

AUTOMATED SETTING UP EXHIBITION HALLS BASED ON DIGITAL METHODS

Dr. HAZEM ELDALY*

ABSTRACT

Setting up an exhibition hall with its exhibits, circulation, and entries, has infinite number of alternatives related to many constrains. In order to arrange exhibits inside the hall, some external factors such as (Type of exhibits - Exhibition techniques - Visitor's behavior...etc.) should be taken into consideration. To achieve a set up close to the optimum a great effort will be done.

As a result of the paradigm shift occurred in computer applications that removes the burden of common software, new ideology in digital field shows revolutionary solutions to studying and comparing design permutations. According to that the architectural design ideology for many types of buildings especially the museum has been developed rapidly. In order to facilitate the set up of an exhibition hall's design, the designer could benefit from the computational methods to achieve an automated design stages. This paper proposes a new digital method with an application for exhibit's arrangement in museum's halls, related to preadjusted rules for the set up of hall.

Keywords: Computational tools, Algorithms, Museums, exhibitions.

1- INTRODUCTION

According to the Greek mythology; Museum is known as "The seat of the muse" or it is "The place where the philosophers meet for discussing issues" [1]. It was developed over the centuries until it became a separate building, reflecting the artistic sense and urges to inspiration and imagination. In the design of any museum; the challenge is to create a form and a functional plan reflecting the main design concept and its cultural value. The museum's functional plan is depending on the relations between the main three zones (Public - Administration - Exhibits service) [2]. According to that; the visitor's movement will be an important factor in the design process. Exhibition halls are considered to be the most substantial spaces in public zone, and the value of any museum is evaluated by the amount of information to deliver, in order to get visitor's approbation.

Many types of buildings have been affected by this new trend of design especially public buildings such as Museums. As museums are considered one of the main civilization reflectors in all its different kinds and one of the evidence of the science and technological progress; it became also a reflection to the architectural evolution in this period of time.

In this paper; a demonstration of the design of exhibition hall and the effect of this design on the

*Associate professor of Architecture, Ain Shams University, Cairo

museum's visitors and their interaction with the built environment, will be introduced. With the help of digital applications; an automated design methodology for hall arrangement through digital applications will be highlighted with an application

2- SETTING UP EXHIBITION HALLS

Museum's display hall is the space that hosts and presents exhibits for a while or it is the space resulted from some decisions taken during the museum's design criteria stage including the following:

- a-The museum type (General, Historical, Art, Science ...etc.).
- b- The museum size (Small, Medium, and Big); according to the museum (No. of exhibited pieces, Budget, Income...etc.).
- c- Museum's design concept.

Exhibition halls are divided into two types (Main hall – Temporary hall). The Main exhibition hall is used for permanent exhibition; this hall mainly has the largest or the most important exhibits in the museum. Temporary exhibition halls are considered as minor spaces inside the museum because its presence depends on the museum's size [3]. The design of the hall includes (hall shape & dimensions, entrances locations, exhibits arrangement, and lighting system).

Exhibition is the process of displaying artifacts with some interpretations. It is influenced by the

amount of information to be presented to public. Museum visit is a trip, aims to make the visitor live an unforgettable entertaining experience. This experience could motivate the visitors to come many times, which definitely will help museums to increase their income [4]. According to that; the exhibition path through halls should combines the two factors Aesthetic and Entertaining. In order to make an exhibition plan; some other factors should be taken into consideration first before starting to place each exhibit in the hall arrangement pattern, explained as followed:

2-1-Exhibit's Types

Exhibited artifacts are not just objects to be placed in a certain arrangement; it should be studied, in order to get the visitor's interest. Exhibits are differing according to the museum type, and each one will has its narration to the visitor. Consequently; the history of each exhibit, its status, its material, and other important details about the exhibited collection should be studied. There are two main types of exhibits 2D and 3D. 2D exhibits are the objects with a small thickness and could be seen in X & Y plan such as (Paintings, prints, drawings, posters & textiles), and it could be presented as fixed to wall, or to a plan surface, or on the ground. 3D exhibits are the objects which have a length, width and a visual depth, and have protrusions in all directions such as (Sculptures, temples 3d models & mummified animals and other living creatures), and it could be presented in a larger free space, as it is one of the factors affecting the visitors movement [5]. In many cases exhibition hall could have 2D and 3D exhibits presented inside at the same time, and sometimes they are separated in different halls, as shown in (Fig. 1). Exhibits could be presented in the hall in many different ways (e.g. show case, or presented free, or surrounded by barriers). Each hall is unique; as it has different rules and regulation to decide the exhibits priorities on the arrangement layout. These rules are defined according to the hall shape, size and exhibits value for expected visitors.

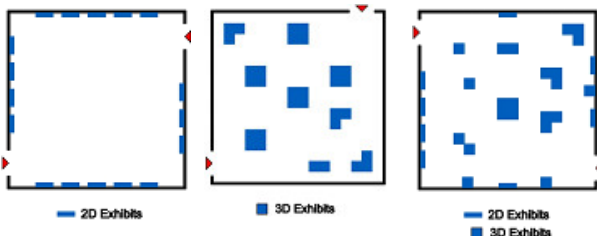


Fig. 1- Exhibits types, number, and priorities and its relation with the hall design

2-2- Exhibition Techniques and Approaches

Exhibition techniques are the way exhibits could be presented in, they are of the main factors

that affect the way to deliver the museum's messages and its popularity. There are mainly three techniques for exhibition explained as followed:

- **Historical**; exhibits are arranged in a historical sequence.

- **Aesthetic**; exhibits are presented separately or collected in an aesthetic way.

- **Ecological**; exhibits are surrounded by its real environment, or depending on the interaction between visitors and exhibits.

There are four approaches could be found, in order to arrange exhibits according to the previously described techniques, explained as followed:

- **Open storage approach**; it is depending on arranging the exhibits, as it is required, without organization or previous selection for exhibition. Same objects in size, same donor, or period are put together.

- **Object approach**; in this approach, exhibits are selected from the collection and arranged to form an educational exhibition.

- **Idea approach**; this approach is concerned with the educational role of museum, so a story will be presented using selected exhibits from the collection. It depends on presenting each exhibit as a separate unite not in a group of exhibits.

- **Combined approach**; in this approach, just significant exhibits and ideas are selected, in order to deliver the museum's message.

2-3-Visitor's Behavior

One of the factors that have a deep effect the exhibition hall's design is the visitor's behavior and their movement inside the hall. The visitor's movement inside the hall is unpredictable; due to the main differences between visitor's characteristics [6], accordingly their movement styles. Visitor's movement has an interrelated relation with the exhibits arrangement in the hall, which make the designer thinks about the exhibits visual directionally and the changes that occur due to the visitor's behavior. There are four styles of visitor's movement inside the exhibition hall, according to the concept proposed Veron & Levasseur [7,8] are described as followed and shown in (Fig. 2).

- **Ant visitor**: This type presents the curious visitors, who are paying attention to details, so they spend quite long time near each exhibit and follow a specific path in order to observe all exhibits.

- **Fish visitor**: This type of visitors is less curious than the Ant visitor; he/she spends enough time to observe all exhibits and keep a quite distance with the exhibits.

- **Butterfly visitor**: This type of visitors is observing most of exhibits and ignoring the rest; which makes him/her choose to follow a specific path guided by his/her orientation.

- **Grasshopper visitor:** This type of visitors is spending a long time to observe preselected exhibits closely and ignores the rest, and follow his/her own path.

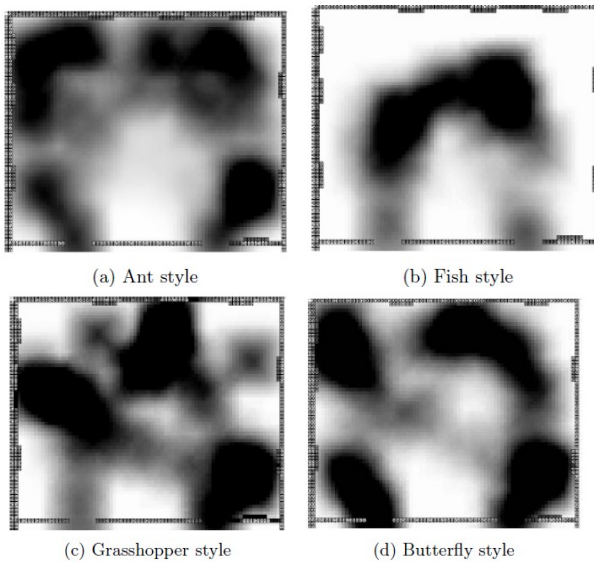


Fig. 2- Four styles of visitor's movement [9]

According to these styles, there are three approaches to control the visitor's traffic flow; Free, Visual and addressed. Due to the differences between visitor's characteristics; the best approach to choose is the visual one which provides the visitors their freedom to move in the hall [5]. This approach will lead the visitor inside the hall from the entrance. According to visitor's visual perception the hall arrangement will be affected; as the ability of visitor to realize the space should be started from the hall entrance, so the concept of visual approach will be achieved.

The exhibits arrangement according to that will depend on the designer imagination to draw a certain path for the visitors through the hall using exhibits, with a certain visual directionally, taking into consideration the exhibition technique according to museum type. In this stage of hall design, decisions should be taken to decide the most suitable location to place the main exhibits - from the designer point of view - and then moving gradually to less important exhibits.

3- COMPUTATIONAL METHODS FOR SETTING UP THE EXHIBITIONS

Contemporary architectural movements are influenced by digital tools in the design technology and their problem solving techniques. In addition to digital tools integration between different disciplines have changed the world's vision about the future in many fields. Mathematics could be found as one of the scientific fields that became the base of the new developments in other fields including Architecture. New visions for scheduled problems

have been introduced by logicians to meet the new architectural requirements of this era depending on mathematical solutions and approaches through new sets, functions and relations [10].

Architects start exploring new realm of forms through applying digital concepts, and techniques. New mathematical functions are run through computer based applications, and based on different parameters the results are different [11]. Applying different digital rules through algorithms with various aims could help to find better design alternatives. From the architectural point of view; those algorithms are implemented to solve many of the design problems regarding the main design aspects including form, function, economy and time and also during the main architectural designs [12].

With the help of algorithms to examine design permutations, the exhibits arrangement inside the hall became easier.

The common algorithms to be applied in setting an exhibition hall can be summarized as follows:

1- Swarm Intelligence:

Based on studying movements of traveling group of creatures such as fish, birds, and other groups. This concept derives its steps from studying this movement with the focus the interactions on individuals (Fig. 3).

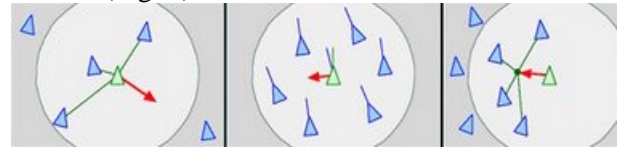


Fig. 3- Concept of the moving swarms

The following step summarizes making a swarm system;

- a- For each moving object, determine the direction of movement.
- b- Determine the minimum distance between the objects.
- c- Align with the direction of group.
- d- Move toward the center of the moving groups.

This concept can simulates studying the movement and interaction of persons in an exhibition hall.

2- Cellular Automata:

Based on dividing a space into grid of cells, each cell has a state. At first the state of a cell is determined, and the states of neighbor cells are according to predefined rules. According to the predefined rules when state of first cell is modified the other cells also are modified (Fig. 4).

The grid can be of any number of cells in the two

directions. To create a cellular automata system the following has to be modified:

- a- The form of the Grid in the two directions.
- b- State of main cell (could be variable).
- c- The neighbor hood cells.
- d- Rules of modifying cells.

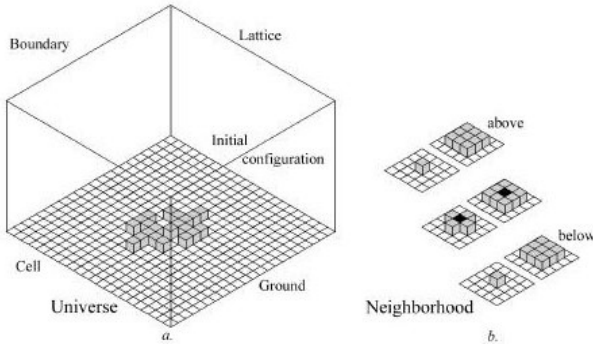


Fig. 4- Terminology of a cellular automata

This system when applied in an exhibition setup helps in allocating the exhibits by generating lots of alternatives.

3- Evolutionary Algorithm:

The concept of evolutionary algorithm is derived from merging computer science, Evolutionary computation, and evolution in biology (Fig. 5).

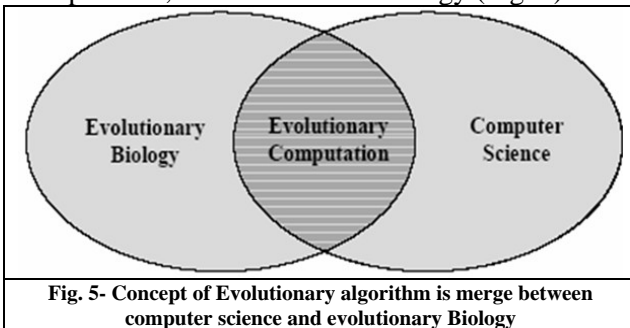


Fig. 5- Concept of Evolutionary algorithm is merge between computer science and evolutionary Biology

Based on the idea of moving characteristics of creatures from an offspring to the other, through digital programming the same idea could be applied. Each design alternative is given a fitness

function as an evaluation for its performance. Every alternative design performance is improving from generation to the next. The following figure (Fig. 6) summarizes the main issues for an evolutionary algorithm.

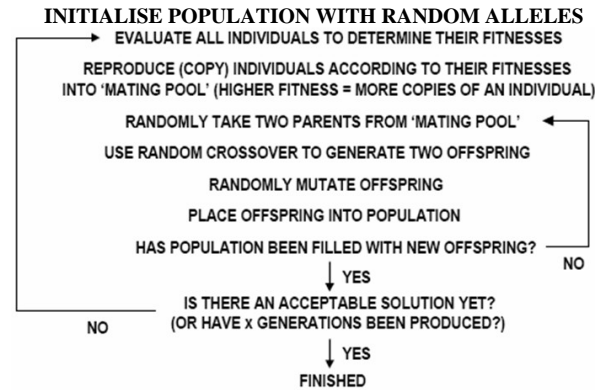


Fig. 6- Main steps for running an evolutionary algorithm

This concept can be applied in studying alternatives of designing an exhibition hall, and optimizing design.

4- Stochastic search:

A stochastic search is a random search in alternatives till a given condition is reached.

Stochastic Process is a search algorithm that is repeated over a site or zone with special rules until the needed design requirements are met. This algorithm is intended to make clear distinction between the non-deterministic form-making process and the rule-building, which facilitates the architect to select better solutions and neglect others.

4- AUTOMATED SETTING UP OF AN EXHIBITION

The following table summarizes the proposed design stages for setting up an exhibition hall. Through consecutive four stages the exhibition hall set up will be achieved (Table.1).

Table 1- Design Process Matrix

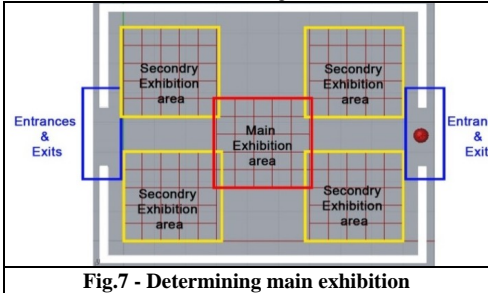
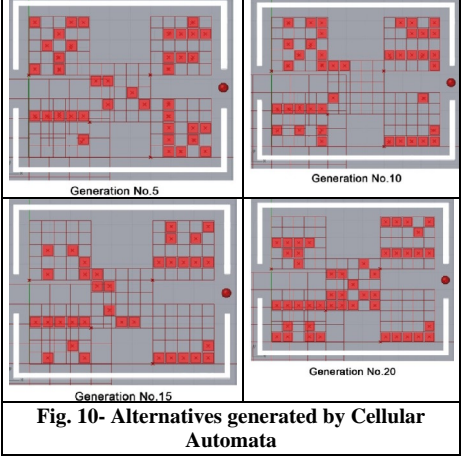
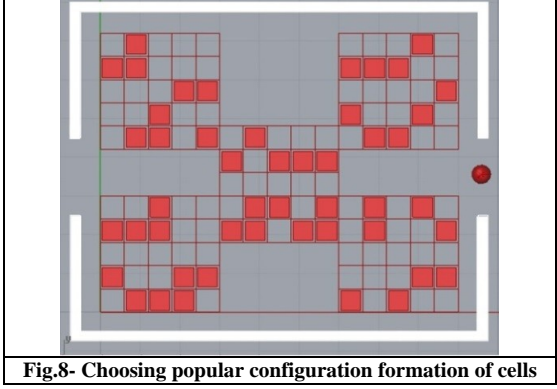
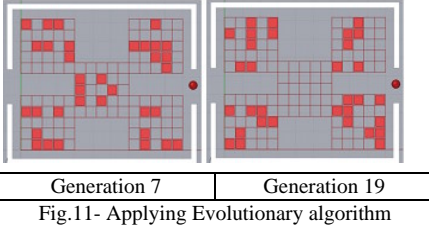
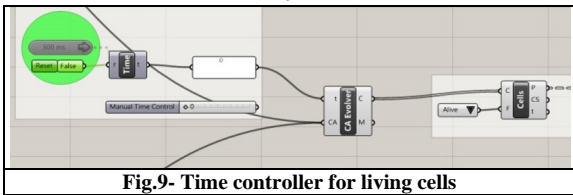
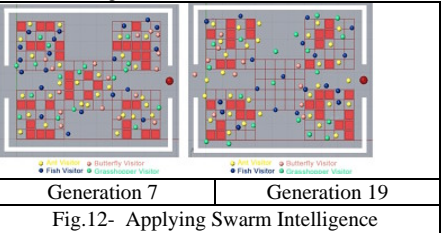
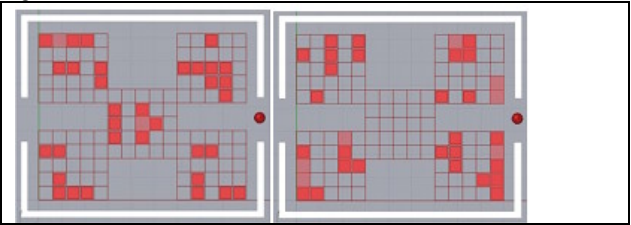
Design stage	Done by
Stage No.1:- General space parameters In this stage; some decisions needed to be taken before starting the program as inputs for the design space. Some of those decisions are related to the museum itself (Museum type and size), others are related to the hall (shape - dimensions - entrances), and the rest are related to the exhibited artifacts (Exhibits type and size - Exhibition techniques). Cellular automata algorithm will run (computed); in order to generate an infinite number of alternatives for the way for arranging exhibits inside the selected hall with previously defined dimensions. At the same time for the same hall Genetic algorithm is running (By the Architect) to produce number of alternatives for entrances and exits.	Architect
Stage No.2:- Exhibits arrangement In this stage; exhibits are going to be arranged according to certain rules as a result of the previously selected exhibition technique and approach, and the exhibits types and size. In this stage the architect has to choose the best alternative based on astochastic search or evolutionary algorithm, using a matrix gathering between the most suitable exhibitions arrangement working with an alternative for hall's entrance and exit according to certain rules.	Automated Architect or Automated
Stage No.3:- Visitor's Behavior In order to see the interaction between the visitors and the built environment, according to the visitor's movement styles and their perception, a simulation will be done to study the visitor's movement and their visual field along the movement path. The previous step will be followed also by an evaluation step to check the ability of visitors to move freely and safety inside the hall, which will make some modifications on the tested alternatives. Swarm intelligence algorithm will run; in order to simulate the visitor's movement through the hall. As the human behavior is unpredictable; the generated design may go back through the	Automated
Stage No.4:- The final Exhibition area fine tuning.	

5- CASE STUDY

The application has been made using Rhinoceros & Grasshopper platform for exhibits arrangement inside the hall depending on two concepts of exhibition; first, is the centered exhibition pattern or main attracting point, in order to direct the visitors to the hall center and then to the four sides

of the hall. The second is to make more than one attracting point, using Aesthetic technique and Object approach, and make the visitors free to move inside the hall by arranging exhibits in the hall corners, as shown in (Table. 2).

Table 2- General application for Exhibits arrangement

Steps	Description	Steps	Description	
Givens	<ul style="list-style-type: none"> - Human scale (Tall \approx1.70m), Personal territory (Radius = 0.9m). - No. of exhibited pieces = 25 to 50 piece, each piece with area = 0.5 to 11.5m², height = 0.5m. - Exhibits are Historical statues presented in showcases. - Expected No. of visitors = 15 to 50 person. - Hall shape: Rectangular with two entrances and exits with dimensions (8.5m*10m*4m). (Fig. 7) 	Generations	-A large No. of alternatives has been generated.(Fig. 10).	
 <p>Fig. 7 - Determining main exhibition</p>			 <p>Fig. 10- Alternatives generated by Cellular Automata</p>	
Initial state	<ul style="list-style-type: none"> - Defining evolution's rules. - Creating 2D cellular space to move. - Choosing popular configuration formation of cells. (Fig. 8) 		Evaluation	<ul style="list-style-type: none"> - The first 20 Alternatives will be evaluated according to exhibition technique and exhibits distribution in the hall, under some rules such as (the distance between two neighbors exhibits on the same axis X or Y shouldn't be less than 0.90m). This step could be done by the Architect or through a fitness function. - Then the most suitable alternatives will be chosen (G7 & G19). (Fig. 11)
 <p>Fig.8- Choosing popular configuration formation of cells</p>				 <p>Fig.11- Applying Evolutionary algorithm</p>
Time control	<ul style="list-style-type: none"> - Timer control evolver to generate alternatives for living cells. (Fig. 9) 	Visitor's behavior simulation	<ul style="list-style-type: none"> - A Simulation by visitor's styles has been made, in order to see the effect of exhibits arrangement on the visitor's movement. (Fig. 12) 	
 <p>Fig.9- Time controller for living cells</p>			 <p>Fig.12- Applying Swarm Intelligence</p>	
Exhibition area	Due to the visitor's behavior and circulation some modifications have took place on the arrangement to avoid the overcrowding spaces, till the final alternative is generated (Fig. 13).		 <p>Alternative - A Alternative - B</p>	
	<p>Fig.13- Modifications on final selected alternatives</p>			

6- CONCLUSION

Setting up an exhibition hall is based upon determining the museum type, size, and concept. Other design issues such as characteristics of exhibits (2d or 3d), techniques (historical, Ecological, ... etc), visitors types (ant, fish, Butterfly....etc.).

When setting up an exhibition hall lots of problems evolve related to studying large number of varieties, examine each alternative with its problems, and fulfilling design concepts in arrangements.

An automated setting up method based on

computational tools could be achieved, through merging common digital applications such as cellular automata, Evolutionary, Swarm intelligence and stochastic search.

Through these applications (examined on an application) an automated setting up an exhibition method could be achieve in four steps; general space parameters (based on cellular automata), exhibits arrangements (evolutionary or stochastic search), visitors behaviors, and fine tuning.

REFERENCES

- 1- H.H, B.C, "The New Encyclopedia, Macropaedia", Chicago, volume12, P (657), 1983.
- 2- Lord G., D. and Lord B., "The Manual of Museum Planning", Grown CR, HMSO for publication, London, 1991, p115-116.
- 3- Abd El Rahem, M.M., "Museums and Architecture", Master's Thesis, Faculty of Engineering, Cairo University, 2005.
- 4- Buracw, G.E., "Introduction to Museum work", Altamira press, USA, 1997, p 132.
- 5- Dean, D., "Museum Exhibition – Theory and Practice", Routledge, London and New York, 1994 – 1996, p 53-56.
- 6- Assem, A., "Recognizing the design Ideology of contemporary trends in the museum's architecture, Master thesis, Faculty of engineering, Ain Shams University, Egypt, 2007.
- 7- Antoniou, A. and Lepouras, G., "Adaptation to Visitors' Visiting and Cognitive Style", University of Peloponnese, Department of Computer Science and Technology, p 1-2, 2009.
- 8- Oppermann, R., and Specht, M., "A Context- sensitive Nomadic Information System as an Exhibition Guide", German National Research Center for Information Technology, 2000.
- 9- Sookhanaphibarn, K. and Thawonmas, R., "A Movement Data Analysis and Synthesis Tool for Museum Visitors' Behaviors", Intelligent Computer Entertainment Laboratory, Department of Human and Computer Intelligence, Ritsumeikan University, Japan, p 145, 2009
- 10- Sipser, M., "Introduction to the theory of computation", Second edition, Thomson Course Technology, Massachusetts, USA, 2006, p1-2.
- 11- Gross, D. and Mark, D., "Form Writer – A little programming language for generating three dimensional form algorithmically", CAAD futures, 2001, p 577-578.
- 12- Penna, William and Others, "Problem seeking, an architectural programming primer", AIA press, 1987, p 36.
- 13- Ratti, C., "Space Syntax: some inconsistencies, Environment and Planning B: Planning & Design", 2004.