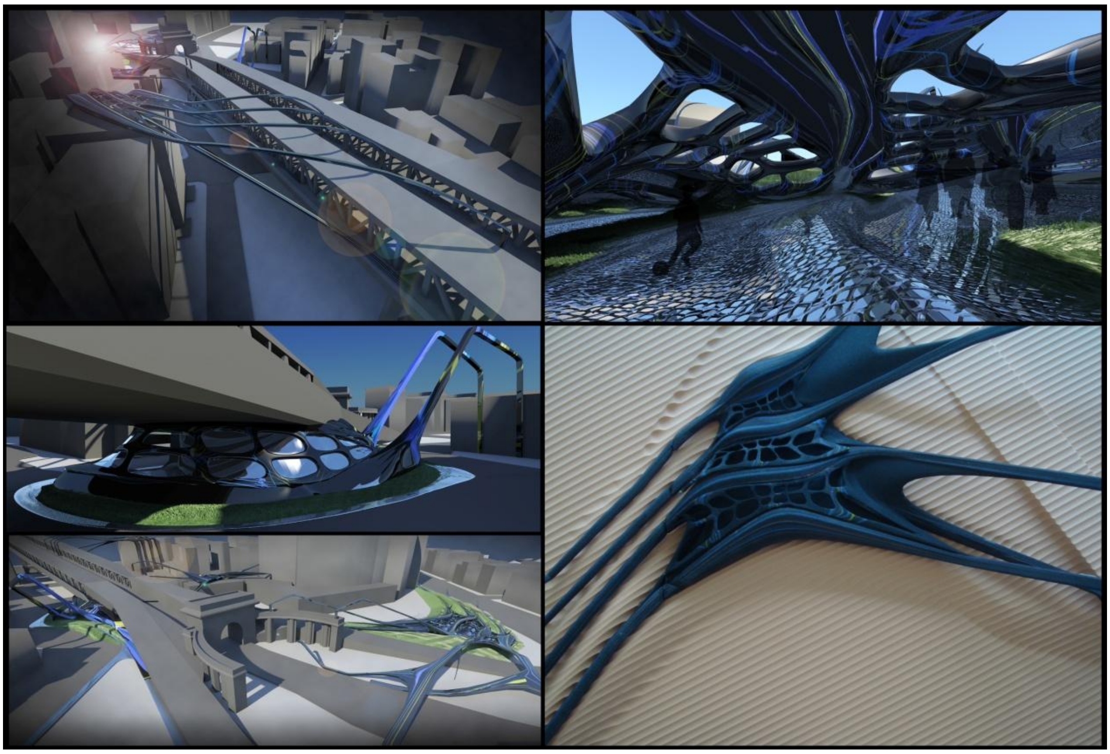

Figure 2: Polygonal modeling in Maya and 3D print of the prototype.

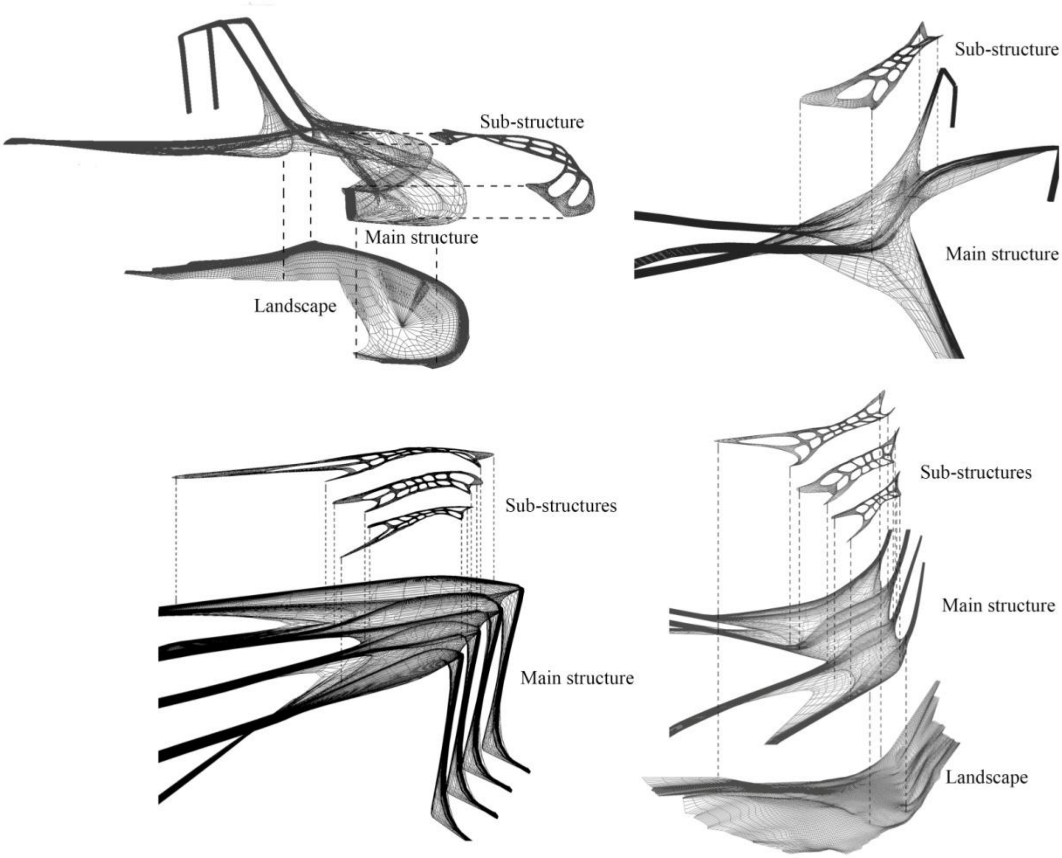

Figure 3: Composite identity of prototypes.

The design was considered to be made by moving from the whole to the detail. Thus in this project, form does not follow function (in contrast to the approach of the modernist movement), since the form is created by starting from the curves of a network (analyzed in the particular region), and then progressed into the details. This method, in this type of regional size of projects, can be a good way to avoid losing the integrity of the form and to maintain aesthetic values.

The network system of the project was interpreted as morphing topology. The work was begun with the intention to strengthen the network, and the construction of the form was achieved by changing the topology of the network. Thus, the form-finding process began with an urban problem and was based on a theoretical infrastructure.

Urban research is generally done on a 2D-basis. However, the third dimension of cities is now very important, and for example, the fact that entrance floor of a skyscraper is public while the upper floors are private, can affect the whole meshwork of the region. In this study, the creation of meshwork as being 3-dimensional in the area proved to be an advantage for shaping the particular form. Thus, the process of giving a 3rd dimension to the form does not only consist of a simple operation such as extrusion.

This design which began from the boundary effects on a city and was then developed, gave prototypes with a different originality from each other and which were not of Euclidean geometry. In addition, the form was made more composite by creating a main structure and necessary sub-structures. (Figure 3)

CONCLUSION

In general, experimental 'infrastructural urbanism' projects, associated closely with forms, are not carried out to answer of a specific research question. Theoretically, to define a problem in contemporary urban design approaches (in the context of this work: on urban boundaries) can give direction to those form-finding studies which are the common research challenges of today. This is true because the form can accordingly be created according to the particular defined problem.

In the scope of this study, we have presented an identification of the problem and formation of the forms according to the problem. In our approach, the problem was determined to be a weak network in the area. Then, the creation of the forms began with the topological transformation of this network. In the study, the designer was directly effective in producing the form. However, future, research work is likely to concern the ways in which non-humans (such as artificial intelligence, machines, agents) can create the necessary forms as are required according to a particular problem in a city. However, along with the aesthetic contributions to design, the response to specific problems can work well in a form-finding process in a city. Thus, non-humans can both give an answer to a problem and, contribute to the aesthetic values of the city.

Once the human problem is defined, machines may enhance and can provide unexpected and optimized solutions to complex problems. Today, some problems are defined in architecture and these problems are solved by non-humans. For example, efficient intake of light in architecture is a challenge, and so the relevant shape optimization, based on minimization of solar radiation studies (Kampf and Robinson, 2010; Gonzalez and Fiorito, 2015), is done by means of algorithms. As another example, in the field of engineering (Walls and Elvin, 2010; Beghini et. al, 2014), topology optimization can be used to produce a structure of minimum weight. In the present study, a solution to a specific problem (urban boundaries) in the field of urban design was sought. A solution to this problem was proposed in terms of strengthening the connectivity of the nodes of the existing meshwork in the city. To test this solution, a study was made based on the morphodynamic approach (Chu, 2006) for the area where the Manhattan Bridge meets the ground level, which was selected to be the case study area. This study can furthermore provide a basis for future studies of the morphogenetic approach (where, non-humans are more effective than the designer). Therefore, as a next step of this study, with respect to the nodes, an optimized solution involving non-humans will be made via a morphogenetic approach and this will be examined and compared with the morphodynamically generated form of the design.

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