Rajapaksha.U, et al (eds), 2015, "Making built environments responsive"*: Proceedings of the 8th International Conference of Faculty of Architecture Research Unit (FARU), University of Moratuwa, Sri Lanka,* pp. 357–368. © December 11-12, 2015

SPATIO-VISUAL PATTERNS IN RESPECT TO VISUAL EXPERIENCE: AN EXPLORATION OF ARCHITECTURE OF GEOFFREY BAWA

K.K. MANULA VIMUKTHI[1], and U. RAJAPAKSHA[2]
[1,2]*University of Moratuwa, Sri Lanka*
manu77illusion@gmail.com

Abstract. The spatial qualities enhanced through his architectural approach are often talked of due to the positive emotional responses from those who experience the spaces. It has been said that spatial progression in Bawa's architecture is a distinct feature in which spatial experience is heightened to its best possibility. While such interpretations are apparently accepted, very less quantitative evidence is to be found that confirm the fact Bawa's architecture acquires those qualitative attributes. Thus there is a lack of research evidence to discuss if Bawa's architecture is actually space specific with having different spatio-visual patterns which are unique to each design or he has unconsciously or consciously occupied similar spatio-visual patterns in his architectural approach which is similar in every design yet is not identified. This paper utilizes Isovist analysis and Visibility Graph Analysis to seek scientific evidence to identify existence or non-existence of similarity in spatio visual patterns in Geoffery Bawa's architecture by analyzing selected domestic architecture in Colombo context. This analysis reveals consciously or unconsciously Geoffrey Bawa has maintained a similar design frame in creating visual experience and visual connectivity in his urban house designs.

Keywords. *Isovist Analysis; Vibility Graph Analysis: Geoffery Bawa; Spatio-visual patterns.*

1. Introduction

The ability of enhancing the experience depends on the creator of the space, in other words on the architect whereas the way of feeling the space depends on the person who experience it. Yet, very rarely architects emerge who can address to the soul of the experiencer through the space by evoking emotional feelings with the spatial qualities. Geoffrey Bawa is one such architect who was and still is praised all over the globe for his unique architectural

approach and for his special ability of creating spaces that are memorable. Inspired by vernacular architectural features his spatial arrangement signifies visual axis that enhance connectivity within spaces and the connectivity between inside and outside can be identified to be sensitively achieved (Robson, 2002). His architecture is often taken as examples to demonstrate spatial connectivity and creating eye-catching vistas that append inside and outside. When experiencing the spaces it is felt that Bawa has been sensitive to the site context and his architectural products are place specific and are generated by the context (Robson, 2002).Many literature have been composed in appreciation of the unique spatial and visual experiences created through Bawa's architecture.

The literature on his architecture defines that he has caught the attention of architects, many related professionals and even thousands of people outside the field and his architecture has been studied widely in terms of quality of space theoretically. It is noted that this appeal in the spaces he has created is obtained from the unique way of connecting spaces visually and physically and giving unhindered vistas from one space to capture the essence of the surrounding. Even though it is said that his architecture is inspired by the context and his architecture has a unique\ approach different to one another it is not proven quantitatively. It is not observed quantitatively if his architectural approach in creating spatio-visual patterns and connectivity has been similar or unique from design to design.

The present paper examines three main spaces Living, Dining and courtyard of six selected urban houses in Colombo context of Geoffery Bawa using isovist and visibility graph analysis. Isovists represents the collected spatial range of all views from a single location within a specific place visibility graph is a more scientific and logical explanation of space arrangement and visual experience and it abstracts the environment into a series of polygons representing the space visible from a series of observation locations. The six VGA used for this paper depicts the highest connectivity point of each house while indicating the distribution of the visual connectivity of spaces. The eighteen isovists represents three selected positions of each house. Three mathematical measures are derived for each house in isovist analysis, which are compared using simple statistical methods as a ratio against the floor area of each house to investigate the level of similarity or dissimilarity demonstrated in Bawa's designs. While such a study of Bawa's domestic architecture has never been undertaken before, the paper also attempts to analyze the pattern of connecting interior spaces with exterior views up to a defined limit.

In the coming sections a brief introduction to the relevant aspects of spatial experiences, isovist analysis and visibility graph analysis. Then the research question is outlined. Thereafter the methodology of the research is explained and lastly results are analyzed and discussed.

2. Spatial patterns and Bawa's residential architecture, Isovist and visibility graph analysis

Often literature speaks of Bawa's work in appreciation of aesthetics and spatial experiences. It is always emphasized that Geoffrey Bawa's architecture signifies the spatial progression of a built space with the use of visual connections in between spaces. Links between spaces and the way Geoffrey Bawa creates the visual connection inside the built space can be realized and experienced in real. He has a unique way of giving this visual experience through his architectural practice.

The term "Isovist" denotes to the collected spatial range of all views from a single location within a specific place. It is usually presumed that Isovists are two dimensional and extend all over 360° around a vantage point (Montello, 2007). It is claimed that Isovist analysis reflects the theories of the psychologist J.J.Gibson (1950, 1979) which brings out the necessity of vistas in visually perceiving the environmental layout.

Visibility graph analysis abstracts the environment into a series of polygons representing the space visible from a series of observation locations. The method's origins lie within the work of environmental psychologist James Gibson (1947) where he has proposed that visible space could be represented as a polygon and illustrated the way in which the properties of these polygons changed as the observation location changed position. These polygons were called "Isovists" by Michael Benedict (1979) for the very first time and he developed mathematical measures to describe properties of Isovists. Benedikt explained an Isovist as "**the set of all points visible from a single vantage point in space with respect to an environment**" (Benedict, 1979).

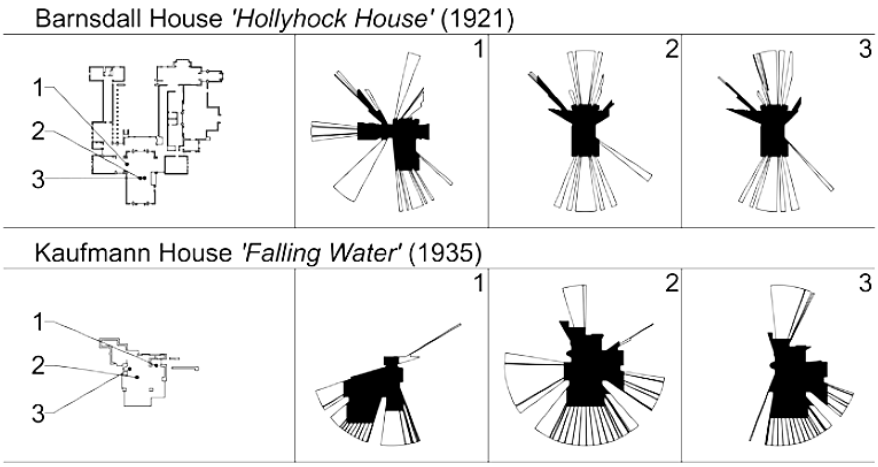


Figure 1: Isovist polygons - 1 threshold, 2 room center, 3 hearth in the living room for two unique house designs by Frank Lloyd Wright

3. Research Question

Geoffrey Bawa's architecture and the spaces created are significant in terms of evoking emotional spatial experiences. When experiencing, it is felt that the quality is unique to the space itself and it holds no resemblance or similarity to any other spaces even created by him. Research question if Geoffrey Bawa has utilized a similar two dimensional approach in connecting and planning spaces in relevance to spatio-visual experience that are different three dimensionally. It is further questioned if there is a similar pattern in creating spatial visual patterns in his architecture to obtain a visual range and visual connectivity.

4. Research Methodology

The houses selected for this study represent urban domestic architecture of Geoffrey Bawa built in Colombo context. The selected houses are Ena de Silva House, Stanley de Saram House, P.C. de Saram House, Dr. Bartholomeusz House, Jayakodi House, Wimal Fernando House. The analysis commences by preparing 2D plans as required for the isovist and visibility graph analysis of the selected houses based on the plan drawings obtained from Geoffrey Bawa trust.

Both floor plan versions are analyzed using UCL DepthmapX with a grid spacing of 250mm and a set of rules is constructed to maintain the accuracy

of the analysis. When conducting VGA depending on the floor area of the plan the grid count can be selected. In this study a single grid's size was kept constant as 250mm x 250mm.

For the VGA, all the doors, windows and openings of the perimeter wall of the house (not the perimeter boundary wall) **were considered as closed**. For the computational analysis, house had to be set on a grid, and all the data were taken according to a grid count. So for this quantitative analysis system, it needs a well-defined, enclosed plan form with a limited grid to measure the data (according to the standards of the specific instrumentation). Internal courtyards were treated as rooms/ as internal spaces. Rear gardens/ External courtyards were considered as valid areas for the VGA only if they were covered/ enclosed with walls higher than 1.4 meters (higher than the human eye level.) at least from three sides and should be connected to the house. Louvered opening were treated as windows (as transparent). Car porches/ garages located apart from the house, separately, were not counted for the VGA as they were useless in visual experience wise.

For the Isovist analysis, all the doors, windows and openings of the perimeter wall of the house (not the perimeter boundary wall) were considered as open as they connect the interior with the exterior. 3m offset outer boundary line was created on plans to limit the visibility range towards outside of the houses (View Limit). Isovist measures the visibility area in a 2D plane at eye level to analyze how the interior is connected with exterior (dispersion of the Isovist polygon), so a view limit is needed to create the Isovist polygon at a considered point of a plan. For the comparison of Isovist fields, 3 main common points were selected for all houses. They are,

- Highest Visual Connectivity point found from previous VGA
- Courtyard Center
- Living Room Center

To compare the Isovist result of each house, the size of the Isovist area cannot be considered because it differs in a high range from house to house due to the size of the area of the specific house. Since the Isovist field cannot be compared for different housed Isovist field was calculated as a ratio against the floor area of each house and the ratio was compared to analyze the results. So a ratio between Isovist field area and original plan area was taken and took it as a percentage.

(1)

Isovist field area / VGA plan area x 100 = percentage value (ratio)

If,
Isovist Area (at highest connectivity point) = 268.3 m2
Original Plan Area = 582.9 m2
268.3 / 582.9 x 100 = 46.02 % (Isovist percentage value)

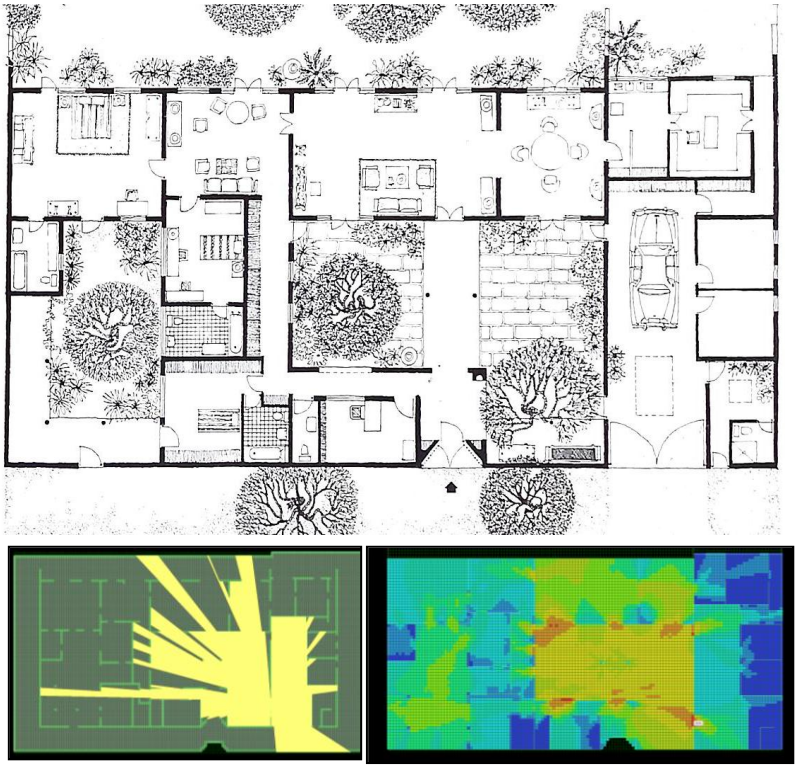


Figure 2: The analysis process

5. Results

Visibility Graph Analysis of selected urban domestic architecture produces results indicating the distribution of connectivity of internal spaces of each house when taken as enclosed entities. The results depict the point where the connectivity is highest as well.

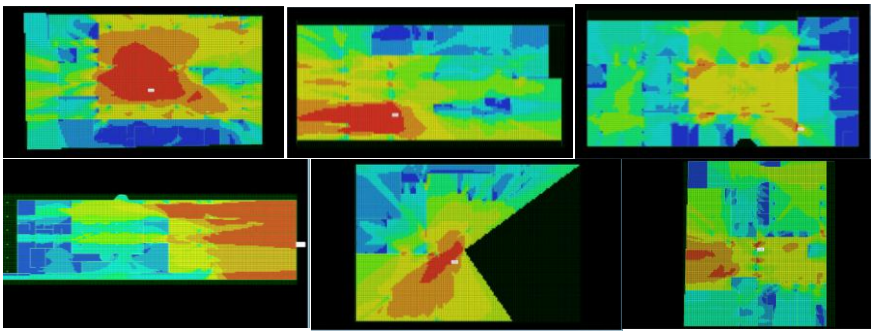
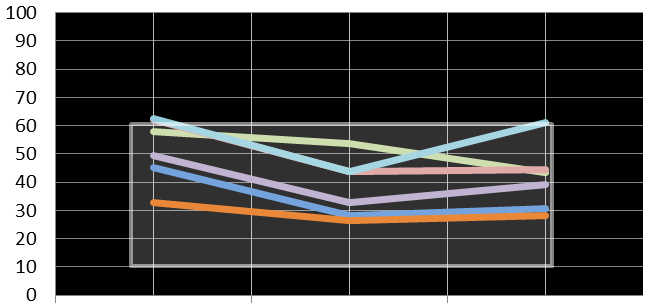


Figure 3: Visibility Graph Analysis results

Table 1: Results summery for VGA

	House	Visual Connectivity Behavior
01.	Ena de Silva House	Highest visual connectivity point is located **adjacent to the center of the main courtyard which is visible to the main entrance door.**
02.	Stanley de Saram House	Highest visual connectivity point is located at the **Entrance point from garage to the center courtyard.**
03.	P.C. de Saram House	Highest visual connectivity point is located at the **Entrance to the Courtyard from the Living Room.**
04.	Dr. Bartholomeusz House	Highest visual connectivity point is located at the **edge of the Rear courtyard, visually covering a large area.**
05.	Jayakodi House	Highest visual connectivity point is located at the **Rear Courtyard in-between the Living and Dining spaces.**
06.	Wimal Fernando House	Highest visual connectivity point is located at **one of the three entrances from Living room to Center courtyard.**

Data for Isovist analysis for all three observation positions indicate the in five of the six cases when the three points are arranged in the descending order according to the visual connectivity there is a similarity in creating visual connection. And the variation of visual connectivity has been maintained within a similar range without reaching higher deviations.



	Highest	Courtyard center	Living room center
Ena de silva	57.88	53.86	43.35
Stanley de Saram	45.27	28.22	30.82
P.C. de Saram	62.35	43.71	44.53
Dr. Bartholomeusz	49.33	32.88	39.32
Jayakodi	62.42	43.77	61
Wimal Fernando	32.62	26.59	28.07

Figure 4: Isovist Analysis results for selected points

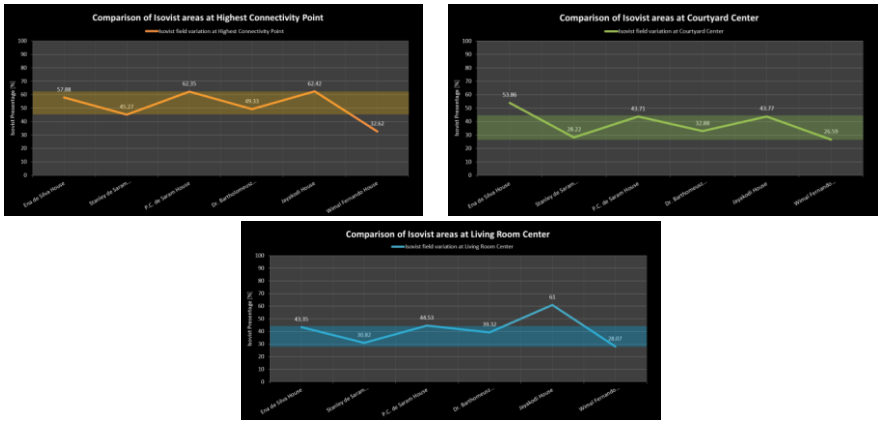


Figure 5: Comparison of Isovist Analysis results for each point of selected cases

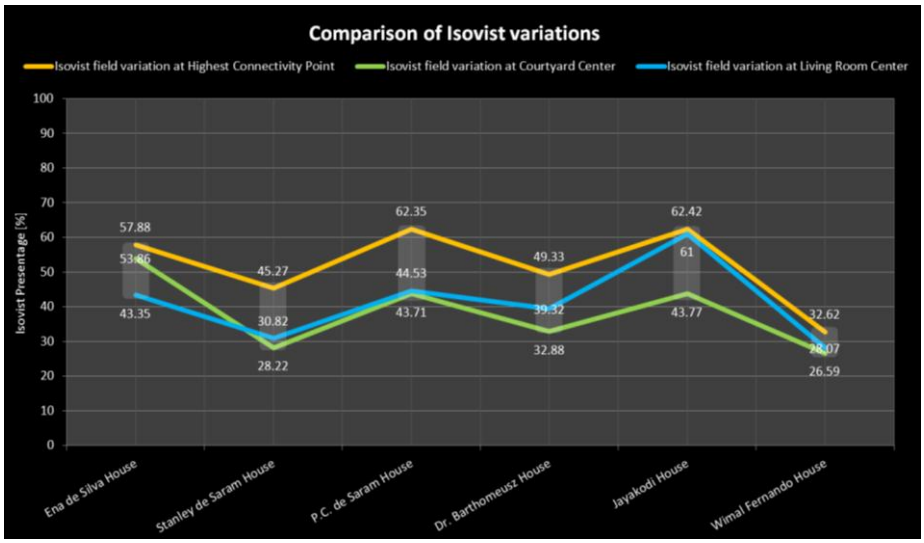


Figure 6: Comparison of Isovist Analysis results for selected points of all cases

6. Conclusion

The results of the analysis cleared the way to identify the characteristics of house designs by Geoffrey Bawa relevance to spatial connectivity and spatial planning when considering the interior spaces. In each case it was clear that highest visible point/ visually connected point were found to be located in a courtyard or at an entrance to the courtyard. Thus it demonstrated that courtyard plays a major role not just as an element but as the main space that connects other spaces. This can be further justified by the radial spreading of the connectivity having the courtyard as the focal point.

Further, highest connectivity point being at an entrance with clear view of courtyard almost in every case indicates that courtyard has made to be the main point of attraction and prominence while common areas such as living spaces have been placed highly connected with the main courtyard. Courtyard of every house seems purely visually active and strongest in visibility. The results of the simulation provide mathematical evidence for this.

Ena de silva house has the strongest visual connectivity rated courtyard out of all the cases. In designing Ena de Silva house the client had requested a traditional courtyard based house with a modern touch which is granted totally through the design while making them not just feature elements but as the binding space of all common spaces. This gives evidence that Geof-

frey Bawa has truly considered visual connectivity of spaces specifically with the courtyard. On the other hand in almost all houses private bed rooms and such spaces and service areas indicated the least connectivity. This denotes that privacy has been a greater consideration in placing rooms whereas service areas have been placed hidden as much as possible.

6.1 Area of Visibility from a Certain Point

In terms of a single house (cases taken separately)

Isovist field taken at the highest connectivity point, center of the living room and the center of the courtyard determined with a decided boundary was calculated against the floor area of each house to obtain a percentage/ a ratio of Isovist field at each point. The resultant percentages were compared against each other to analyze the variation in Isovist fields. Isovist analysis result denotes a contrasting situation than the VGA results. Even though VGA showed a visual prominence in courtyard when the doors and windows of the outer perimeter of the house were closed, when all the openings are concerned as opened, the living room center indicated a higher percentage of interior and exterior connectivity with a larger Isovist polygon.

According to the graphs, all houses taken as cases indicated a similar pattern which showed the Isovist percentage level variation maximum to minimum as, Highest connectivity point > Living room center > Courtyard center (except Ena de Silva house) signifying living room center has more observation capacity with high Isovist field than courtyard center. This can lead to an assumption that though Bawa has made the courtyard as the most visually connected space when considering only the internal planning, he has connected the living room with the exterior giving it more significance in overall planning and higher potential in observation in terms of center point of a space. Since all the houses are planned with living rooms to have higher Isovist field this can be identified to be a similar pattern to create visual experience through spatial orchestration.

6.2 Comparison of All Houses

Isovist field percentages at three selected points of each case were compared with other cases with the purpose of exploring any similarity in between the cases. At highest connectivity point, which is at a courtyard or at the entrance to a courtyard Isovist field percentage of every case shows only a slight variation of 20% (45% - 63%) except the un-built Wimal Fernando house. Isovist percentage at courtyard center has a variation of nearly 18% (26% - 44%) except Ena de Silva house which has the highest connectivity rated courtyard.

At Living room center Isovist percentage of all the case indicate a variation of nearly 17% (28% to 44%) except Jayakodi house which has an odd shaped plot. This variation which is 20%, 18% and 17% in the considered three points respectively highest connectivity point, courtyard center and living room center shows the variation in Isovist field percentage in each case in respect to specific space varies only in a very slight range and the variation range is very similar for all three spaces. And the Isovist ratio of the three considered points varied only within a small range of 20% which was also a similar observation in all houses. This demonstrates that a similarity exists in creating spatio-visual patterns in Geoffrey Bawa's urban domestic architecture in terms of visual connectivity between inside and outside.

7. References

Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A pattern language : towns, buildings, construction.* New York: Oxford University Press.

Benedict, M. (1979). To take hold of space: Isovists and Isovista field. *Environment and Planning*, 47-65.

Bhat, R. (2014). Understanding complexity through pattern languages in biological and man-made architectures. *International Journal of Architectural Research*.

Daswatte, C. (2003). A Tribute to Geffry Bawa. *Explore Sri Lanka*, 10-14.

Davis, L. S., & Michel, L. B. (1979). Computational models of space: Isovist and Isovist fields. *Computer Graphics and Image Processing*, 49-72.

Dawes, M. J., & Ostwald, M. J. (2013). Using Isovist Analyse Prospect-Refuge Theory: An Examination of the Usefulness of Potential Spatio-Visual Measures. *The International Journal of the Constructed Environment*.

Dawes, M. J., & Ostwald, M. J. (2013). Applications of graph theory in architectural analysis: past, present and future research. In A. Cavalcante (Eds.), *Graph Theory* (pp. 1-36). New york: Nova Science Publishers Inc.

Dawes, M. J., & Ostwald, M. J. (2012). Lines of Sight, Paths of Socialization: An Axial Line Analysis of Five Domestic Designs by Richard Neutra. *The International Journal of the Constructed Environment*, 1-28.

Dosen, A. S., Ostwald, M. J., & Dawes, M. J. (2013). Environmental preference and spatio visual geometry. In the Proceedings of the *Cutting Edge: 47th International Conference of the Architectural Science Association*, (pp. 653–662).

Hildebrand, G. (1999). *Origins of Architectural pleasure.* Berkeley: University of California Press.

Keniger, M. (1996). Bawa: Recent Projects 1987-95. *Brisbane: Queensland chapter of the RAIA.*

Montello, D. (2007). The contribution of space syntax to a comprehensive theory of environmental psychology. In Proceedings of the *6th International Space Syntax Symposium.*

Ostwald, M. J., & Dawes, M. (2014). Spatio-Visual Patterns In Architecture, An analysis of living rooms in Frank Lloyd Wright's houses, *Architectural Research through to Practice: 48th Interna-tional Conference of the Architectural Science Association,* The Architectural Science Association & Genova University Press.

Ostwald, M. J., & Dawes, M. (2013). Using Isovist to analyse Architecture: Methodological considerations and new approches. *The international journal of the constructed environment* , 85.

Ostwald, M. (2011). A Justified Plan Graph Analysis of the Early Houses.(1975-1982) of Glenn Murcutt. *Nexus Network Journal*, 737-762.

Robson, D. (2002). *Geoffery Bawa: The Complete Woks.* London: Thames & Hudson Ltd.

Turner, A., Doxa, M., Sullivan, D., & Penn, A. (2001). From Isovists to visibility graphs: a methodology for the analysis of architectural space. *Environment and Planning B: Planning and Design, 28(1)*, 103-121.

Turner, A., & Penn, A. (1999). Making Isovists syntactic: Isovist integration analysis. *Second International Space Syntax Symposium*, (pp. 1-10). Brasilia.

Wiener, J. F. (2005). Isovists as a Means to Predict Spatial Experience and Behavior. *Spatial Cognition IV. Reasoning, Action, Interaction.*, 42-57.

www.geofferybawa.com. (n.d.). Retrieved 2015, from Geoffery Bawa: http://www.geoffreybawa.com/