Pieter le Roux & Wilandi Esterhuysen

Revitalisation of a historic building through performance evaluative research into workplace environmental conditions

Peer reviewed

Abstract

Following the centennial celebrations of the University of the Free State in 2004, the need was identified to initiate a program according to which the image and future development of the university as a whole could be assessed. This included optimising the use of existing physical resources and prioritising on proposed new development. As part of this program, the historic Main Building was identified for revitalisation through an adaptive reuse program into office space for the executive management of the university. Completed in July 2005, the refurbished facility now provides an updated approach to the concept of workplace by providing a mix of private and open plan offices.

In an attempt to introduce the concept of performance evaluative research in workplace environments to students of architecture at the University of the Free State, the revitalised Main Building workplace environment was regarded as a suitable example. Performance evaluative research in workplace environments is a form of evidence-based research which aims to assess the functionality and serviceability levels of a specific facility on the basis of its ability to support and facilitate diverse work styles, as well as the user-needs and -requirements associated with it. The evaluation process was conducted according to the principles of an Investigative-level Post-Occupancy Evaluation (POE) study, and aimed to assess the impact of stimuli from the workplace environment on the ability of users to optimally perform and accomplish work-related tasks.

The methodology according to which information for this POE study was collected consisted of various surveys. This included an activity survey, an activity duration survey, a communication survey, and a movement survey. The POE study lasted one working day, with the various mapping surveys undertaken simultaneously in 15-minute periods with 5-minute rest and preparation intervals between them. Data collected in this manner thus provides a comprehensive view of all aspects pertaining to work performance and accomplishment in the specific office environment. The survey also included questionnaires distributed to all occupants of the workplace with a return rate of 86%.

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Conclusions drawn from results of this study have indicated the response of users to the new workplace environment in terms of their perception of the impact of the overall work environment on their ability to concentrate and perform work-related tasks. In this regard problems related to limited or inconvenient access to office resources and problems related to poor thermal comfort (specifically with regards to the penetration of direct sunlight and lack of control over air-conditioning) occurred with a similar frequency (N = 48; f = 0.15). Results of this study will:

- serve as feedback for the continued alignment of the University's physical resources with its dynamic resource management strategy —; and

- contribute to a database on work performance characteristics in South Africa.

Keywords: Building Performance Evaluation (BPE), Post-Occupancy Evaluation (POE), Facility Management (FM), revitalisation, functionality, serviceability

1.   Introduction

Research findings presented in this article are indicative of the workplace environmental quality in the newly refurbished office space in the historic Main Building on the campus of the University of the Free Sate (UFS) for members of its Executive Management. The Main Building (Figure 1) is the oldest building on campus (built circa 1907) and is situated in the geographic centre of the campus (Figure 2).

Figure 1:   The historic Main Building on the campus of the University of the Free State
            Source: (photo by author)

Figure 2:   Layout of the core area on campus indicating the locations of the Main Building and the George du Toit Administration Building
            Source: (graphics by author).

The decision to relocate members of the Executive Management from the current George du Toit Administration Building to the Main Building aimed to bring together considerations regarding the adaptive reuse of existing physical resources on campus — a topic which was previously discussed at length by the author at the 2005 SAFMA (South African Facilities Management Conference) under the title Towards the improvement and optimisation of facilities on the campus of the University of the Free State (SAFMA, 2005).

Although matters pertaining to the Facilities Management (FM) policy of the UFS fall outside the parameters of this article, it must be emphasised that the revitalisation of the Main Building into executive office space form part of a wider strategy of overall resource optimisation. The process of transformation through adaptive reuse from class rooms to executive office space as illustrated in Figures 3 to 5 are by no means an isolated effort. It forms part of an all-encompassing strategy which deals with campus FM on various levels — ranging from administration and lecture facilities to pedestrian circulation routes and overall traffic management.
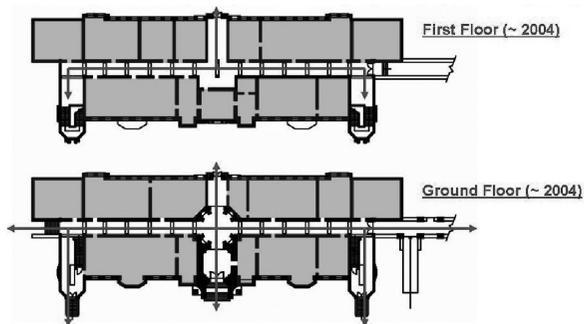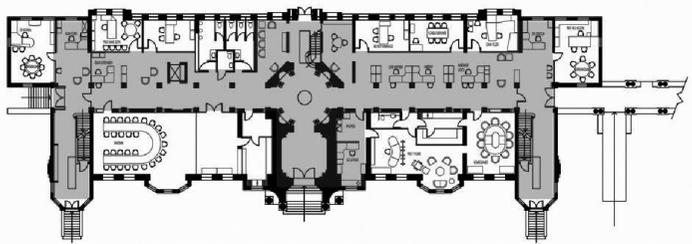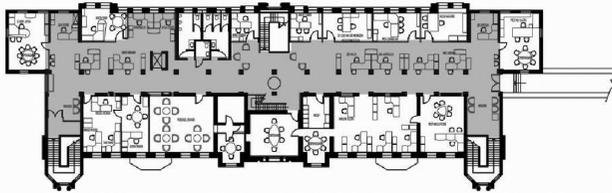

Figure 3:   Ground and first floor plans of the Main Building prior to the commencement of refurbishment
Source: (graphics by author).

Main Building: Refurbished Ground Floor (2005 ~)

Figure 4:   Refurbished ground floor plan of the Main Building. The shaded areas indicate the open plan work office area which was the focus of this study Source: (graphics by author).

Main Building: Refurbished First Floor (2005 ~)

Figure 5:   Refurbished first floor plan of the Main Building. The shaded areas indicate the open plan work office area which was the focus of this study Source: (graphics by author)

2.   Research objectives

As was stated in Le Roux & Kato (2004) employee satisfaction in the workplace environment can be interpreted from the perspective of Marans & Spreckelmayer (1982 cited Boubekeri *et al.*, 1991) who identify 4 factors to impact on the level of employee satisfaction. These factors are:

•   the specific organisational context;

•   job type and the characteristics of individual employees;

•   the nature of the workplace environmental attributes (spatial quality, colour, light, air quality, *etc*.);

- the quality of the overall work environment as per the individual employee's qualitative assessment thereof.

Given the executive nature of the specific environment in which this study was undertaken, two of the aforementioned factors are reflected in the primary objectives of this study. These are to determine:

- the level of overall environmental satisfaction with the new workplace layout as perceived by employees; and

- patterns of use and adaptation to the new open plan office environment.

A secondary objective of the study was to introduce students of architecture to the concept of Building Performance Evaluation (BPE) through Post-Occupancy Evaluation (POE) (Le Roux, 2006). Since these concepts are usually not intrinsic to the teaching of architectural design, the study was further aimed at providing an opportunity of illustrating the potential benefits of the awareness of these concepts during the conceptualisation of new design proposals in the design studio.

Although the collection of data and its contribution to workplace environmental conditions in the South African context remain the primary goal of this study, this initial exposure to concepts of BPE is indicative of how studies related to the reciprocal relationships between people and the built environment — generally referred to as person-environment studies — can be adopted into the teaching curricula of architectural design and other related subjects.

3.   Research methodology

The research methodology for the BPE study of the refurbished Main Building workplace environment was structured according to the various stages of building performance evaluation through POE as per Preiser *et al.* (1988). Accordingly, stage one — Indicative-level POE — was used to undertake a walkthrough of the office environment. This step ensures members of the research team have the opportunity to familiarise themselves with the specific environment, determine the accuracy of layout drawings received prior to the walkthrough, and identify possible problem areas that should receive special attention during the actual survey (stage 2).

Following the Indicative-level POE, a more in-depth survey was undertaken to determine aspects of workplace environmental quality. This stage is referred to as an Investigative-level POE and

consists of various approaches aimed at obtaining information regarding aspects of workplace environmental quality such as workplace and workspace layout, workspace spaciousness, movement, filing, storage, and support facilities. During the one-day survey of the open plan office, data was collected with regards to the range of activities performed by employees, the duration of the various activities, and the extent and location of work-related movement and communication. This specific research methodology is consistent with that developed and discussed by the author and collaborative researchers in Kato *et al*. (2005).

In addition to the various mapping surveys, a questionnaire survey was distributed to all employees as a means of comparing perceived and actual or observed work performance characteristics. The questionnaire aimed to elicit employee-perceptions related to:

•	their level of job satisfaction;

•	the nature and extent or duration of their activities in the office;

•	the extent and location of work-related movement and communication; and

•	the overall level of satisfaction with the environmental quality of the new open plan office layout.

Questionnaires were distributed to all employees present in the office. With the consideration of employees who were not in the office during the survey, a return rate of 86.05% was achieved (37 out of 43 questionnaires distributed).

Observations made during the initial Investigative-level POE resulted in the formulation of various hypotheses regarding the impact of the new open plan workplace environment on the work performance of employee. It was hypothesised that there would be:

•	a greater sense of satisfaction among employees who value the performance enhancing aspects of the new office environment;

•	a higher level of cross-functional and cross-departmental awareness, communication, and collaboration;

•	increased movement between the various departments to facilitate the increased levels of cross-functional and cross-departmental activities; and

•	more opportunities for employees to express and act according to individual work styles.

4.   Sample characterisation

The surveyed workplace environment is located on the basement, ground, and first floors of the historic Main Building. The building served as lecturing facilities prior to it being identified as suitable for refurbishment into executive office space (Figure 3). The new workplace environment accommodates a total of 43 employees (Table 1) who belong to 12 different departments as detailed in Table 2. From a total of 47 workspace settings (of which 4 is vacant) the workspace utilisation ratio — the relationship between the number of workspace settings provided and the number of employees accommodated — for the overall office was 91.50%. Individual workspaces are provided in both open plan and enclosed layouts. From a total of 47 workspace settings, 19 (40.4%) are enclosed offices, 23 (48.9%) are open plan offices, and the remaining 5 (11.1%) settings are located in the basement work area as part of Department M: Meeting Administration and Language Services (Table 2).

Since only the ground and first floor layouts provided a layout diversity of both enclosed and open plan workspace settings, the basement layout was not included in the initial mapping survey. Overall, these ground and first floors allow for a total of 1,390.50 m2 useable office space. Of this area, 47.06% of the floor area (654.33 m2) is dedicated to 11 departments, 30.93% (430.04 m2) to primary circulation space, and 20.01% (280.65 m2) to meeting and support spaces (kitchens, copy rooms, etc.) as illustrated in Table 3.3. The average depth of floor (when measured from the inside of the perimeter wall to the centre of the primary circulation route) for the largest part of the office was measured at approximately 7,730 mm. Accordingly, the interior spatial quality of the building is categorised as a shallow-depth space, and illustrates the ability of the building to afford all employees direct visual access to the outside.

Table 1:   Accommodation of staff compliment in open plan and enclosed offices

Overall number of individual workspace settings in the open plan layout:	Total number of enclosed offices assigned to individual employees:	Total number of occupied workspace settings
25	18	43

Interior finishes, as well as furniture in both the enclosed and open plan offices are of a high standard and reflect the executive status of the work environment. Opaque glazing and doors with wooden frames were used together with partitions to separate the enclosed workspaces from those in the open plan office area. Although the architect had originally intended to allow for visual contact between employees in enclosed and open plan offices by means of transparent glazing — and thereby contribute to the improvement of the level of cross-functional awareness and transparency — employees strongly opposed this idea due to their perception that it would contribute to their lack of privacy. Subsequently, the different workspaces in the work environment are less integrated than what would have been the affect had transparent glazing been used (see Figure 6c). As a result of this, employees are perhaps less aware of the functional nature diverse work styles and job descriptions in the workplace environment.

In terms of workspace spaciousness, the average individual workspace surface in the open plan office area measured 2.15 m2 per setting (see Table 3b). Measurement of workspace spaciousness is a useful factor to relate possible complaints regarding too little workspace to, and as such forms part of the survey of the existing environment.

Lighting conditions in the workplace also received attention in terms of energy efficiency and aesthetic appearance. The selected light fittings as illustrated in Figure 6b allow for a sufficient level of light on work surfaces (according to employees' responses to related questions in the questionnaire). Together with natural light from windows and the relatively shallow depth of the space the overall lighting environment was deemed satisfactory as no specific complaints were received to the contrary.

Although employees in the basement offices were included in the questionnaire survey, the actual mappings were limited to the office areas on the ground and first floors (compare with Fig. 7 for the location of each department within the new office environment).

Table 2:   Departmental classification and the respective staff
             compliment

Department	No. of settings provided
Ground floor:	
A: Office of the Vice-Rector (Student Affairs):	2
B: Office of the Registrar (General Affairs):	3 (1 vacant)
C: Office for Diversity:	2 (1 vacant)
D: Office of the Director (Physical Resources & Special Projects):	3
E: Office of the Chief Director (Operations):	2
F: Office of the Rector:	3
First floor:	
G: Community Service:	4
H: Strategic Communication:	8 (1 vacant)
J: Planning Unit:	11
K: Office of the Vice-Rector (Academic Planning):	2
L: Office of the Vice-Rector (Academic Operations):	2
Basement: M: Meeting Administration & Language Services:	5 (1 vacant)
Total:	47 (4 vacant)

a). Primary circulation route

b). General open plan office

c). Glass partitions separating enclosed and open plan offices

d). Average individual workspace in the open plan office

Figure 6:   Photographic survey of the interior
              Source: (photos by author)

Table 3: Dimensions of individual workspace settings

| a). Individual workspaces in enclosed offices (3.13 m2) | b). Individual workspaces in the open plan area (2.15 m2) |
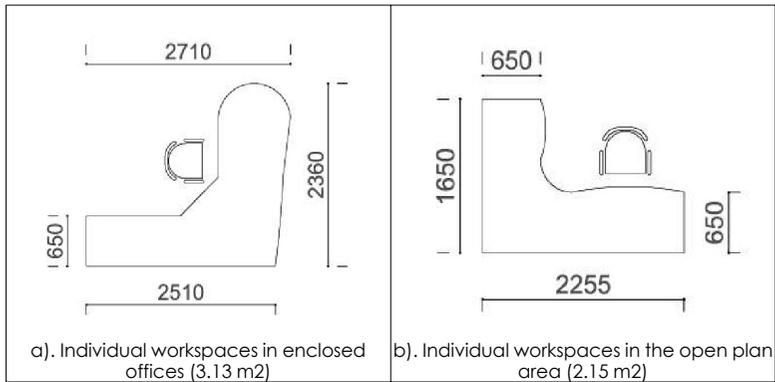
5. Research results

Results of the research activities in the Main Building workplace environment were obtained through various mapping procedures as previously discussed. The data as discussed here serve as an indication of the workplace environmental quality within six months of occupation of the new workplace environment.

5.1 Questionnaire analysis

As was discussed by Kato *et al*. (2005: 149-159) the mapping procedures depend primarily on observations by the research team regarding the workplace environment and the work performance behaviour of employees. Since these observations are entirely based on what members of the research team observe themselves, there is a concern regarding the objectivity with which data is recorded. In order to address this specific concern, a questionnaire survey forms part of the data collecting process. Questionnaires are distributed to all employees in the office and provide an opportunity to employees to give feedback pertaining their perceptions of workplace environmental quality, facility functionality (diversity in terms of user-requirements), and facility serviceability (the extent to which the facility accommodates diverse user-requirements).

The responses employees gave to the questionnaire provided an indication of their level of satisfaction with the new workplace layout and the resulting environmental conditions. All responses received were subjected to a screening process during which their validity

were assessed and where necessary, disqualified for not bearing directly on matters related to the workplace environmental quality. From a total of 73 responses 6 (8.22%) were disqualified due to respondents following incorrect or inappropriate procedures in answering the questionnaire. Following the screening process, a total of 67 (91.78%) comments pertaining to perceived performance inhibiting aspects of the workplace environment were identified and categorised as per Table 4. Accordingly, the most frequently perceived performance inhibiting categories were:

- problems related to insufficient storage and filing space (n = 13; f = 0.19);

- distractions due to background noise (n = 8; f = 0.12), as well as problems related to poor thermal comfort (n = 8; f = 0.12); and

- problems related to inconvenient / poor space planning (n = 7; f = 0.10).

Negative perceptions pertaining to insufficient storage and filing space, inconvenient / poor space planning, and glare on work surfaces due to the penetration of direct sunlight matched the problem areas initially hypothesised.

Table 4: Frequency distribution of perceived performance inhibiting workplace environmental variables (n = 67).

	Workplace environmental variables	n	f
1.	Problems related to insufficient storage and filing space: • insufficient storage space • archive too small • no storage space in meeting rooms • no storage space for confidential documents	13	0.19
2.	Distractions due to background noise: • wooden floor is noisy • noise from telephones in open plan office • conversations from colleagues • the workplace environment is noisy	8	0.12
	Problems related to poor thermal comfort: • ineffective air conditioning • no personal control over air conditioning • no windows	8	0.12
3.	Problems related to inconvenient/poor space planning: • bathroom in basement too small • enclosed office too small • paraplegic toilets not private • visitor's area not practical • computer CPU not easily accessible • no bookshelves	7	0.10

Workplace environmental variables		n	f
4.	Problems related to excessive workplace / workspace spaciousness: • personal desk too large • too much open spaces • too many visitor spaces are not being used	5	0.07
	Problems related to office furniture (general): • office furniture very impersonal • not enough drawers • small mobile cupboard under desk is ineffective / impractical • no provision for stationary storage at desk	5	0.07
5.	Problems related to insufficient workplace/ workspace spaciousness: • desk space too small for filing / sorting work • not enough storage space for files at desk / personal items	4	0.06
	Problems related to the open plan layout: • no privacy for personal calls and/or conversations • have to share office space • no partitions • emphasise status barriers	4	0.06
6.	Problems related to insufficient meeting space/ seating in meeting spaces: • not enough seating in meeting room • insufficient meeting spaces	3	0.04
	Problems related to OA (Office Automation) equipment: • wrong type of printer (too slow) • copier located too far from workspace • copier on other floor	3	0.04
7.	Discomfort due to sunlight and glare: • sunlight penetration a problem in summer	1	0.01
	Problems resulting from the absence of notice boards: • no 'pin-up' boards	1	0.01
	Problems related to movement / circulation: • wooden floor 'bounces' under movement and causes computers to move	1	0.01
	Problems related to staff rooms/additional support spaces: • staff room not private due to people walking through it	1	0.01
	Problems related to insufficient width of space: • toilet facilities too small	1	0.01
	Problems related to management of the overall workplace environment: • very little opportunity for personalisation	1	0.01
	Problems related to security: • poor locks on doors, cabinets, and desks	1	0.01

5.2   Activity and activity duration mapping

The objective of the activity mapping is to determine firstly, the range of activities that form part of employees' daily workplace activities, and secondly, the duration or time spent on the various activities. Workplace activities consist of two main categories — these being:

- work performed at individual workspace while in the office; and
- work performed away from individual workspace while in the office.

The subcategories which represent the diversity of activities performed in the workplace are indicated in Table 5. Classification of employees' workplace activities in this manner enables the interpretation of both the frequency with which the various activities are performed, as well as the various locations where these activities are performed. As such, a clear indication of the extent to which individual workspaces are appropriated is obtained. By using this information it is possible to formulate individual employee profiles pertaining to the extent and location of workspace utilisation. A combination of these individual profiles further allows the formulation of departmental profiles that enable an improved overall understanding of departmental characteristics and the related spatial requirements. Ultimately, this approach allows for improved departmental and organisational space budgeting. Aspects of workspace utilisation were also addressed by Becker (1990) with specific reference to the provision of territorial (fixed-address) and non-territorial (free-address) workspace settings and staffing typologies. Accordingly, fixed address workspace is classified as workspace which is occupied for more than 60% of the day, while free-address workspace is classified as workspace that is occupied for less than 60% of a day. The implications of these indicators on space planning strategies in open plan office layouts have been discussed at length by Le Roux (2005).

Table 5: Range of activities performed at and away from individual workspace while in the office

Activities performed at individual workspace		Activities performed away from individual workspace	
Cw:	Computer work	Mf:	Formal meeting
D:	Desk work	Mi (away)	Informal meeting / conversation
Tel.:	Telephone	F (away)	Filing
Mi (at):	Informal meeting / conversation	F/C/P:	Fax / Copy / Print
F (at):	Filing	M	Movement
F/C/P:	Fax / Copy / Print	O	Other

Although the body of evidence related to these implications is too extensive to be included in this article it can be summarised by means of the conclusion which states that employees who spend more than 60% of a day in the office should be accommodated through fixed-address workspace solutions. These employees are referred to as 'sitters' (Le Roux *et al.*, 2001) and represent the traditional function of the office to provide individual workspace to employees. However, where employees spend less than 60% of a day in the office alternative workspace solutions such as free-address workspace might be more appropriate. This group of employees is referred to as either 'walkers' or 'runners' and represent a new type of work style where employees exhibit higher levels of mobility in performing and accomplishing their workplace activities (Le Roux *et al.*, 2001). Data from the activity mapping is therefore highly relevant to determining and adequately providing for work style diversity among employees.

Data presented in Diagram 1 clearly illustrate the various activities on which employees in the different departments spent most of their time. The activity in which most departments — with the exception of Department K (Office of the Vice-Rector: Academic Planning) — scored high levels of performance, was computer work (Cw) at individual workspace. Performance of this activity ranged between a low of 26.7% (an average of 4 minutes per 15-minute interval) and a high of 51.5% (an average of 7.72 minutes per 15-minute interval). All departments appear to spend very little time (below 20%; an average of 3 minutes per 15-minute interval) doing desk work. Two important findings relate to the relatively high frequency of telephone use at

individual workspaces (an average of 1.86 minutes per 15-minute interval) and the relatively high occurrence of filing (F) away from individual workspaces. This last observation corresponds with responses tabled as perceived performance inhibitors (Table 4). Although the relatively high occurrence of informal communication at and away from individual workspaces appear to be the result of increased cross-functional awareness and contact between various departments in an open plan office layout, data from the communication mapping in section 4.3 illustrates that such communication was primarily between employees of the same department. Movement in the office (M), as well as other activities (O) were similarly of a relatively high nature. However, based on the results of the questionnaire survey, these were not perceived by employees as performance inhibiting.

Findings presented in Diagram 2 illustrates that the departmental averages for time spent at individual workspaces by employees in the open plan area for 4 departments were below 60%. This implies that individual or fixed-address workspaces were not used optimally. These departments are Department B (Office of the Registrar: General Affairs), Department F (Office of the Rector), Department J
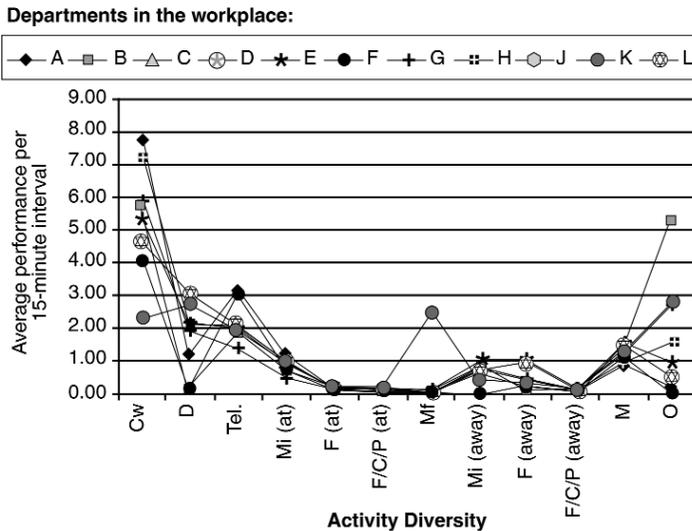

Diagram 1:   Activity profile for all departments (see Figure 7 for
            Departmental classification)

(Planning), and Department K (Office of the Vice-Rector: Academic Planning). Since no employees belonging to Departments C (Office for Diversity) and D (Office of the Director: Physical Resources & Special Projects) were present in the open plan office during the survey, no data were entered into the comparisons illustrated in Diagrams 1 and 2.
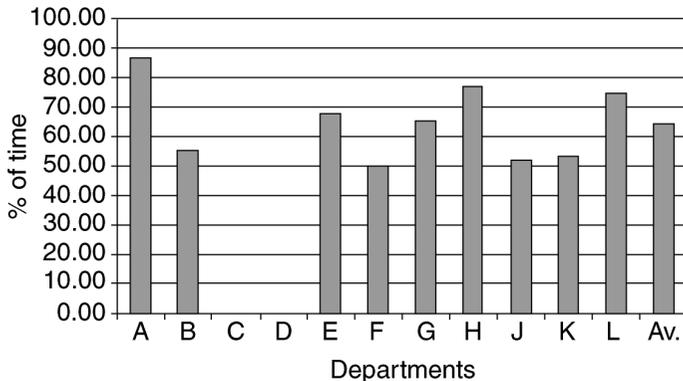

Diagram 2:   Time spent at workspaces (Note the office average)

Bringing together data pertaining to time spent in the office and time spent at individual workspace as illustrated in Diagram 3 enables evidence-based decision-making pertaining to the allocation of workspace based on employees' performance behaviour and their work style diversity. The matrix illustrated in Diagram 3 contains 4 quadrants structured around previously mentioned research findings by Becker (1990) pertaining to workspace utilisation above and below the 60% mark (refer section 4.2). As will be discussed in the following paragraph, interpretations of this matrix serve as a decision-making tool for issues related to workspace allocation strategies. In order to fully comprehend the interpretation of this matrix, a short discussion thereof is deemed necessary.

The first quadrant refers to the hatched area where time in the office and time at individual workspace are both below 60%. This group of employees is identified as 'walkers' or 'runners'. Due to their increased level of mobility in work performance, this group is most likely to benefit from a free-address workspace solution. Employees spending the majority of a day at their individual workspaces in the
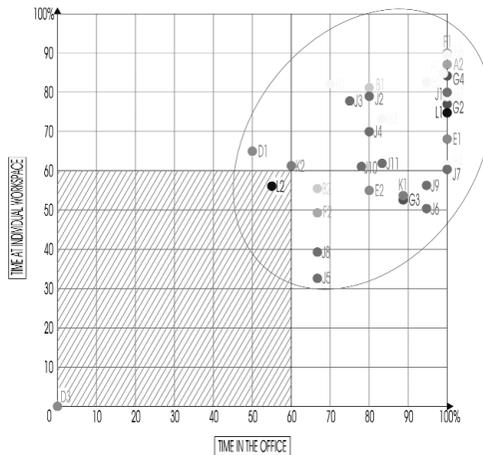
Diagram 3:   Illustration of work styles according to time spent in the office
              and time spent at individual workspace

office are classified as 'sitters' and belong to quadrant three where time in the office and time at individual workspace are above 60%. These employees are best accommodated through a fixed-address workspace solution. Quadrant 2 refers to employees who spend less than 60% of a day in the office, but with individual workspace utilisation above 60%. These employees are usually those performing work requiring high levels of concentration. The last quadrant — quadrant 4 — includes employees who spend more than 60% of a day in the office, but less than 60% at individual workspace. This group of employees is characterised through increased levels of mobility in their work performance and accomplishment within the workplace environment. Based on the information provided in Diagram 3, the majority of employees in the Main Building office environment belong to quadrants 3 and 4. This implies that employees in this specific workplace environment display a tendency to be in the office for the larger part of the day — thereby justifying the current fixed-address workspace solution.

5.3   Movement and communication mapping

Data regarding employees' movement and communication behaviour in the open plan office environment provide further insight into the extent of performance and work style diversity in the office. Movement-related data was collected simultaneous to the activity mapping, and is

used to illustrate where employees circulate in the course of work performance, as well as their preferences in terms of the location of communication and collaboration in the office. Movement lines for individual employees are constructed using the data collected during the 15-minute intervals. By combining these movement lines, it is possible to illustrate individual and departmental movement behaviour. Combined movement patterns illustrated in Figure 8 shows the overall movement for the ground and first floor respectively. An important observation in this regard is that when comparing the overall departmental movement lines as indicated in Figure 8 with that of the departmental boundaries illustrated in Figure 7, it is found that movement for all departments are mostly limited to:

• movement within the same department;

• between the department and the various support facilities (kitchens, copy rooms, and toilet facilities); and

• shared entrance/exit areas.

The high frequency of movement along the primary circulation route on the first floor also corresponds with negative feedback from respondents to the questionnaire. Accordingly, most complaints were related to the noise of people moving on the wooden floors, as well disturbances due to movement of the wooden floor when people walk on it. The latter was particularly disturbing in instances where the floor movement resulted in computer monitors moving on desk surfaces.

Communication patterns as illustrated in Figure 9 appear to be mostly the result of the observed movement patterns. In a similar fashion, communication was found to be primarily between employees of the same departments — a situation which emphasises the fact that there is less than expected cross-functional and cross-departmental communication and awareness. This situation is contrary to what was initially hypothesised.

The communication behaviour observed in the departmental zones illustrated in Figure 9 is also reflected in the respective communication wheels for the observed ground and first floor communication as presented in Figure 10. The communication wheel — as discussed by Kato *et al*. (2005) — is a circular diagram that contains reference to all employees in the surveyed workplace environment. Employees are grouped in a departmental manner to ease illustration of the extent and frequency of communication between different employees and departments. Based on interpretations of the communication wheel for the first floor, frequent communication occurred
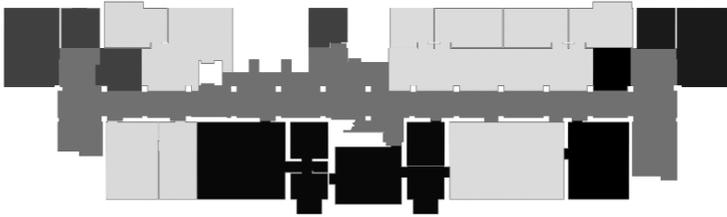
Figure 7-1: Ground floor plan illustrating overall departmental layout and proximities, as well as the location of the primary circulation area

Figure 7-2: Ground floor plan illustrating overall departmental layout and proximities, as well as the location of the primary circulation area
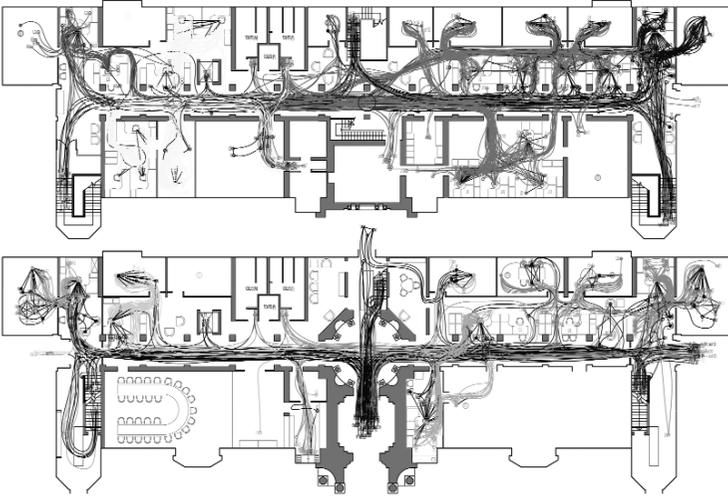
Figure 8:   Overall results of the movement showing the extent of departmental movement on the ground (bottom) and first (top) floors (see Figure 7 for Departmental classification)
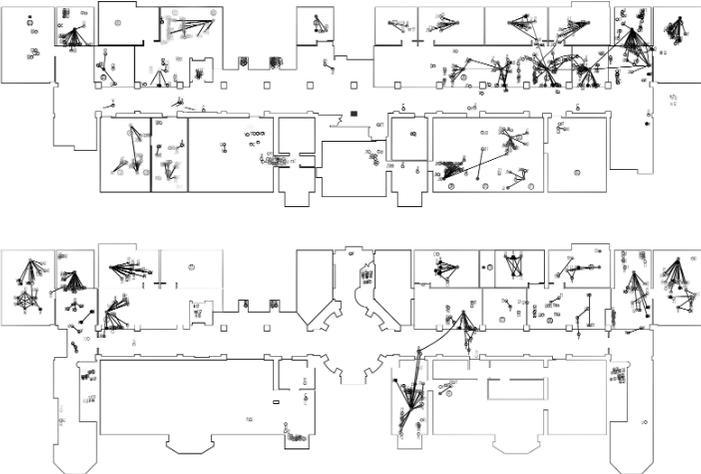

Figure 9:   Overall points of communication in terms of departmental boundaries for the ground (bottom) and first (top) floors. The use of matching colours for points of communication and departmental boundaries illustrate the extent of intra- and interdepartmental communication

within Department J (Planning), as well as between Departments J (Planning), K (Office of the Vice-Rector: Academic Planning), and L (Office of the Vice-Rector: Academic Operations). Based on observations during the mapping surveys, it is concluded that this situation can be explained more on the basis of adjacency and proximity of location in the open plan layout, than as a result of functionally related workplace activities. Similar to the communication behaviour observed on the first floor, communication on the ground floor was found to be primarily intradepartmental. An important observation relates to employees F1 and F2 in Department F (Office of the Rector). According to the communication wheel there was a high frequency of communication between these two employees. In comparing this finding with the movement study illustrated in Figure 8 and the points of communication in Figure 9 the frequency of contact between employees F1 and F2 was confirmed. What is significant is that these two employees are not located within visual or audio range, yet have frequent work-related contact. A conclusion to be drawn from this is that an improved adjacency for these two employees might contribute to improved job satisfaction, as well as improved levels of effective and efficient work performance and accomplishment.

6.   Discussion of research results

The performance evaluation study of the executive office environment in the Main Building has emphasised a number of important and highly relevant issues pertaining firstly to workplace planning and design in this specific environment, and secondly, to BPE research in workplace environments in the South African context in general. In analogy to previous research on workplace environmental planning standards and methodologies (Le Roux *et al*. 2005; Le Roux & Kato, 2004; 2003; Le Roux *et al*. 2001) a discussion of the application value of the results of the study for the surveyed office environment can be done according to previously developed database categories. The most applicable categories for discussion in this paper are:

•   Floor area per workspace; and

•   Individual workspace area.

In addition results will also be discussed in terms of adjacency and proximity of locations and the deployment of spatial resources according to work style diversity.
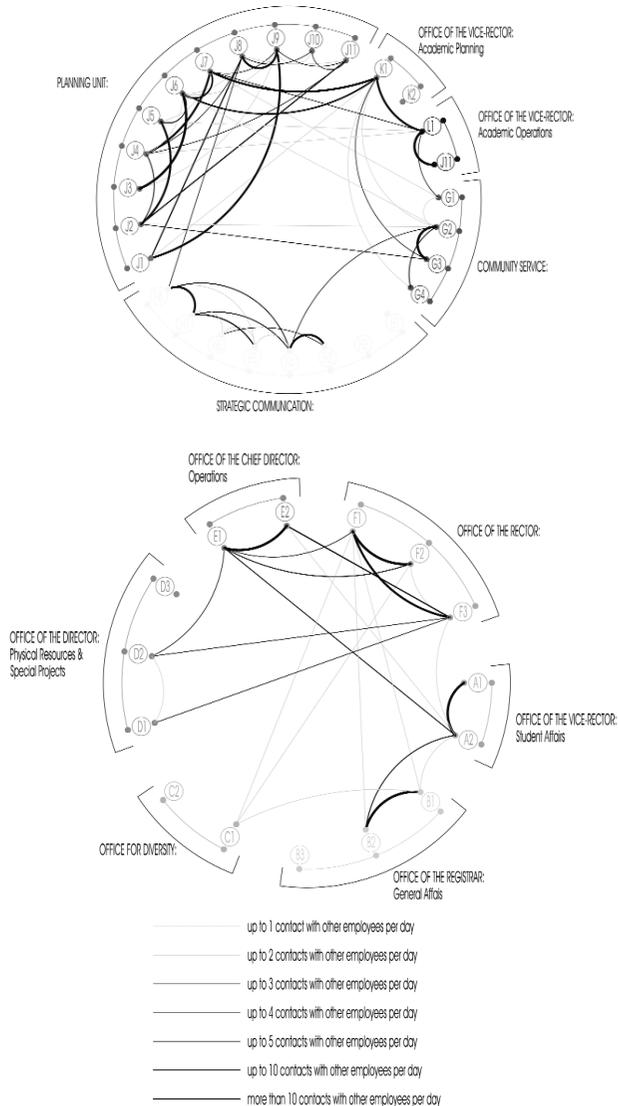
Figure 10: Visualisation of data collected during the communication mapping. The communication wheel clearly illustrates the extent of communication between all employees in the office during the survey. Communication between employees of the ground and first floor was found to be minimal

6.1   Floor area per workspace

For this part of the analysis, the useable office (departmental) floor area was calculated. This excluded areas such as primary circulation, staff rooms, tea kitchens, and primary support spaces such as storage rooms, archives, and copy rooms. In this case the floor area of the personal suite of the Rector on the ground floor was also excluded due to the uniqueness of the specific environment. For this discussion on floor area per workspace, two indicators were identified to ease the interpretation and discussion of data. Data for the ground floor indicated the average departmental floor area (indicator 1) to be 42.95m2. The average departmental floor area per workspace (indicator 2) was found to be 18.42m2 (refer to Table 6-1). Accordingly, departmental floor areas on the ground floor ranged from 29.18m2 (Dept. C) to 64.14m2 (Dept. B), while individual workspace settings ranged from 14.59m2 (Dept. C) to 21.38m2 (Dept. B) when interpreted in terms of the number of workspace settings per department. Consequently, results of the evaluation of spatial characteristics of the ground floor layout indicated that maximum and minimum values for both departmental spaciousness and the spaciousness of individual workspaces were found within similar departments. Accordingly, the maximum values pertaining to both indicators were found in Dept. B (Office of the Registrar — General Affairs), while minimum values for both indicators were found in Dept. C (Office for Diversity). Important to note, is the fact that while Dept. B has only one employee more than Dept. C (3 as apposed to 2), the departmental floor area was more than double that of Dept. C.

Occupation of the first floor was significantly higher than that of the ground floor (refer to Table 6-2). Data for the first floor indicated the average departmental floor area (indicator 1) to be 84.22m2, while the average floor area per workspace (indicator 2) was 15.60m2. Departmental floor areas on the first floor ranged from a minimum of 38.68m2 in Dept. L to a maximum of 179.43m2 in Dept. J. Individual workspaces ranged from a minimum of 12.58m2 in Dept. H to a maximum of 20.93 in Dept. K. Contrary to similar data for the ground floor, minimum and maximum values for both indicators did not occur within similar departments.

Average floor areas per workspace for the overall office environment are illustrated in Table 6-3. Accordingly, floor area per workspace when expressed in terms of the overall available floor area varies from 33.91m2 (inclusive of all excluded areas as discussed previously) to 16.56m2 (less all excluded areas as previously discussed). Since no

recommended minimum standards regarding workspace spaciousness currently exist in South Africa, data from NOPA (the New Office Promotion Association of Japan) on office planning standards (Le Roux *et al.* 2005), as well as literature from The Netherlands (Van Wagenberg, 1999) on healthy office building management will be used to comparatively illustrate recommended standards in this regard.

Table 6-1: Spatial characteristics of the ground floor

Department / area name	Overall area (m2)	Number of settings	Aver. Area per setting (m2)
Dept. A	38.85	2	19.43
Dept. B	64.14	3	21.38
Dept. C	29.18	2	14.59
Dept. D	45.88	3	15.29
Dept. E	38.68	2	19.34
Dept. F	40.98* (+ 94.61)	2	20.49
Total:	257.71 (+ 94.61)	14* (+ 1)	
Aver./Dept.	42.95		
Aver./Setting:			18.42
Meeting and support spaces	166.39		
Primary circulation	230.23		
Total:	654.33* (+94.61)		
Note: * Data indicated for Dept. F excludes that of the Rector's personal suite (94.61 m2)			

Table 6-2: Spatial characteristics of the first floor

Department / area name	Overall area (m2)	Number of settings	Aver. area per setting (m2)
Dept. G	60.48	4	15.12
Dept. H	100.66	8	12.58
Dept. J	179.43	11	16.31
Dept. K	41.85	2	20.93
Dept. L	38.68	2	19.34
Total:	421.10	27	
Aver./Dept.:	84.22		
Aver./Setting:			15.60
Meeting and support spaces	114.26		
Primary circulation	200.81		
Total:	736.17		

Table 6-3: Spatial characteristics of the overall workplace environment on the ground and first floors (Refer to Table 6-1 and 6-2)

Spatial characteristics: Overall	Floor area (m2)
1. Overall useable floor area (excluding the Rector's suite):	1,390.50 41 (+ 1)
2. Overall meeting & support space:	280.65 (20.18%)
3. Overall primary circulation space:	431.04 (31.00%)
4. Overall departmental area:	678.81 (48.82%)
5. Overall number of workspace settings:	41 (+ 1)
6. Average overall floor area / setting (incl. primary circulation, meeting space, and support space):	33.91
7. Average departmental floor area / setting (excl. primary circulation, meeting space, and support space):	16.56
8. Personal suite of the Rector:	94.61

NOPA — through its 'New Office Minimum Standard' — recommends a minimum of 7 m2 per individual workspace setting. Since this standard does not make reference to job function, the Dutch standard for floor area allocation per job function as per Van Wagenberg (1999) is a useful means of comparison (Table 7).

Table 7: Minimum and optimum floor areas of Dutch offices relative to the functional nature and the required facilities

Function	Utilisation	Min. floor area (m2)	Optimum floor area (m2)
Level 1	Basic individual workplace	7	9
Level 2	+ additional computer equipment	9	11
Level 3	+ additional computer equipment and sufficient workspace for 2 people	11	12
Level 4	+ additional computer equipment and sufficient workspace for 4 people	13	14
Level 5	+ additional computer equipment and sufficient workspace for 6 people	18	18
Level 6	Employees with representative responsibilities	28	28

The Dutch example (Table 8) aims to enable the objective allocation of workspace in the office according to actual occupation and the required level of office automation and IT in the specific workspace.

The comparison of the spatial characteristic of the Main Building workplace environment is thus similarly an exercise in evidence-based reasoning and decision-making with regards to the utilisation of spatial resources (Figure 7).

Table 8: Comparison of floor areas in the Main Building office environment with those recommended by the Dutch standard

Dutch Standards (Table 7)			Main Building	
Function	Min. floor area (m2)	Optimum floor area (m2)	Employee / Department	Area (m2)
Level 1	7	9	Employee C2: (Office for Diversity)	12.34
Level 2	9	11	Employee G3: (Community Service)	12.20
Level 3	11	12	Strategic Communication	21.74
Level 4	13	14	Planning (current)	58.53
Level 5	18	18	Planning (future)	58.53
Level 6	28	28	Employee A1: (Office for the Vice-Rector: Student Affairs)	28.60
			Employee F3: (Office of the Rector — personal suite)	94.61

6.2 Individual workspace area

An interesting comment resulting from the questionnaire survey was employees' mixed response with regard to workspace spaciousness. More responses were received of individual workspace being too large (n = 5; f = 0.07) than the same workspace being too small (n = 4; f = 0.06). Workspace in the open plan office area measured on average 2.15 m2 while those in the enclosed offices were 3.13 m2 (Table 3).

6.3 Adjacency and proximity of location

As was mentioned previously in the discussion of the results of the movement and communication mapping (refer to section 4.3) the frequency of movement and communication between employees, as well as the effectiveness thereof, can be managed through the improved understanding of adjacency relationships and the proximity of location. Most workplace layouts accommodate employees on the basis of adjacency decisions that use spatial proximity to address

decision-making on where employees should work. This means that employees are accommodated where they are closest to those they have frequent interaction with.

According to research by Becker (1990) workplace planning and design methodologies that support spatial mobility effectively shift the focus from the design of individual 'cockpit' workplace settings where employees are functionally isolated, to the notion of the office as system of loosely coupled settings appropriated on the basis of functional need. Considerations on adjacency and proximity thus either enforce departmental cohesion by grouping people closely together, or employ the concept of 'functional inconvenience' to locate employees in such a manner as to promote cross-functional interaction and awareness.

Given the strongly departmental character of movement and communication in the surveyed office environment, careful consideration based on the organisational character and objectives might suggest a different approach to accommodating selected employees and functional groups. The most visible example in this regard is Employees F1 and F2 (Office of the Rector) who had frequent work-related contact, yet were situated out of visual and audio range of each other. Rethinking such relationships on the basis of data resulting from the movement and communication mappings could improve functional cohesion and improve perceptions of the office environment's level of serviceability (the extent to which the office layout accommodate user requirements and work style diversity).

6.4 Deployment of spatial resources according to work style diversity

A last discussion on the results of this study pertains to the acknowledgement of employee and work style diversity. Data presented in Diagram 3 on the relationship between time spent at individual workspaces and time spent in the office emphasises the need for recognition that there are real differences in the way people work. However, mere acknowledgement of these differences will not help employees to exercise autonomy with regards to the time and place according to which work is structured and performed. Considerations in this respect are of special importance for employees identified as runners and walkers (employees that either spends more than 60% of their time in the office but less than 60% of the time working at individual workspaces, or employees that spend less than 60% of the time in the

office). Special measures such as core time (a set time during the day during which all employees must be present in the office, for example, between 11:00 and 15:00) will help highly mobile employees such as those identified in quadrant 3 (refer to Diagram 3) to be more effective and productive in performing their workplace activities.

Adoption of such strategies has the added benefit of enabling a better work-life balance since the focus moves from controlling the process (time in the office) to managing and facilitating work performance and accomplishment.

7.   Conclusion and recommendations

Conclusions from this body of research can be drawn on various levels. The most significant to be discussed here relates to the relevance of this study and its findings for the improvement of the Main Building workplace environment in terms of its functionality and serviceability levels, and the educational value thereof in sensitising students to the opportunities for, and value of person-environment studies in architecture.

Since the Main Building workplace environment was refurbished with work performance innovation in mind, the findings of this study serve as a benchmark of the level of achievement in terms of employee satisfaction with the environments level of serviceability. Employee and work style diversity as discussed in this article in response to the research results imply that different employees will have different needs based on the work they are performing. According to Becker (1990) optimal settings for work performance should vary according to changes in work content over time. Given the emergence of increased spatial mobility in the performance of work among employees in the Main Building office environment, considerations regarding facility flexibility and serviceability are deemed of relevance for this specific office environment. The Main Building's new status as an executive office further emphasises the need for implementing alternative solutions to the allocation and appropriation of spatial resources. This includes the careful assessment of specific work style diversities and the provision of dedicated space for concentrated work for employees in the open plan office. Although alternative staffing typologies and workplace strategies on the basis of work performance characteristics require more effort in terms on proper management, the autonomy provided to employees to perform their work when, where, and how they deem necessary, is highly conducive to improved levels of employee satisfaction

and productivity (Clements-Croome, 2000). Since employees regarded the lack of space for private or concentrated work as one of the performance inhibiting aspects of the new office environment, this aspect should receive proper attention. Another aspect which was also perceived as contributing negatively to the working environment — the noise resulting from wooden floors, as well as problems related to the movement of the wooden floor — should similarly be addressed in an effort to improve the user-satisfaction with the workplace environment.

Results of the questionnaire were highly effective in identifying specific areas of user-dissatisfaction. The most frequent aspect which employees complained about was the lack of storage and filing space. This problem can be addressed by providing better access to the existing filing cupboards in the open plan workspace. By allocating individual filing space to each employee would also address the complaint regarding inadequate storage space for documents at individual workspaces. Complaints pertaining to the archive being too small can similarly be addressed by adopting a more organised filing system and a better spatial planning in the archive room. In addition, complaints about the archive not being dust proof should be attended to as soon as possible.

Complaints pertaining to noise and movement of monitors on desks due to employee circulation across the wooden floor are however, more difficult to address. Although loose carpets might provide the necessary dampening of sound and causes less movement of the wooden floor structure, careful consideration should be given to the impact thereof on general employee safety. This refers specifically to aspects of slip resistance. An added benefit of using loose carpets in this manner might be its contribution to the executive nature of the office. Another performance inhibiting aspect of the open plan office is that of inadequate meeting spaces. Complaints by employees regarding the low level of use of visitor spaces provide a solution to this problem. Visitor spaces can be used as secondary meeting spaces — thereby using such areas more effectively. Complaints pertaining to inadequate storage spaces in meeting areas should be addressed simultaneously to ensure all meeting spaces enjoying a high level of accessibility and ease of use. By doing so, the formal meeting rooms, combined with the visitor spaces serving as secondary meeting areas, can form a network of meeting spaces and facilities throughout the office environment. Implementation of this solution would contribute to the workplace layout becoming

more efficient through its support of user-diversity, while also ensuring the optimisation of resources.

A last aspect perceived by employees as inhibiting performance is that of copiers being too far from individual workspace. At present, a central copy room is provided which contains the photocopy units as well as paper and other related consumables. Given the length of the open plan office and the fact that it is located on three floors (including the basement work area), the current policy of expecting employees to use an inconveniently placed central copy room contributes to dissatisfaction employees have with regards to the workplace layout. This specific problem can be addressed by locating photocopiers in distributed areas throughout the open plan office where they will be more accessible to employees. This arrangement will result in less time being spent on movement and circulation in the office (refer to Diagram 1) and thus contribute towards higher levels of user-satisfaction while creating an oppor-tunity for increased productivity. The distribution of photocopiers throughout the open plan office might also address the problem of movement of the wooden floor caused by high levels of movement between individual workspaces and support spaces.

In addition to the direct implications of this survey and its results for the surveyed office environment, the survey also had an important edu-cational value for students of architecture. By sensitising students to the importance of the reciprocal relationships between architecture as the built environment and people as the primary users thereof, the objectives of person-environment studies as discussed under the heading Research Objectives are also promoted.

The inclusion of these concepts within the curriculum or architecture, together with the research activities of the Centre for People and Buildings — South Africa (CfPB-SA) at the Department of Architecture, UFS ensures that graduates are made aware of their responsibility to consider the impact of their designs on the built environment and to formulate more responsive design solutions. The discussion of research results contained in this article will be used to formulate a feedback to the Office of the Director: Physical Resources & Special Projects, UFS who was responsible for the overall refurbishment of the existing Main Building into an executive office environment. Follow-up studies are planned as part of an ongoing performance evaluative approach to office place-making in the Main Building office environment.

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