POST-OCCUPANCY EVALUATION STUDY: OCCUPANT'S PERCEPTION VS. OCCUPANCY SURVEY

Julia Mundo-Hernández, PhD
Universidad de las Américas Puebla, Mexico
Ma. Cristina Valerdi-Nochebuena, PhD
Jorge Sosa-Oliver, MA
Benemérita Universidad Autónoma de Puebla, Mexico

Abstract

This paper presents the results of an assessment of a higher education building located in the city of Puebla in Mexico. The research carried out is a post-occupancy evaluation study of a building built forty years ago but still very heavily used. The building is covered by four concrete shell structures joined together by a translucent dome. A focus group and a questionnaire provided us the views of the building users regarding environmental factors, aesthetics and functionality of the building. People's perceptions have been compared with the results of an occupancy survey, which has shown how people is using the building, peak usage times and space occupancy. Improvements to the building are suggested based on the data obtained. The main aim of this research is to improve the interior environment of the building while learning from it in order to design new good quality and sustainable education buildings.

Keywords: Post-occupancy evaluation, comfort, education building, user's perception

Introduction

People's perception regarding the built environment has been studied for the past thirty years. However, very recently these Post-Occupancy Evaluation (POE) studies have taken a new perspective and a greater importance for designers, developers and clients (Mundo-Hernández, 2008). The reason is the increasing awareness of people towards the preservation of our natural environment, the imperative reduction of fossil fuels as energy sources, the importance of energy efficient design of buildings and users´ comfort. The latter is highly important in order to design for people,

minimising absenteeism, sick building syndrome symptoms and reducing energy consumption by knowing how and when people use certain spaces (Heerwagen, 2000).

This paper presents the results of a POE assessment of an educational building located in the city of Puebla in Mexico. The building is called La Monja Cultural Centre and is part of the Architecture Faculty of the University of Puebla (BUAP). La Monja is covered by four concrete hypar shells joined by a central translucent dome. Due to the particular building´s shape and its history, it is considered an iconic university structure not only for the Faculty of Architecture but also for the whole university campus. It is a place where activities such as lectures, seminars and exhibitions take place. There are also some offices, a computer room and cafe on the ground floor[2]. Due to the shape of the roof the building is commonly known as ´la Monja´ or the ´Nun building´ (Figures 1 to 5).

La Monja was built in 1969, designed by architects Miguel Pavón Rivero and Jorge Belches Landero. It is believed that Felix Candela contributed to the structural design of the building. Even though the construction has suffered several changes in its interior design, it has always been used for educational purposes.

La Monja is a two-storey building. It has been modified in its interior layout several times in order to adapt it to the Faculty´s space needs. In 1969 the Architecture Faculty had 800 enrolled students, while today it has around 2,800 students enrolled in eight different programmes, hence the lack of space is an important issue for the Faculty and space adaptations have been done quickly and without considering a long term plan.


Figure 1 (left) Exterior view of the second floor of La Monja building. Figure 2 (right) Exterior view of one of the concrete shells.

[2] In its origins La Monja Cultural Centre was designed to host architecture and art exhibitions on the ground floor (open plan floor), and lectures or conferences in the four seminar rooms located on the first floor. Each seminar room is covered by one hypar concrete shell.

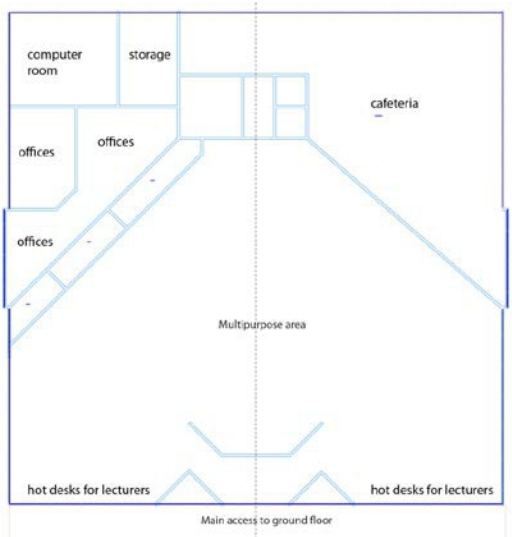

Figure 3 Ground floor plan of the building.

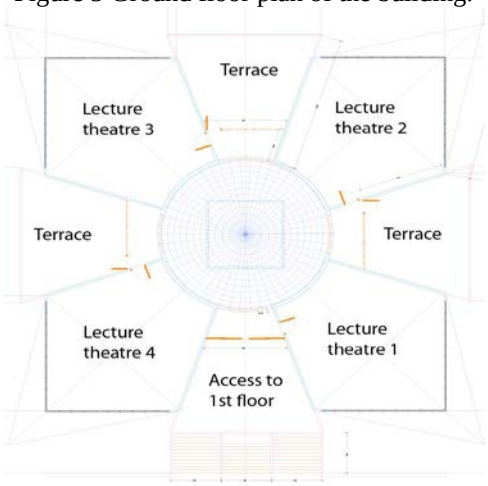

Figure 4 First floor plan of La Monja building.

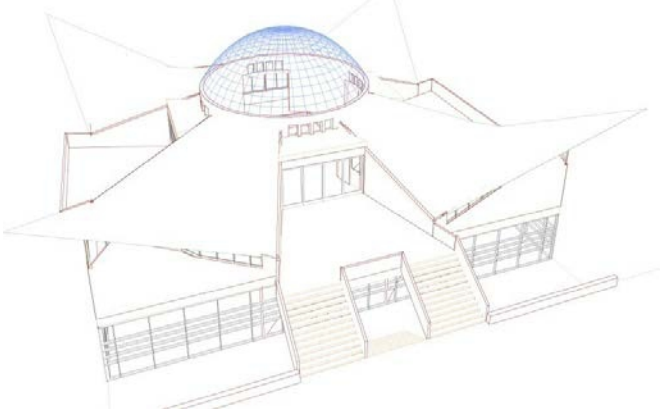

Figure 5 Exterior perspective of the building with the central dome and the concrete shells.

The selection of La Monja as a case study relies on the importance that concrete shell structures have had in Mexico´s contemporary architecture. In addition, the case study was also selected due to the intense use of the building, but also because people constantly complain about its interior environmental performance. The latter is evident when, according to some lecturers, certain activities particularly the ones held on the second floor have to be suspended because the students are very sleepy or distracted. The assessment of this building will help us to identify some building characteristics or usage strategies that are causing occupants' discomfort and excessive energy use.

Methodology

The main objective of this research is to identify environmental factors in the building that restrict their use or make unbearable to perform certain activities in it. Furthermore, it is necessary to determine if there are certain underutilised areas and the reasons for that. This is important since the student population of the Faculty is around 2800 people, there are almost 200 full time academic staff and 32 admin staff; therefore, the Faculty is always short of space. Moreover, economic and environmental consciousness is forcing architects and managers to consider energy efficiency of buildings obtained mainly by a better use of buildings.

A focus group with 12 people, academic staff, admin staff (who particularly work in this building), undergraduate and postgraduate students, was organised. Participants were asked to discuss the issues or characteristics of the building that influence their work when they are in La Monja. Proposals were suggested to improve the environment and functionality of the building and its surroundings. Questions used in the focus group followed a set of categories based on CABE´s Design Quality Indicators: functionality, build quality and impact on its surroundings (CABE, 2008). In addition, a space occupancy survey (SOS) was carried out during five working days in the 2014 Summer Term (July).

The survey consisted on observing every hour (from 7am to 8pm) the use of the building recording the number of people utilising each space and the activity they were performing. Activities included: taking class, working in a group, working with a computer, talking on the phone, talking, having coffee or eating. Occupants' perception recorded during the focus group discussion plus results from a previous users´ survey (Mundo-Hernández, et al, 2014) are compared against the SOS data. Suggestions for improving the building space use and interior environment are included.

Results

Focus Group

It was held in April 2014 during a two-hour session, participants were asked 11 main questions that derived in a vast amount of comments and discussion between all of them. Participants of the focus group included people with different jobs or responsibilities within the Faculty: 6 architecture and graphic design professors, 1 postgraduate student, 2 undergraduate students, the administrative director of the Faculty and 2 admin staff.

People gave their views according to a set of categories based on CABE´s Design Quality Indicators (DQI) developed for post-occupancy evaluation of schools (CABE, 2008). The following is a summary of their opinions.

a. Functionality

- Access: No handicapped access. No emergency exits. Bad signalling outside and inside the building. No service entrance. Staff parking with pavement that allows plant grow, there are some trees. There is non-physical relationship with other Faculties of the University.
- Spaces: Lecture theatres, computer room, hot desks for academic staff, cafeteria, offices, storage area, and 3 terraces.
- Use: Conferences, lectures, seminars, degree examinations. Does not follow its original purpose: exhibition and cultural centre. Interior areas never had specific uses.

b. Build quality

- Structure: One of the finest concrete shell structures in Puebla. The dome is an attractive structure. The central interior translucent pyramid has no purpose. “It´s an untouchable structure”, “it has not been possible to make changes to the structure because no one has been brave enough”. The building has four identical facades that do not respond to orientation.
- Installations and services: No toilets on the first floor. IT installation everywhere in the building.
- Environmental quality: Thermal discomfort: especially in lecture theatres (high temperature). Translucent pyramid absorbs heat and radiates it to interior spaces. Thin concrete shells transmit heat to lecture theatres. Acoustics on the ground floor are bad despite the cork panels.
- Furniture and décor: Uncomfortable furniture does not help to use the spaces in a flexible way. Cork panels used as interior divisions on ground floor.

c. Impact

- In the city and the university campus: La Monja is an iconic building. Represents an important style of Mexican architecture.

- In the Architecture Faculty: Representative building, it is the logo of the Faculty. All important events are held in this building.
- Shape and materials: Unusual and attractive shape, good for acoustics. Ground floor is windowed and first floor is covered by concrete shell roofs and a polycarbonate dome.
- Character and innovation: It has a lot of character but it is not functional.

d. Suggestions to improve the building

1) Include passive systems and eco-technologies.
2) Consider good and bad decisions taken over time.
3) Remove old windows and replace them with double-glazing openable ones.
4) Give users control over their environment.
5) Green roof for thermal control.
6) Use of terraces for cross ventilation and stack effect through central dome.
7) Introduction of natural ventilation in lecture theatres.
8) Landscape design.
9) Rescue former features like the central staircase to improve relationship between two floors and contribute to stack effect.
10) Improve security for exhibitions and art pieces.
11) Planning for future needs. Integral approach for future planning considering comfort as a top priority.
12) Use of air as insulation.
13) Different solutions for each facade according to orientation.
14) Use same colours as in other university buildings to integrate La Monja into the campus.
15) Organise education campaigns to avoid vandalism in the buildings and to promote sustainable actions.
16) Improve maintenance actions.
17) Include a peripheral porch to serve as a thermal cushion, rain protection and to provide outside views.
18) Include support spaces such as storage for cleaning material, vending machines, reading areas.

Overall, participants of the focus group pointed out issues that influence the performance and mood of users of La Monja. Those issues directly correspond to the results and conclusions obtained from a users´ survey carried out during April 2014. The main aim of the survey was to gather information regarding users' perception towards the interior environment of La Monja. A total number of 494 questionnaires were answered by students representing 17% of the total number of enrolled students, while 32 were answered by Faculty staff, which also represents

17% of the total number of academic and non-academic staff (Mundo-Hernández, et al, 2014).

Occupants were asked to give their impressions regarding the interior environment of the building. Most students think it is neutral or bad, while most staff respondents were more critical saying that the environment of La Monja is bad and very bad (Figure 6) (Mundo-Hernández, et al, 2014). One third of the staff stated that the quality of daylight is bad/very bad for the activities they perform in the building. On the other hand, users believe the acoustics of the building is not too bad while others believe it is good/very good. Most of them think the shape of the concrete shells contribute to the quality of the acoustics of La Monja, particularly in the seminar rooms which are located underneath the concrete shells. However, some people reported bad acoustics on the multiple use area on the ground floor, regardless of the cork panels; particularly when it is divided into smaller rooms and all are used at the same time.

Finally, thermal control (temperature) and ventilation are the environmental aspects that were rated by most staff and students as being very bad and bad.

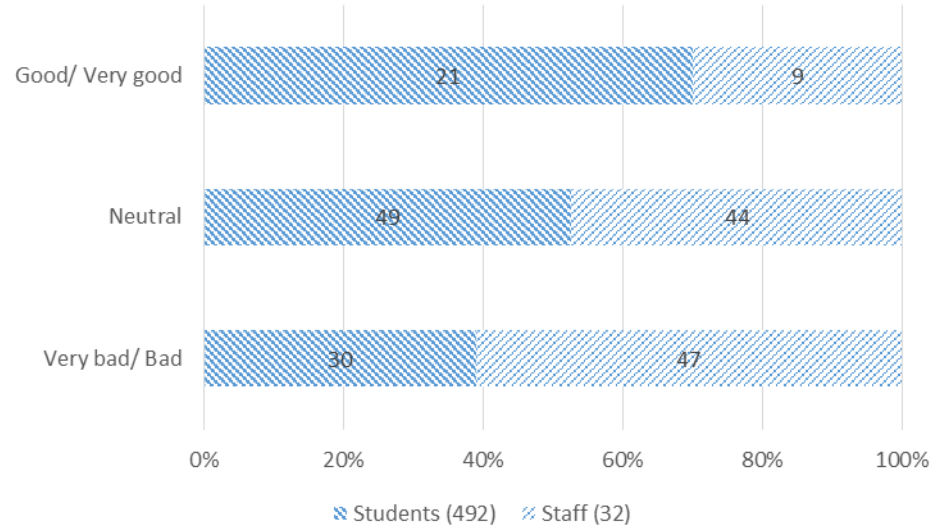

Figure 6. Users' perception of the interior environment
(source: Mundo-Hernández, et al, 2014).

Space Occupancy Survey (SOS)

Results from the SOS showed some interesting considerations that need to be taken into account in order to preserve La Monja in good condition and as an iconic building. This basically means: improving its environmental approach as well as increasing users´ comfort. During the 5 working days of the SOS, observations were made by four people. They

followed two different routes registering every hour the number of people present in each space of the building and the activity they were performing at that moment. Results are presented in the tables below (Tables 1 and 2).

Table 1: Space Occupancy of La Monja Cultural Centre during five working days of the Summer Term (2014 data).

No. of people	**TOTAL**	**HOT DESKS FOR LECTURERS**	**COMPUTER ROOM**	**OTHER AREAS (corridors, halls, waiting area, spare chairs, storage, kitchen)**
TOTAL SPACE CAPACITY	**802**	99	23	60
Total number of visitors (5 days)	**3261**	666	258	558
Average no. people observed/day	**652**	113	52	112
Maximum capacity within 70 observ. (no. of people)	**56140**	6630	1610	4200
% of Occupancy	**6**	110	16	13
% of visitors vs. total no. of staff and students of the Architecture Faculty	**21%**			

Table 2: Space Occupancy of La Monja Cultural Centre during five working days of the Summer Term (2014 data).

No. of people	**TOTAL**	**OFFICES**	**4 LECTURE THEATRES**	**TERRACES (1st floor)**	**CAFETERIA**	**MULTIPURPOSE AREA**
TOTAL SPACE CAPACITY	**802**	16	469	30	95	100
Total number of visitors (5 days)	**3261**	100	1686	17	414	162
Average no. people observed/day	**652**	20	337	3	83	32
Maximum capacity within 70 observ. (no. of people)	**56140**	1120	32830	2100	6650	7000
% of Occupancy	**6**	9	5	1	6	2
% of visitors vs. total no. of staff and students of the Architecture Faculty	**21%**					

From the above tables it is possible to identify the occupancy percentage of the case study building, which is 6%. This figure was obtained considering the total capacity of La Monja (maximum number of people that can use the building at the same time) and the total number of people observed in the building at the same time (average no. of people per hour) during the SOS. This shows a low occupation of the building, even though the total number of people observed during the five days of observation sounds shocking: 3,261 people used the building.

The least utilised areas according to this study are the three terraces located on the first floor (Figures 7 and 8), with only 1% occupancy. These terraces lack of proper exterior furniture, are not integrated into the main hall and corridor of that floor and the main problem is that the doors that communicate the hall with the terraces are most of the time locked. This problem was also raised by the focus group and through the questionnaire,

where people pointed out this as one of the reasons of having bad ventilation on that floor.

Figure 7 (left). Interior view of the door and windows that communicate to one of the terraces.
Figure 8 (right). Exterior view of one terrace, 1st floor of La Monja building.

Moreover, the multipurpose area located on the ground floor (Figure 9) is also under-utilised with only 2% of its capacity. Originally, all the ground floor was a big open plan area for exhibitions. Currently, the floor has been divided to host the cafeteria, office space, storage space and one computer room. A central area with access through the main entrance of La Monja is considered to be a "flexible" space where special events take place, students work exhibitions, seminars and workshops. Furniture can be arranged to suit the event. However, there seems to be too few activities taking place in this area, or the activities that are held there are performed by only a few people. Hence, the space is not utilised to its full capacity.

On the other hand, the area of the building with a highest utilisation rate is the computer room (16%). This room is used by graphic design students. Two main reasons have been identified as causes of this effect: it is the only computer room with Apple computers in the Faculty running special software for the graphic design college, and computer lectures are taught in this room forcing people to use it.

In general, the peak utilisation times of La Monja are between 10am to 5pm. Lecture theatres are mainly occupied from 10am to 2pm, and from 5 to 10 pm. Office areas are occupied from 8 and 9am. The busiest time of the cafeteria is from 12 to 5 pm. Although Summer Term at the University of Puebla is a regular and compulsory term for students, it seemed necessary to carry out a second SOS during the Autumn Term in order to have a wider picture of the use of La Monja building. This study was then repeated during a week of the Autumn Term in 2014. Comparisons of results from both studies are still in process but it is clear that the building needs to be refurbished in a very sensible way considering the interior environmental quality, including: users' comfort, furniture, materials, IT technology. La

Monja must be refurbished according to its place and relevance within the Faculty and other university buildings, and following innovative ways of teaching and learning.

Figure 9. Multipurpose room with movable partitions (ground floor).

Conclusion

This paper is a short version of the POE study carried out in an iconic university building. It is part of the Faculty of Architecture and it is probably the most representative building of the university campus, it clearly shows the architectural style from the sixties when the university campus was built. The building is covered by four thin concrete shell structures.

The building has suffered several interventions mainly due to the rapid growth of the number of enrolled students in the faculty. Once again, La Monja does not meet the minimum requirements of comfort and functionality for a higher education building. And what is more worrying, the building does not meet the needs of the new education system of the University that demands flexible, comfortable, healthy spaces that people could adapt to the needs of each lecture, and where it would be possible for everyone to stay virtually communicated.

This POE study is to be translated into an architectural and organisational proposal for the building. According to some authors (Wood, S. & Worthing, D., 1996; Preiser, W., et al, 1988; Preiser, W., 2005; Preiser, W., & Nasar, J., 2008; Preiser, W., & Vischer, J., 2005) POEs allow us to diagnose the causes of specific building, organisational or individual (e.g. health) problems of building occupants; to inform organisational change and

to improve the future running of the building; to feed into the design process of future similar buildings. POEs also provide insights into the consequences of past design decisions and the resulting building performance. The findings of a POE study are relevant to improve the experiences of building users, but are also relevant to a large number of building design and management decisions.

As a conclusion the following aspects are recommended to be addressed in the refurbishment proposal of the case study building:

1) Lighting, ventilation, thermal and acoustics design according to the local climate and the function of the building;
2) Removal of old air conditioning systems in computer room and lecture theatres;
3) Replacement of old windows for new ones with better thermal and acoustical insulation. Opening of new ones to improve natural ventilation;
4) Furniture and décor need to lift the spirit and be comfortable and modern;
5) Rearrangement of areas going back to its original open plan area on the ground floor but considering the use of: natural light, natural ventilation and outside views;
6) Passive solutions and the use of technology such as Photovoltaic panels to reduce the energy consumption of the building;
7) Organisational change to increase the use of the building;
8) Improve the relationship between La Monja and other faculty buildings, and inside La Monja between areas such as: entrance halls, corridors and terraces;
9) Landscape design using native plants and efficient irrigation systems.

Finally, the refurbishment of the building will set precedent for other university buildings, in terms of converting it into a sustainable building, not demolishing but transforming a beautiful construction with three priorities: users´ comfort, adequate space utilisation and energy efficiency. Future work with this case study includes field measurements of light, temperature, humidity and sound. Furthermore, it is intended to establish a database of higher education buildings in Mexico with information from other POEs.

Acknowledgements

This project has been sponsored by Conacyt and VIEP-BUAP. We would like to thank the Faculty staff and students participating in the Social Service and the Young Researchers Programmes for their support.

References:

Commission for Architecture and the Built Environment (CABE). Assessing secondary school design quality, research report. UK: CABE, 2008.

Heerwagen, Judith. Green buildings, organizational success, and occupant productivity. *Building Research and Information*, 28(5), p. 353-367, 2000.

Mundo-Hernández, Julia. Evaluación post-ocupacional en la arquitectura: definiciones y metodologías. *Pragma espacio y comunicación visual*, 02, p. 23-36, 2008.

Mundo-Hernández, Julia, María C. Valerdi and Jorge Sosa. Occupants' perception of a concrete shell building. In evaluation by the *Engineering and Architecture Journal*, November 2014.

Preiser, Wolfgang. Building performance assessment- from POE to BPE, a personal perspective. *Architectural Science Review*, 48(3), p. 201-204, 2005.

Preiser, Wolfgang, Harvey Rabinowitz and Edward White. Post-Occupancy Evaluation. New York: Van Nostrand Reinhold, 1988.

Preiser, Wolfgang and Jack Nasar. Assessing Building Performance: its Evolution from Post-Occupancy Evaluation, Archnet-IJAR, *International Journal of Architectural Research*, 2(1), p. 84-99, 2008.

Preiser, Wolfgang and Jacqueline Vischer (Ed.) Assessing building performance. USA: Elsevier, 2005.

Wood, Sue and Derek Worthing. The Cutting Edge 1996, Post-occupancy evaluation of higher education buildings: a case study. RICS Research, University of the West of England, 1996.