The composition of the work of architecture – processuality in design

Slawomir Wojtkiewicz, PhD
Faculty of Architecture, Department of Visual Arts,
Bialystok University of Technology, Poland
www.artwojtkiewicz.com
e-mail: s.wojtkiewicz@pb.edu.pl

Abstract

The paper describes the process of designing a single-family housing estate and focuses on the issue of forming a contemporary form of architecture. Generative methods in architecture design can support the revitalization of such areas. Additionally, the generative design method joined with the architectural code of local architecture gives us an outstanding opportunity to discover new shapes of contemporary architecture according to the culture, history, and landscape aspects of a project place. The designed housing estate, in its final form, is a model of transformation of the features of the traditional country house in the taken project area. The paper explains the phases within the methodology and shows how the method influenced the building design process.

1. Introduction

The design of buildings is a common purpose by the need to meet a set of minimum efficiency criteria such as beauty, functionality, budget, energy requirements. To achieve better performing and sustainable architecture, the architect needs to work together in a focused effort. Generative synthesis systems offer us several options to compare and select from entirely. Once we encapsulate our design intent in procedural terms, we can automate the design process, and generate many alternatives.

2. Design Experiment

In this section, I will demonstrate the application of my proposed methodology within a design experiment for the single-family residential area, which is an actual housing building currently under design in the Bialystok neighborhood, Poland.

2.2 Design Concept

The goal of this project was to design a unique mid-class residential single-family

house. Several architectural aspects were taken into consideration while designing this building.
The design experiment's assumption was to develop an architectural solution obtained by designing with the use of internal structures resulting from mutual relations, parameters, and constraints. The applied generative methodology and work on the BIM model would allow for the automation of the design process and the simulation of solutions that would best suit the architectural goal.
The rule of the house structure concept was defined, which was supposed to be a completely private space from the side of the main entrance - preventing access to the open zone and other parts of the house zones. The public area was to open up to the gardens and create mutual relations between architectural interiors. Apart from the standard functional layout of the house, the essence of these interiors was the function of an artist, painting studio. The studio was to connect spatially with each other a part of the garden and the open living area of the building. In the free section, the idea of separating the most important functional components in the body of the building, especially the art studio zone, integrated through a connector and a separate atrial garden with the rest of the building was born. The concept was developed to maximum integrate the interior with the exterior of the house. The design concept provided expansion possibilities for the private and public areas.
Views to the outside from the house rooms were considered a priority. Also, impressive internal views were provided within the building.
The building design was unattached to any design style with a limited time frame. However, even in this matter, the priority was to define the local traditional architectural features of the house form that would be the carrier of the characteristic features with the modern language of architecture. The design process has acquired evolutionary functions, and thus inscribed in the generative design methodology.
In regards to energy conservation, different approaches and strategies were implemented to provide high comfort levels for occupants without depending on the overkill of mechanical systems. It was taken into consideration that the policies implemented should be easy to maintain, efficient, and long-lasting. Finally, the structural system proposed was based on the commonly used post and beam system, both economical and reasonably easy to implement.

3.4. Hierarchies and Levels

In this study, the design system was broken down into two design levels. The first level handles the internal spatial zoning while the following second level relates to the massing design solutions. However, it should be noted that when the design system in level two is developing the building skin, it is also considering several factors mentioned in level one of the design system. (Figure: 10)

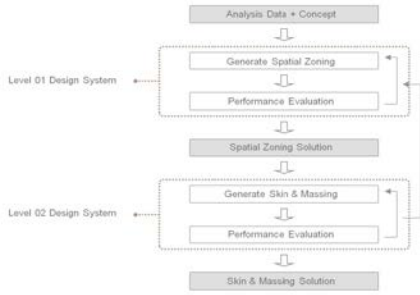


Fig.10.Hierarchies and levels diagram.

3.4. Design System Level One

As stated earlier, the first level of the design system is responsible for generating spatial zoning options that will be analyzed based on qualitative as well as quantitative aspects. Qualitative aspects include characteristics like the quality of the internal space, while quantitative elements will consist of real estate and lighting attributes. (Figure: 11)

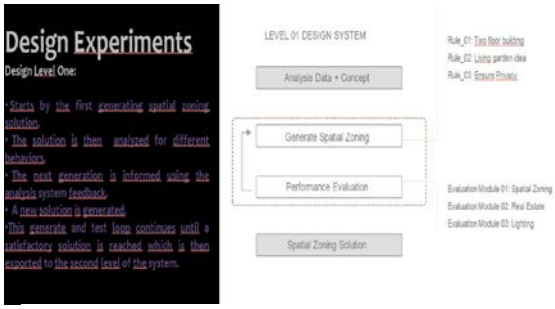


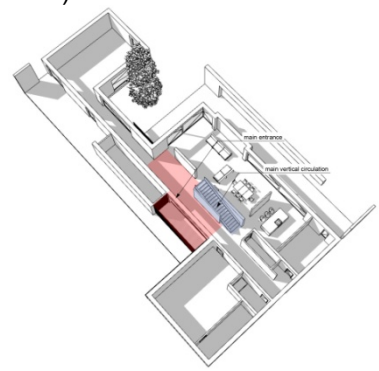
Fig.11.Design experiment – level one - diagram.

3.5. Generative System

The system will consist of parameters, constraints, rule sets, and a design algorithm. The generated solutions will be evaluated within the analysis system in level one. The feedback from the analysis system will then inform the generative system, and a new solution will be produced. This operation generates, and the test loop will continue until we reach a satisfactory solution that can then be exported to the second level of the design system.

3.6. Parameters

The parameters of the system in level one are divided into constants and variables. The constants will include the location of the main entrance and central circulation spine. The entry represents the access point to the building, which is also connected to the central vertical circulation core. The corridor spans the building functions like living area, art-studio area, and private, night area on the second floor. It is also attached to the central vertical circulation core.
The variables in the system were chosen as the internal garden cell location, mode of moving walls in the art studio room. (figure:12)



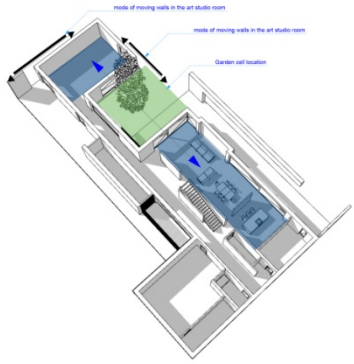


Fig.12. Constants and variables parameters of a design experiment.

3.7 Constraints

Certain design constraints were imposed on this level. For instance, the central corridor, living room, and art studio have to have a semi overlooks to internal garden, the interior garden has to link an art studio room with a living area of the house informally and intimately, garden side of the house obtains maximum sizes of glass windows while entrance area of building must be maximum private, and closed, hence to have minimal numbers of windows, and window covering system. Finally, using BIM technology and generative thinking of design in architecture, I created a typology of the house taken value from traditional architecture. First – his shape is an effect of a study of landscape relationship and a probe to the maximum open to impressive landscape panorama view, still keeping a form however contemporary but has been transformation code of traditional architecture. (Figure: 13)

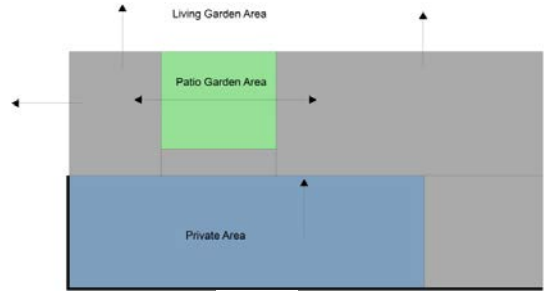


Fig.13.

5.3.1.2. Rule Set

The rules applied in this level are mainly spatial zoning rules and related to the generation of the internal garden, central corridor, and outside the line of the building. The interior garden will be located as a link between two parts of the building. The hall will provide a relationship between the primary building function and the garden. It offers a semi-private zone for the living area and art studio area. The garden is also related through the elevation to the living room, corridor, and art-studio room. The garden provides both view and lighting for the main rooms and a hall. He also provides a solution for the view code restriction towards the surrounding residential buildings. The last rule important to design windows was the rule of living garden house. Living garden house attempts at redefining the single-family home to integrate architecture with nature, a local architecture code. The classic household division into the living area, located on the ground floor and the sleeping area above, was transformed into a new typology. During the day, we should be able to interact with the environment, with the light (cognitive functions), whereas at the night, we appreciate separation from the

environment (safety function). The dichotomy is thus born: the ground floors open up to the garden under the floor ledge, whereas the first floor is more introverted. Living space merges with nature; glass partitions are the sole protection against the weather. This rule I tried to implement to this project organizing idea of the resized living room in open garden spice outside.

5.3.1.3. Algorithm

After defining the system rules, I sequentially apply them to generate a design alternative. Initially, the system constants provide us with a layout that is only occupied by the main entrance and the main circulation elements (main corridor and central vertical circulation). The internal garden coordinates on the floor are variable. The algorithm starts by locating the interior garden on the ground floor boundaries while checking to maintain a satisfactory level of view and light to the zones of the room. Applying this system generated a large number of solutions and alternatives. Each solution is then analyzed based on our performance criteria. The internal garden plays the role of sub corridor between two relevant functions of the house; from the second side, he integrates garden architecture with interior architecture by "system of moving wall rule." This rule distinguished an individual role of the art studio room in the architecture and defined designing architecture as a standard structure of exterior and interior.

5.3.1.4. Analysis System

After receiving a solution from the generate system, the analysis system starts evaluating it. The analysis system at this level includes a spatial zoning analysis representing a qualitative aspect, real estate, and lighting analysis that represents quantitative aspects. The spatial zoning analysis will assess the floor plans' general arrangement with a focus on the architectural space features, including the circulation smoothness through the horizontal and vertical systems. The real estate analysis will calculate the percentage of the useful area and compare it to the built area. Finally, the lighting analysis will be responsible for calculating the quality of lighting provided in each living space. Each criterion discussed above will be given a certain weight. All standards and weights will be combined to define the objective and evaluate a single solution. (Figure: 14)

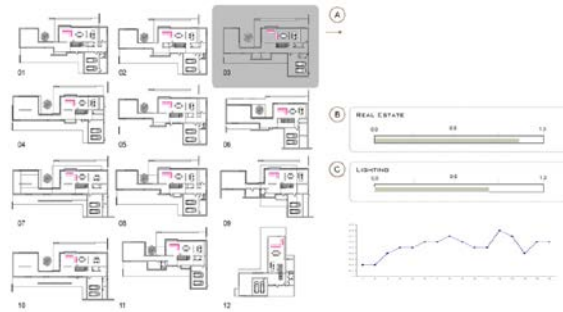


Fig.14. Using the analysis system to choose the best solution to the building plan

5.4. Design System Level Two

The design system at level two will be responsible for generating the building massing and the external building features. The options made from the generative system will then be analyzed based on qualitative aspects such as

balance and proportion, as well as quantitative aspects such as floor solution and solar intensity on the facade. (Figure: 15)

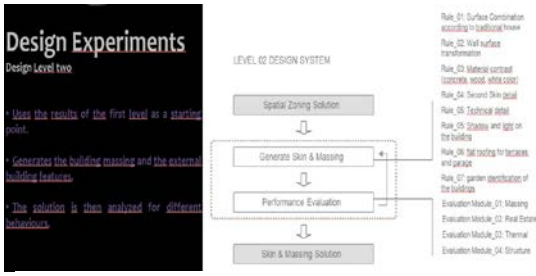


Fig.15. Design experiment – level two – diagram.

5.4.1. Generative System

The given solution from the level one design system will be this level's generative system starting point. This generative system aims to produce a new building form by exploring the design space in search of satisfactory solutions. Solution variations will be provided after running the design algorithm with its elements that include parameters, rule sets, and constraints. (Figure: 16)

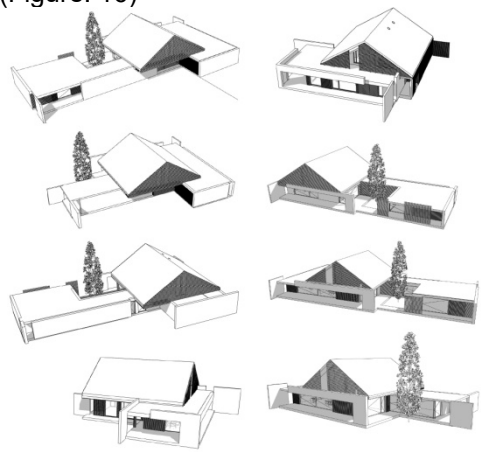


Fig.16. Generating a form of building

5.4.1.1. Parameters

The parameters of the level two generative systems are divided into constants and variables. All the system level one results are considered to be constants. On the other hand, the variables in this level are the surface of the shading system, the surface transformations of the walls in the art studio area to make the maximum transparent surface in the garden context (Figure: 17).

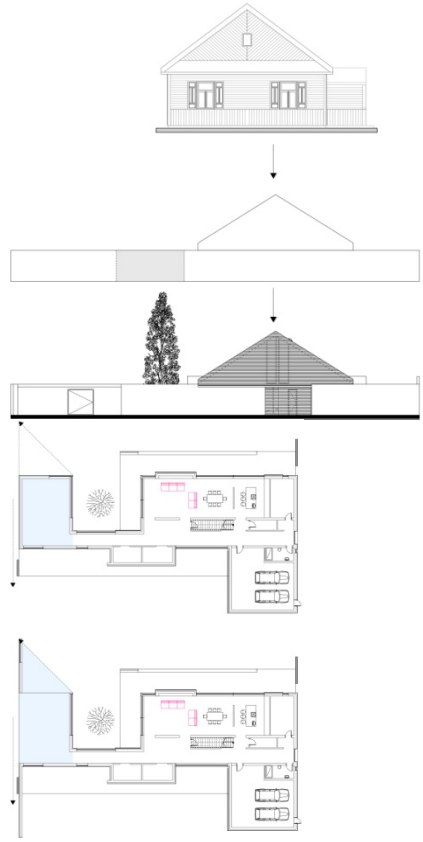


Fig.17. The parameters of the level two generative systems

5.4.1.2. Rule Set

The rules to be applied in this system are mainly massing regulations. They will be related to the elevations treatments such as surface division, surface transformation, surface transparency, surface shading, building skyline, traditional shape of first-floor roof vs. contemporary flat roof. The building facade will be divided into horizontal and vertical surfaces. This approach will help scale down the length of the building and create a proper scale. The transparent surfaces are two types: transparent surfaces that provide view and light, and transparent strips that can only provide light. Based on the location and internal need, one of the two types will be implemented. The surface shading system represents a second skin to the building. It acts as a filter allowing indirect light to penetrate the structure but preventing direct solar radiation. The building's skyline will be transformed to follow the surface division and to conform to the massing breaks.

5.4.2. Analysis System

After getting a solution from the generative system, the analysis system can start the evaluation process. This notion will include amassing analysis, which is a qualitative aspect. Besides, real estate, thermal (solar intensity), and structural performance will be evaluated as quantitative aspects. The massing analysis will evaluate balance proportion and aesthetics. The thermal analysis will calculate the surface solar intensity and the effect of deformation on it. Finally, the structural system will be evaluated based on an estimate of construction cost and complexity generated by surface deformations and architectural details.

6. Conclusions

In this paper, I demonstrated a Performance-Based Generative Design methodology that I applied in my practice. The method starts by identifying a design concept. This design concept is then broken down into different levels and hierarchies. Each of these levels includes a generate and test design loop in which a generative system produces a solution that an analysis system can verify. The generative system includes parameters, constraints, rule sets, and algorithms, while the analysis system tests for qualitative and quantitative aspects. The system is relatively flexible and can allow the architect to maintain individual design intentions. The methodology was able to generate solutions that have high-performance levels. This contributes to the building's sustainability, which is an essential current issue in the architecture discipline. My objective in the development of this methodology was to provide a robust design system that can be included in early conceptual design phases. This proposed methodology can present both the architect and the client with a better understanding of the design space and the effects of different design decisions. The design system generated by the methodology provides for emergent properties that are only identified through the integrated interactions of the design elements as a whole. Besides, the system lends itself well to computation and simulation implementation. The processing power of

the computer can provide for better breeding capabilities. Also, the use of more sophisticated analysis tools would provide for more robust solutions. (Figure: 18).

Fig.18.

7. References

1. Alexander C. (1977), "A pattern language: towns, buildings, construction," Oxford University Press, Oxford, Great Britain.
2. Britt, D. (2000), "Durand Precis of the Lectures on Architecture: With Graphic Portion of the Lectures on Architecture." Getty Publications, Los Angeles, California, U.S.A.
3. Cookie C. (1983), "Form is a Function: The Development of the Constructivist Architects' Design Method" in id (ed.), Russian Avant-Garde Art and Architecture, London, UK.
4. Eisenman P. (1983) "House X," Rizzoli Universe International Publications, New York, N.Y., U.S.A.
5. Mandelbrot M. (2004) "Fractals and chaos: The Mandelbrot Set and Beyond". Springer. New York, N.Y., U.S.A.
6. McCormack, J., Dorin A., and Innocent T., (2004) "Generative Design: a paradigm for design research" in Redmond, J. et al. (eds) Proceedings of Future ground, Design Research Society, Melbourne.
7. Morgan M. (1914), "Vitruvius, the Ten Books on Architecture," Harvard University Press, Cambridge, Massachusetts, U.S.A.
8. Rowe, P. (1998), "Design Thinking," The M.I.T. Press, Cambridge, Massachusetts, U.S.A.
9. Simon, H. (1996), "The Sciences of the Artificial," The M.I.T. Press, Cambridge, Massachusetts, U.S.A.
10.Stiny G, Mitchell W J, (1978), "The Palladian Grammar" Environment and Planning B: Planning and Design. 5 5-18
11.Twombly T., Narciso M. and Menocal N. (2000) "Louis Sullivan: The Poetry of Architecture," W. W. Norton & Co Ltd, New York, N.Y., U.S.A.