677: OPEN URBAN SPACES QUALITY: A STUDY IN A HISTORICAL SQUARE IN BATH – UK

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Abstract

The quality of open urban spaces is very important for urban vitality. Nowadays urban designers have to face the great challenge of designing urban spaces able to respond to people's need for liveable spaces. The success of these spaces depends on various aspects and the microclimatic condition has been recognized as one of the most influential. However, studies on thermal comfort in open space have shown that the user's thermal sensation does not depend only on microclimate parameters but also on other local qualitative aspects. Thus, environmental quality evaluation of successful public spaces can contribute to understand this issue. This paper focuses on a case study regarding Queen Square's environmental quality, a public space of historical importance in Bath-UK. The first stage of the research, a study on local characteristics and people observations, allowed a preliminary evaluation of the space performance, their social aspects, while it characterized and quantified the hourly variation of the space use in different days and seasons. In the second stage, short microclimatic surveys were carried out simultaneously with a perception survey through a questionnaire. The results show the strong vitality of the square and socio-environmental significance, not only for its location in the urban context, but also for its historical value. The environmental quality of the square contributes to the users' sensation of comfort even in adverse climatic conditions. This research is part of a project that aims to investigate the impact of the environmental stimuli in the use of open spaces and intend to develop design strategies that aim to maximise the use of open spaces in different weather conditions.

Keywords: open spaces, quality of urban spaces, outdoor thermal comfort.

1. Introduction

The real concern in urban open space quality is its role in improving the environment, quality of life and contribution to social inclusion in urban areas. These issues have stimulated the development of a large body of research aiming to define environmental requirements to be used in the design process of remodelling and development of urban spaces (Nikolopoulou & Lykoudis, 2006; Scudo & Dessi, 2006; Katzschner, 2006; and others). In agreement with Nikolopoulou & Lykoudis (2007) "it has become apparent that the environment conditions, imposed on people using open spaces, may improve or ruin their experience of them".

Good environmental conditions of the open spaces depend on a range of aspects such as microclimate, security, availability of urban equipment and furniture, etc. In relation to microclimate, the quality of open spaces is associated with balance of sunny and shaded areas to allow appropriate use during all seasons. The microclimate characteristics can stimulate the use, the length of visit and the way of occupation of open spaces. In this context "Microclimatic conditions have begun being viewed as integral to the success of an open space, indirectly a critical parameter for the use of theses spaces in the urban environment" (Nikolopoulou & Lykoudis, 2006).

In agreement with Scudo & Dessi (2006) "microclimate mitigation techniques came out of specialized research fields and enter into design practice as a tool give solutions for better comfort or, at lest, to reduce thermal stress". These authors suggest three steps to subside the design process: the first step is to learn from users behaviour through detailed observation of open spaces in different periods of day and in different seasons; the second step is to do a short microclimatic survey though measures of the main variables (air and radiant temperatures, solar radiation, relative humidity, wind velocity) to evaluate the physiological response to environmental stimuli; the third step consists of a

survey about the users' perception of the site, carried out during the microclimate measures.
This paper illustrates a case study, Queen Square, located in the commercial area of Bath, United Kingdom, a world Heritage city. This research analysed the use of this historical public open space in different seasons of the year, aiming to evaluate the influence of the weather conditions and environment stimuli in the uses of this important open space. This research also verifies how the environmental stimuli can influence the users' thermal comfort sensation.
The first stage of this research, developed during summer 2006, used only unobtrusive techniques. Similar field surveys were done in the autumn of the same year and winter of 2007. In the second stage, developed in the autumn period, short microclimatic surveys were employed, with measurements of the main variables (air and globe temperatures, solar radiation, relative humidity, wind speed) and structured interviews with users, to evaluate the physiological response to the environmental stimuli.
This work allowed evaluation of the reasons that make Queen Square a successful place. Is it just the visual impact or other senses also play an important role in experiencing this historic place? Along with Rassmussen's (2003) ideas, for good architecture, the overall experience includes various properties of the built environment, which should be taken into account in the design process.

2. Study area

Queen Square is located in Bath – UK (51°23′N, 2°22′W), which was considered a World Heritage City by UNESCO in 1987. The city possesses well preserved Georgian Architecture - current architectural styles between 1720 and 1840, with approximately 84,000 people and is a regional hub of employment, shopping and entertainment. Bath is located in the SW of the country, approximately 25 km from larger cities and port of Bristol, 160 km west of London. The climate is temperate, but on average is drier and warmer than northern parts of UK. The prevailing winds are south-westerly, from the North Atlantic Current and more than 50% of the days are overcast.

Table 1: Climatic historic data of Bath in the period from 1971 to 2000 (Beechen Cliff School)
Source: UK Met Office (http://www.metoffice.gov.uk). (Accessed in June 2006)

Month	Mean temperature (°C)	Mean rainfall (mm)	Mean sunshine (h)
January	4.5	79.6	1.19
February	4.6	56.4	2.16
March	6.6	64.1	3.74
April	8.4	55.9	4.93
May	11.7	57.0	6.15
June	14.5	56.9	6.12
July	16.9	47.1	6.6
August	16.7	64.6	6.47
September	14.1	76.4	4.73
October	10.8	75.1	2.54
November	7.3	74.1	1.69
December	5.5	91.4	1.13

Bath boasts 119 open public spaces which range from small play areas for children to the large parks maintained by the City Council, including areas of open land within housing estates. According to Bath & North East Somerset Council (1997) it is important that all local residents, including minorities and the elderly, should be able to walk within an open space area easily and safely. It is hoped to increase the number of easily accessible open spaces by arranging for the informal use of school fields. Open space in the City also has an important amenity function and is valued as part of the urban landscape (Bath & North East Somerset Council, 1997).

2.1 The Queen Square

Queen Square (0.4 ha large), located in the central area of Bath, is an integral part of a formal Georgian square along with the surrounding buildings. It was the first undertaking of John Wood in Bath, master builder and architect known as the elder, and the first significant expansion beyond the medieval walls. It began to be built in 1728 and was completed in 1736. "The great innovation of Queen Square is its treatment of a whole side of a square as one palace-like facade. John Wood did on the N side, a composition of seven houses with a central emphasis" (Forsyth, 2003). This treatment is in many ways the most important development of eighteenth-century Bath and is the first successful block of individual houses as a monument in Britain; the E and W sides were conceived like wings enclosing a forecourt…" The S side of the Queen Square is far less palatial than the N.
Fig. 1 shows Queen Square's schematic plan with its natural paths and grassed areas; place to play the *pétanque* game; location of the wood´s benches, trees, stone obelisk in central area and its aerial view. Fig. 2 demonstrates, through pictures taken by the same angle, the shades cast by the buildings and trees in the square. The pictures were taken in sunny days at different time periods (between 10-12h, 12-14h and 14-16h), days and seasons of the year.

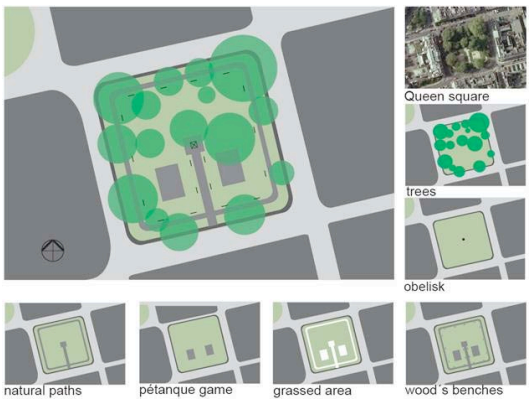

Figure 1. Queen Square's schematic plan
(Source: Adapted from http://maps.live.com accessed in Dec. 2006)

The square, with a single access on the south, has a fence surrounding its perimeter blocking pedestrians from crossing through. According to Forsyth (2003) the architect's original intention was to separate the square from the Ground common to Men and Beasts, an enclosure free from the traffic of daily life. Although, road traffic has been the cause of immense damage to his original scheme and nowadays any appreciation of the site is severely compromised by its function as a roundabout.

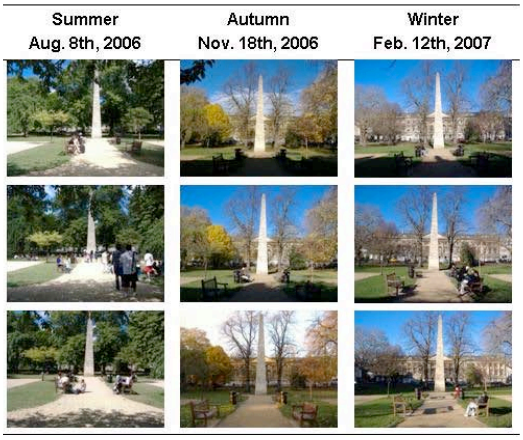

Figure 2. Views of Queen Square at different times of day and seasons (Source: author)

3. Research Framework

The core aim of this research was to analyze the environmental quality of a historic public space. For this, two issues were investigated: the use of the square in different weather conditions and the impact of the environmental stimuli in the kind of use and in the user's thermal comfort sensation. This research was divided into two stages: field observations and short microclimatic surveys carried out with simultaneous structured interviews with users.

3.1 First Stage

In the first stage field observations were carried out in Queen Square, during five days during summer, in different weather conditions and different days of the week, using unobtrusive techniques. Photographic observations, from the same angle were employed, along with field surveys to observe characteristics of the open space and people in their natural environment during different periods of the day: 10:00-11:59, 12:00-13:59, 14:00-15:59, 16:00-17:59 and 18:00 until 20:00h.

These surveys concentrated on form of space use, user's profile (children (<12), young (12-18), adult (>18-64) and elderly (>64)), distinction between different time periods and the relation with number of people in the open public and preference for specific areas within the square. At the same time, meteorological data was being collected from a station located at the University of Bath, about 2 km from the analyzed public space. This was necessary to study the actual use of space at different weather conditions. According to the methodology used by Nikolopoulou & Lykoudis (2006) these data "are independent of the local microclimate and thus more representative of the average conditions in the open space overall".

Similar field observations were carried out during the autumn and winter periods (from 10:00 to 16:00h). The results allowed the characterization of the space use in different seasons. It was also possible to identify the social aspects, based on the analysis developed by Avdelidi (2004) within the EU-funded RUROS Project (Rediscovering the Urban Realm and Open Spaces), along with a preliminary space performance evaluation based on a five items checklist. The checklist is based on structured interview using six questions (based on yes/no answers, graded on a 10 score scale), following Scudo and Dessi methodology (2006).

3.2 Second Stage

In the second stage, developed during autumn, short microclimatic surveys were carried out during 3 days, measures of the core variables were performed (air and radiant temperatures, solar radiation, relative humidity, wind velocity). The microclimatic surveys were done using the portable meteorological station (Fig. 3) using the followings instrumentals: piranometer with silicon cell (from Skye instrumentals Ltd); omni-directional hot-wire anemometer (from TSI incorporated); Hygroclip – Sensor Rotronic of temperature and humidity and data loggers Squirrel (from Grant Instruments); grey globe thermometer (with metal oxide sensor and ping pong ball).

Figure 3. Views of the portable meteorological station

According to Nikolopoulou and Lykoudis (2006) "the grey globe thermometer is considered more appropriate for comfort studies outdoors as opposed to the customary black colored globe thermometer. A black thermometer without correction assumes that all people in the sun are black wearing black clothing, therefore overestimating the MRT in these conditions".

Intending to find the physiological response to the environmental stimuli, users questionnaires (adapted from Nikolopoulou, 2004) were applied simultaneously with data monitoring. Forty-eight users were randomly selected among the square's visitors and asked to answer questions about demographic variables such as age, gender, occupation and residential address. The following questions were answered as well: What is thermal comfort sensation and satisfaction?; Why do you visit the square?; How often do you use the space?; Is there something that you don't like in the area?; What do you like more in this

area?. Data related to the activity being performed by the interviewee, type of clothing being worn, length of the interview (from 4-6 minutes) and user location was also recorded. For questions about Thermal Comfort Sensation (Actual sensations Votes – ASV), the interviewees reported their thermal sensation and judgment value, on a 5-point scale, varying from "very cold" (-2) to "very hot" (+2) (Nikolopoulou et al., 2001).

These data also allowed a comparison between the Actual Sensation Votes with the calculated thermal comfort using the PMV (Predicted Mean Vote), for each interviewee. The PMV was elaborated using "*Conforto 2.02*" software developed by Ruas (2002).

4. Results and analyses

4.1 Queen Square Social Aspects

The Queen Square social analysis aimed to look at all aspects of the open space and its social impact level. This followed the steps suggested by Avedelidi (2006). 1. Record the urban significance of the open space; 2. Record its community significance; 3. Record the actual uses and 4. Record its actual categories of users.

Queen Square has great urban significance, due to its historic importance and its location in the urban centre. The square is used especially by adults and young people for spontaneous activities. During summer the main activities are: to sit free (bench and ground); to meet friends; to gaze at landscape; to take pictures; to have a snack (during lunch time); to read; to take a walk or play with children and to have picnics. Organized collective activities were also observed like pétanque game, at the weekends, and continental market during bank holiday. In other periods analyzed (autumn and winter) these activities were limited due to the weather conditions.

In Fig. 4, it is possible to observe the number of users at the Square during the five summer days, when the surveys were carried out. The graphs reveal that the space is not used much before 12 pm and after 6 pm. The most intense use is between 12 pm and 2 pm, lunch-time. During this period the square functions as a food court. As the square is located in a central area, where people need a space to relax during lunch-time, the intense use during that period is understandable. The historic importance of the site is another attraction even during week days, as illustrated by the data collected on Wednesday 9th August, 2006 (Fig. 4b). Scheduled activities (continental market) also increase the space use (Fig. 4c).

A summary of the mean meteorological data (air temperature and wind speed) for the summer period is presented in Table 2. The field observations were done in weekends and week days with typical weather characteristics of the summer periods: sunny days; partial cloud or overcast days. No days with rain were taken into account. Only on 31st August, there was a short period of rain during the afternoon period.

The user profile included 67,7% males 60,4%, employed, whereas the age distribution was 16,7% in 18-24, 29,2% in 25-34, 25% in 35-44 and 8,3% in 45-54. Elderly (≥65) and teenagers account for 6,3% of the square's population. Regarding having company to go to the square, 56,3% of the users were alone; 29,2% were accompanied by one person and 14,6% by two or more people. As a general trend, the users go to the square to relax and have lunch. In most cases they look for benches independent of whether in sun or shade and as there are not enough benches in the sun, even in cold days 63,2% of the interviewees were sitting in shade.

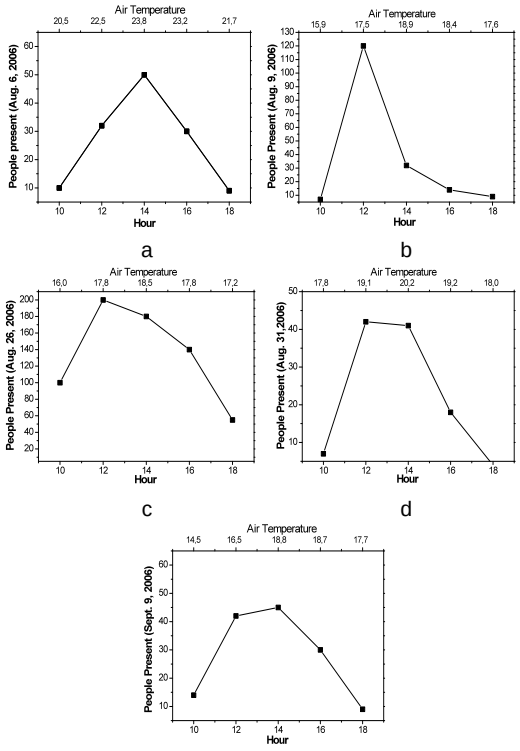

Figure 4. – Graphics of users/hour of the day during summer field research

Table 2: A summary of climatic data (air temperature and wind speed) for the summer period

	Summer Temp. air (Cº) and Wind spped (m/s)				
Days	**06/08**	**09/08**	**26/08**	**31/08**	**08/09**
Hour	Sund. Sun	Wed. Sun and cloudy	Sat. Partial cloudy	Thursd. Over-cast	Frid. Sun
10-11:59	20.5 3.1	15.9 2.6	16.0 2.9	17.8 5.9	14.5 5.9
12-13:59	22.5 3.4	17.5 2.9	17.8 3.6	19.1 4.7	16.5 5.4
14-15:59	23.8 3.5	18.9 3.2	18.5 4.6	20.2 4.8	18.0 5.0
16-17:59	23.2 4.9	18.4 3.7	17.8 4.2	19.2 4.6	18.7 5.3
18-20:00	21.7 5.0	17.6 3.7	17.2 3.8	18.0 2.1	17.7 2.1

Table 3 shows the intensity of space use in different seasons. It is apparent that between 12:00 and 14:00 the use of the space is more

intense, especially during summer, when the length of visit in external areas is higher due to the favourable climatic conditions.
During summer, all spaces are used (bench and ground). During autumn, due to drizzle the grass is wet, thus avoided as a sitting spot. In this case the sitting space is limited to the benches, located along the paths. During winter, especially on the coldest days only the benches close to the entrance are used, and a few people come just for a walk. These data confirm the influence of the weather on the public space use.

Table 3: Intensity of use in different seasons

Seasons Hour	Summer	Autumn	winter
10-11:59	Little	Insignificant	Insignificant
12-13:59	Intensive	Little	Little
14-15:59	Great	Little	Little
16-17:59	Regular	-	-
18-19:59	Little	-	-

Note: very intensive (above 150 people) / intensive (from 81 until 150) / great (from 51 until 80) / regular (from 26 until 50) / little (from 10 until 25) / insignificant (from 0 until 9)

50% of the interviewees stated going to the Square only once a year, 18.8% monthly and 29,2% weekly. Only 2% visit the square on a daily basis, of which 64,6% are Bath inhabitants. It is necessary to highlight that the users were randomly chosen to be interviewed with the only criterion related to their length of stay in the site - at least 10 minutes. For that, tourists accompanied by guides were not approached, as their time spent in the square usually did not exceed 9 minutes.

4.2 Preliminary performance

A preliminary performance approach of Queen Square was done based on the 10 score scale attributed to the items of circulation, activities, microclimate, existence of niches and adequate quantity and quality of seats. The highest performance of the Queen Square was achieved on microclimate aspects. This aspect reached 6,7 points while other aspects achieved 5,0 points (each). In relation to microclimate, the presence of mature trees in this open space provide a good balance between sunny and shaded areas, as well as the correct seasonal use of deciduous vegetation allowing appropriate use during all seasons; the correct use of material in relation to thermal and visual performance and their physical spaces permit penetration of the wind during summer. The buildings around the place function as barriers to the wind during autumn and winter, making the area more comfortable.
Two aspects also contributing to the quality of the square are its good maintenance and security. On the other hand issues that can deteriorate the space quality include surrounding traffic; lack of seating arrangement for groups; lack of privative space; natural paths inaccessible to disable people.

4.3 Impact of environment stimuli on the uses and user thermal comfort sensation

As a way to identify the core reasons for the users' presence in the area, the researchers asked the interviewees why they go to the square and for the most appreciated characteristics of the site. The main reasons for using the site were 'rest/relax' (35,4%), followed by 'to have lunch' (18,8%), 'go for a walk with kids' (18,8%), 'meet friends' (16,7%) and other uses (10,3 %). On the topic of the most important characteristics 39,6% of the interviewees stated more than one aspect: existence of trees and the physical space of the square, or; trees and location of the square, or; trees and neighbourhood architecture. 35,4% stated only the existence of trees, and 25%, stated only one aspect such as: location, architecture, obelisk, or quietness of the site.
As could be observed the urban green is fundamental for the satisfaction of the public open space. The location of the square close to the city centre is another key factor that attracts users, as people come to the square to relax during lunch hour or to take a break from work, shopping or sightseeing. The Square has also another important social function, as a meeting point and food-court. All these aspects highlight the importance of public spaces in central areas, especially in touristic towns such as Bath.
It should be noted that in the autumn, the first day of the microclimatic monitoring the trees still had leaves that were shown in a variety of colours, influencing the users' perception. Another important factor is that during autumn and winter, it is possible to have a nice view of the surrounding architecture that is no longer covered by the tree leaves.
The comparison between Actual Thermal Comfort data (obtained through questionnaires) and simulated data (calculated using the Predicted Mean Vote methodology) resulted in large difference of results as demonstrated by Tables 4-6. These results compare with those of other previous studies already mentioned.

Table 4: Comparison between Actual Thermal Comfort and Calculated Thermal Comfort (Nov. 12, 2006)

Thermal Comfort in the Queen Square November 12, 2006 (Tm = 13,5 ºC HR=72,7% W = 0,9 m/s, SRm= 59 W/m^2)			
PMV	**Unsatisfied people (%)**	**ASV**	**Thermal satisfaction**
**	100	cool	comfortable
**	100	cool	comfortable
**	100	cool	comfortable
-0,15	5	cool	comfortable
-2,13	100	cool	uncomfortable
**	100	warm	comfortable
-0,42	8	cool	comfortable
**	100	warm	comfortable
-1,96	75	Neither cool nor warm	comfortable
**	100	Very cold	comfortable
**	100	cool	comfortable
**	100	cool	comfortable

**	100	warm	comfortable
-2,84	98	Neither cool nor warm	comfortable
**	100	cool	comfortable
**	100	cool	comfortable
**	100	cool	comfortable
**	100	cool	comfortable
**	100	cool	comfortable

** extreme conditions

Table 5: Comparison between Actual thermal comfort and calculated Thermal Comfort (Nov. 18, 2006)

Thermal Comfort in the Queen Square November 18, 2006 (Tm = 10,1 ºC HR=59% W =1,0 m/s , SRm = 117,3 W/m^2)			
PMV	**Unsatisfied people (%)**	**ASV**	**Thermal satisfaction**
-1,76	65	Neither cool nor warm	comfortable
-0,83	19	cool	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	warm	comfortable
**	100	Very cold	comfortable
**	100	cool	uncomfortable
**	100	warm	uncomfortable
**	100	warm	comfortable
**	100	cool	comfortable
**	100	warm	comfortable
-1,87	70	cool	comfortable

Table 6: Comparison between Actual Thermal Comfort and Calculated Thermal Comfort (Dec. 2, 2006)

Thermal Comfort in the Queen Square December 2, 2006 (Tm = 11,6 ºC ºC HR=66%% W =1,3 m/s, SRm = 65,4 W/m^2)			
PMV	**Unsatisfied people (%)**	**ASV**	**Thermal satisfaction**
**	100	cool	comfortable
-0,82	19	cool	comfortable
**	100	Neither cool nor warm	comfortable
**	100	cool	comfortable
**	100	Neither cool nor warm	comfortable
**	100	cool	comfortable
**	100	cool	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Neither cool nor warm	comfortable
**	100	Very cold	comfortable
**	100	warm	comfortable
-1,51	51	cool	comfortable
**	100	cool	comfortable

** extreme conditions

Even when submitted to very cold conditions most users declare feeling only cool or Neither cool nor warm. A difference between thermal sensation and thermal satisfaction was clearly verified. Part of the square's users that declared cold thermal sensation also said that they did feel comfortable (thermal satisfaction). Based on these results, it is possible to conclude that thermal satisfaction depends not only on the thermal sensation, but also on the site's environmental qualities.

5. Conclusion

The findings revealed that Queen Square possesses a memorable urban vitality, mostly related to its historic and aesthetic importance. Other factors such as location, existence of trees, security, furniture such as benches, etc, favour the appreciation of the space by city inhabitants. Eventhough climatic factors are crucial to determine the intensity of open public space use, the specific microclimate of each site, along with other qualitative aspects, influence the way visitors use the space, their length of visit, and most importantly influences their thermal satisfaction and sensation. Such aspects constitute the environmental stimuli and must be taken into account in the design process of old or new public spaces aiming to maximize its use, under different weather conditions.

6. Acknowledgements

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