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A choice of terminals: spatial patterning in computer laboratories

Running Title:

Spatial patterning in computer laboratories

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Abstract

Previous research of the use of computer laboratories in schools and universities has focussed on educational issues. None of the studies so far have considered matters of situational territoriality and spatial patterning that govern human behaviour.

By assessing the user behaviour in 16 computer laboratories at a regional university in Australia, this paper will examine the spatial patterns of student use of machines in each laboratory to whether there are underlying commonalities.

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Keywords

Computer Facilities Design—Spatial Behaviour—Facility utilisation research— Use studies

Introduction

The use of computers is pervading all sections of society and all aspects of life. In the educational environment, computers have long been used for research, instruction, and communication. Most universities have established computer centres as teaching laboratories and to provide financially challenged students equitable access to such resources.

It is important for both educators and managers of educational facilities to understand how students use the technology and what barriers exist, if any, to its use. In a rapidly changing technological environment, ultimately, only an in-depth understanding of the student usage of the facilities and services

will allow university administrators to appropriately tailor their approaches and the implementation of innovations.

Previous studies of computer use by Charles Sturt University (CSU) students looked at questions of e-mail use (Spennemann 1997; Spennemann & Atkinson 2003); data management (Spennemann & Atkinson 2002b); use of web browsers and other programs (Spennemann & Atkinson 2002) as well as student's use of on-line discussion forums (Burr & Spennemann 2004) and general time spent on-line (Spennemann 2006b). Other research looked at the presence of students on campus (Spennemann 2004) and effects on library use (Spennemann 2006a), as well as at the establishment of the Information and Communications Technologies (ICT) infrastructure, such as e-box (Burr & Smith 2003a), the implications of mandatory internet access for all enrolled students (Smith & Burr 2005) as well as issues of access equity between rural and urban areas (Burr & Smith 2003b).

A series of related studies looked into the utilisation of computer laboratories by students at CSU concluding that the available laboratories are under-utilised for much of the year (Spennemann *et al.* in press) and that most of the actual use comes from a small group of students (Spennemann *et al.* 2005). In view of this low machine usage, concepts have been developed to make use of the idle computing power (Atkinson *et al.* 2005; Cornforth *et al.* 2006).

Independent of the question of overall use of the laboratory facilities, we have to ask the question whether some of the machines get more use than others. This has implications both on the wear and tear of the machines but also informs the placement of security cameras and the design of future laboratories. To investigate this, proxy analysis will be used to determine whether there are patterns in the usage of computers in each laboratory or whether all available computers are used evenly? As all machines in a given laboratory are identical from a technical point of view any differences in usage will be the result of behavioural factors. As will be demonstrated, human interaction in confined and semi-confined spaces is governed by spatial patterns of proximity and avoidance.

First, we will review the disparate literature on spatial patterning of human behaviour with special emphasis on seating behaviour and situational territoriality. Second, student log-on patterns at 463 machines in 16 computer laboratories on three campuses of Charles Sturt University will be examined and interpreted with the aim of identifying underlying commonalities.

Spatial Patterning of Human Behaviour

Human behaviour in confined spaces can be circumscribed as *sociofugal* or *sociopetal*, depending on whether they isolate themselves or cluster (Sommer 1969). A diverse range of studies has examined the seating behaviour of people in a number of settings,

ranging from open spaces and public transport to restaurants, movie theatres, libraries and class room situations.

A substantial body of literature exists in the educational arena on the nature of seating arrangements in classrooms and the relationship between low and high interaction seats both in a secondary school (cf. McCorskey & McVetta 1978, Pedersen 1994) and university setting (Brooks & Rebeta 1991); with student behaviour (Hastings & Schwieso 1995); cheating (Murdock *et al.* 2004); and general student performance (Brooks & Rebeta 1991; Benedict & Hoag 2004) related to seating arrangements. Some of this may well have been induced by teachers at an early age (Kasanen *et al.* 2001) and is influenced by cultural conditions (cf. Turnuklu & Galton 2001). Some of the literature deals with the enforced seating arrangements and their relationship to student's learning and perceptions of educability (cf. Kasanen *et al.* 2001). Intriguingly, some of the seating patterns and the correlations with student's personalities have also been observed in more practical situations, such as table tennis instruction (Sugiyama & Ichimura 1994). Of particular interest for the present study, however, are only those studies that address voluntary seating behaviour.

In a study of the self-selected seating of participants of a public jeopardy game competition, Akimoto *et al.* (2000) found that performance expectations affected the desire to be noticed, which, in turn, affected the prominence of the seat chosen. Moreover, participants manipulated their prominence based on their own performance expectations in order to influence the impressions of others.

Territoriality for a specific seat in a free seating teaching environment can establish itself rapidly, often after the second or third occasion in a lecture series (Hall 1959; Guyot *et al.* 1980), mitigated by the factors rapport with students (Guyot *et al.* 1980) and especially of (teacher) authority (Benedict & Hoag 2004). Even in small group settings with a central power figure present, the pattern of human seating is aligned in a semi-circular configuration in front of the authority figure (cf. Hendrick *et al.* 1974).

Unlike class room situations, settings where there is a free choice of seating will be controlled by human territoriality behaviour. Studies of human behaviour have shown that people arrange themselves in a given space in territorial patterns. Lyman & Scott (1967) have defined territoriality of human society in four types: i) public territory, such as a park; ii) home territory (clubhouses, coffee houses with regular patrons); iii) interactional territory (social gatherings) and iv) body territories (personal spaces). The underlying psychology for much of the patterning is the comfort zone towards the 'other,' which varies culturally (cf. Sommer 1968, Sussman and Rosenfeld 1982, Remland *et al.* 1991; 1995; Holland *et al.* 2004). In the USA and culturally similar societies the comfort zones (or 'bubbles') range from the intimate (up to 0.5m) and

personal (0.5 to 1.2m) to the social (1.2 to 3.5m) and public >3.5m) (Hall 1966). The degree of comfort is defined by familiarity with the other, or by the nature of the event or venue as a factor mitigating the desire to maintain the distances, eg. as spectators at a sporting event or while queuing (pers. obs.). Moreover, lighting conditions seems to have an influence on the requirements of personal space in non-familiar settings (Adams & Zuckerman 1991).

Seating location and configuration in open spaces

Seating location and configuration in public and social spaces affects the behaviour of users, who, within the constraints of the existing seating arrangement, make personal choices where they will sit. Such choices are based on the need to establish territory on a temporary basis (Edney 1976) and the exercise of privacy (Collett & Marsh 1980). In the case of small groups of people seating choices are governed by their need for intimacy whether they sit side-by-side or face each other (cf. Leventhal 1978; Ingham 1974).

In open spaces patterning of seating has been observed on beaches (cf. Dixon and Durrheim 2003), parks (cf. Lyman & Scott 1967, Jonge 1968), and urban plazas (Zacharias *et al.* 2004). In open spaces, such as parks, people tend to anchor themselves under trees or near garden furniture. Those who place themselves to view on open vista tend to do so with cover to their backs (Jonge 1968) such as trees, walls or fountains. It can be surmised that such features provide a barrier that reduces actual or perceived encroachment into personal space.

Seating Arrangement in Enclosed Public Spaces

Enclosed public spaces limits the extent of sociofugal behaviour by individuals. This can be demonstrated in institutional settings where spatial patterning of seating has been shown to favour isolated seating along walls. Indeed, the removal of wall seating has been used to improve the interpersonal environment by encouraging interaction (Baldwin 1985).

The two settings to be considered in the following are those where the temporary occupants have a low level of familiarity with each other, albeit a common purpose. The first setting is the case of commuters in a bus, passengers in an airport lounge or diners in a restaurant; and the second where occupants have some familiarity with each other, such as library patrons or users of computer laboratories.

Some research has been carried out on spatial patterning and territoriality in the transportation environment. Studies in commuter environments have found that passengers put as much distance between each other as possible, and if available, generally prefer window seats over aisle seats (Rivano-Fisher 1988). The choice of window seats demonstrate the need of people to be ‘anchored’ in their seating. Echoing findings by Watson and Kearins (1988), Kenner and Katsimaglis (1993) observed in a study of taxi-

seat choice in Australia that single men would predominantly get in next to the driver, while single women would choose the back seat. A similar pattern applied in mixed gender pairs however in same gender pairs, women get jointly into the back, while male pairs would not sit next to each other.

In the restaurant and entertainment environment, where seating arrangements are pre-arranged but where patrons have a choice of seating, studies have found that patrons prefer to 'anchor' themselves by sitting next to walls, pillars or indoor plant features (Robson 2002, Kimes & Robson 2004). When seating was limited (*i.e.* during busy times), there was little difference between anchored and non-anchored seats, but patrons disfavoured sitting with their backs facing the door and facing the majority of diners (data in Kimes & Robson 2004).

Collett and Marsh (1980) investigated seating behaviour in a British airport lounge studying different seating configurations. Individually travelling passengers preferred corner seats and where possible avoided middle seats. This tendency at first seems to run contrary to the model of people preferring anchored seating. The behaviour does conform to the pattern, however, if we consider that a corner seat allows only one side of the seated person to be 'invaded' by another person desiring a seat, while middle seats allow for people to sit on either side. When groups of two or three people desired seating, Collett and Marsh (1980) observed a preferred choice of middle seats. That preference, however, was preconditioned by the fact that the corner seats had usually already been occupied by passengers travelling single.

Seating Arrangement in Enclosed Semi-Familiar Spaces

In an office environment seating arrangements reflected the perceived power hierarchy and found that people chose seating /desk arrangements along walls over those in the centre (Tripathi 2002). Additional 'anchors' can be deployed in form of moveable office partitions that provide additional privacy (Tripathi 2002). Studies have shown that in single-occupancy offices, people generally do not like to sit at desks where their backs face the door (Joiner 1976; with academics being the exception).

In the library environment, studies of group interaction have shown that many individual users prefer 'to sit alone and choose tables further from the door and communication corridors (Fishman & Walitt 1972), preferably 'anchored', *ie* with their sides and backs shielded (Cohen & Cohen 1979). Some studies, however, showed that the majority of students who entered an empty reading room first, often sat in central locations, thus establishing territorial dominance over those coming later (Shoham & Shemer-Shalman 2003). Locations near doorways were least popular, both because of noise and traffic (Shoham & Shemer-Shalman 2003) and because people did not like to point their backs to doors (Cohen & Cohen 1979), with the subliminal fear element prevalent.

Additional influences on seating behaviour can be considered for large audiences as it was observed that seats on the right side of cinema screens were more popular than those on the left. Karev (2000) assumes a causal connection with the lateralization of the brain and emotional response. Pause (2004) found that in a truly symmetrical room, 86% of all participants, irrespective of gender, chose to sit at the right side.

Little work seems to have been carried out on the presence or absence of windows in preferred seating arrangements in confined environments (except in commuter settings), although studies have shown that windows and view provide for a less stressful work environment (Leather *et al* 1998).

The salient commonalities of spatial patterning in these studies are i) the need among people to preserve interpersonal spaces which can be mitigated or reinforced by gender; ii) level of familiarity with the neighbouring subjects; iii) the situational territoriality of subjects; and iv) the need to be anchored through seating at walls, columns or room-scaping features, while avoiding situations where one's back is oriented towards doors. In symmetrical or near symmetrical situations, the right side of the room appears to be favoured. Gender differences have been observed, whereby men avoid close seating with women, but women tend to cluster.

In addition to this spatial patterning, overt as well as subliminal inter-gender relations cause clustering of seating. Studies have shown that men tend to sit on seats recently vacated by women (Young 1984; Gower and Ruparelia 1993, quoted in Pause 2004b), while women and homosexual men prefer to sit on seats exposed to or treated with the pheromone Androstenone (cf. Kirk-Smith & Booth 1980). Pause (2004) has reviewed additional data, as well as carried out experiments showing that people do prefer seats previously occupied, but was inconclusive whether it was pheromones or traces of general body odour.

Computer Laboratories

At present, there is little known about the spatial patterning of human behaviour in relation to computer laboratories. Some conceptual papers exist on the ideal set up of computer laboratories from the technical (cf. Macey 1998), organisational (Albertson & Selwood 1998) and educational perspective (Waddick 1997, Young and Huggard 2003,), but little actual research has been carried out on the spatial patterning of human interaction or student seating behaviour inside computer laboratories.

Waddick (1997) tested three computer laboratory lay-out configurations (lab benches, tables along walls with users facing walls, and clusters of four machines on a table). He found that the layout where users faced the walls, with their backs exposed to the rest of the room, was the least liked configuration. This observation corresponds well with the need of humans to be

'anchored' while at the same time not having their backs exposed in an unfamiliar environment.

In view of the literature it can be hypothesised that terminals on tables which exhibit 'anchored' characteristics will be used more frequently than terminals that are free standing. Moreover, terminals positioned in a way that the user's back faces a doorway will be least popular. Based on the above literature findings, it was expected that statistically significant differences in spatial usage would be observed in this research.

The setting

Established in 1989, Charles Sturt University is a multi-campus institution in New South Wales, Australia. It maintains campuses in Albury-Wodonga (with a satellite campus at Thurgoona), Bathurst, Dubbo, Wagga Wagga and Orange (as of 2005), with associated facilities in Goulburn and study centres in additional localities. The staff establishment comprises of 422 academic and 945 administrative staff (full-time equivalent).

In 2003, the majority of a total enrolment of 38,365 students studied via distance education (71.8%) with another 10.1% studying bimodal (ie. some of the subjects in distance education mode). On average, on-campus students are younger than distance education students, with little difference between the genders. In Albury-Wodonga and Bathurst the gender balance is skewed towards females, while in Goulburn and Wagga Wagga males are in the majority. The on-campus population at CSU is largely homogenous however it is acknowledged that ethnicity and the concomitant factors of inter-ethnic integration or segregation are known to influence seating behaviour (Schofield & Sagar 1977; Page 1997; Dixon and Durrheim 2003; Clack *et al.* 2005). However, these factors do not enter into the equation for the case study at hand, given the ethnically and culturally homogenous nature of CSU's on-campus students, which are predominantly drawn from the south-eastern seaboard of Australis (CSU data).

Bathurst and Wagga Wagga are established major campuses, developed from the former Mitchell Teacher's College (Bathurst) and the Wagga Wagga Agricultural College. Albury, on the other hand, is a more recent campus, developed in the 1980s and 1990s in a commercial district in Albury. Demand for space resulted in the development of a satellite green-fields campus, Thurgoona in 1999. During the time span covered by this study, June 2001 to June 2003, the student population of the Albury-Thurgoona Campus continually expanded with the introduction of new courses (including physiotherapy, podiatry, speech and occupational therapy). The vast majority of courses offered on-campus are undergraduate courses, with postgraduate courses being offered largely by distance education, or on campus at Wagga Wagga and Bathurst.

Computer Laboratories at CSU

In total 463 IBM machines and 99 Apple Macintosh computers were available to students in 2003. These machines are scattered in computer laboratories, media centres and libraries. Access to most of these machines is during business hours only (08:00 to 18:00/21:00), with a number of machines on each campus made accessible 24hrs a day (Table 2). Access to the machines is unlimited, unless the laboratories are booked for scheduled teaching activities.

Methodology

The data were collected to better understand the demands student computer laboratories placed on the Division of Information Technology, which is charged with providing IT infrastructure throughout the university. The bulk of undergraduate courses at Charles Sturt University are taught in semesters. Consequently, the data collection period ran from June 2001 to June 2003, spanning covering two (southern) autumn and two spring semesters, as well as the inter-semester periods and the mid-semester breaks. All individual log-ins were extracted from log files, aggregated into numbers of log-ins per laboratory computer and broken down by major category (by week of the year, by day of the week, by hour). These aggregated data, which are devoid of any personal student information, were provided to the authors for analysis. At the time of writing only the aggregated data were available, which resulted in some limitation in the type of analysis that could be carried out. For each laboratory, a z-test was applied to identify PCs that were underused or overused, defined by a login count significant at the 99% level. A spatial map was prepared for each computer laboratory by visually inspecting each room and speaking to IT support staff to ascertain whether the layout had changed during the study period. The determination of each PC as underused, overused, or not significant at the 99% level was transferred to each map by shading the respective box which indicated the position of that PC. The position of windows, doors and security cameras was also noted. It should be noted that not all laboratories were equipped with cameras. These maps are displayed in Figures 1 to 4.

Excluded from the initial data capture were log-in data for access to the Apple Macintosh laboratories. Even though Apple Computers make up about 20% of the total of 562 machines installed at Albury-Thurgoona, Bathurst and Wagga Wagga (Table 2), data on program usage show that only 1% of the demand for Microsoft Word/Excel/Powerpoint and 2.7% of the demand for web browsers (Internet Explorer/Netscape) originates from Macintosh computers. In the light of this small percentage, the omission of Macintosh laboratory data does not cause concern to the validity of the analysis, although it is acknowledged that they can still represent access to specialist software which is not available elsewhere.

Spatial Patterns within computer labs

Analysis of the lay-out maps represented in figures 1 to 4 shows several clear patterns of usage, particularly for over-use and under-use. What are the factors that can explain the observed patterns? Let us first exclude some of those factors that have been raised in the literature. As all parts of the laboratories are evenly lit at any time, effects of lighting conditions on personal-space requirements (cf. Adams & Zuckerman 1991) can be discounted. The computer labs are small enough that all of the terminal locations would be equally affected by noise levels emanating from student discussions, personal music and the like; none of the doors are near noisy corridors that would act as noise sources and distractions. Thus the ambient noise, elsewhere considered an influence on seating behaviour (cf. Shoham & Shemer-Shalman 2003), is not an issue in the computer laboratory setting.

From a perusal of the seating usage images, several patterns are apparent. In the following we will discuss the influences of doors, windows, security cameras, room symmetry, as well as the influence of 'anchoring' to room elements.

Doors

There is a trend towards more logins on PCs that are close to an entrance door to the room, but not adjacent to it. This is seen in most plots, with the notable exception of Bathurst rooms 305 and 309 (Figure 3a; 3c), where the opposite trend is apparent. However, considering the path a person is forced to take to reach the nearest PC, the ones with highest usage are indeed nearest to the door. Those terminals immediately next to a door, however, where a user's back faces the door (Figure 2c; 2d), are significantly under-utilised. Similarly, in situations where the terminals are aligned around the periphery of a room (Figure 2d; 2f) and the user's back faces the door across an open space, the terminals in line of sight from the door are under-utilised. With the exception of these two settings, there is no evidence of students avoiding seats where they have their back to the door—an observation that runs contrary to expectations.

Windows

The majority of the computer laboratories in this study have windows. In relation to a user and the terminal, three window positions are possible, with the user: i) facing the window; ii) having the window to a side and iii) having the window at the back. Except with the design where whiteboards create an enforced focus (figure 2a–b), users have a full choice where to sit on a first-come-first served basis. There are no occasions where 'window seats' were the statistically more frequented than non-window seats. Bathurst labs 309 (figures 3c–d) is a seeming exception, but as has been outlined earlier, these seats were the closest to the door.

Thus windows are not attractants for users choosing a terminal—nor were they a distractant. While one third of the 21 seats close to windows were statistically underused, three of these seven seats were located at the inside end of rows of desks and the least easy to access (figure 3d).

Security Cameras

There is a trend apparent in some laboratories in this study for usage to be lower in the vicinity of security cameras. This can clearly be seen in the Albury and Thurgoona laboratories however, it is less clear in the Wagga and Bathurst laboratories. Do students try to sit in locations where they assume they cannot be observed? Any trend observed in these data is affected by a strong confounder: IT staff reported to the authors that the cameras had been placed at that corner of the room opposite to the door. In addition, in Bathurst room 309, the PCs that are most frequently used are adjacent to the camera and furthest from the door. Line of vision of the security camera onto the computer screen, thus potentially exposing inappropriate activity, might well be student's factor in choosing a seat. However, there is no clear evidence for this, and in those cases where the screens facing away from the camera showed significantly higher usage, they were nearest to the door (see above). In view of these considerations, we conclude that there is no evidence of an effect on seat preference caused by the position of cameras.

Room symmetry

Two of the laboratories at Wagga, rooms 243 and 259, are roughly symmetrical, leading to an expectation of preferential seating on the right, according to the findings of Pause (2004). However, this was not the case, with a tendency to prefer the right in room 243 and to prefer the left in room 259. As the direction in which the door opens is the same in both cases, the difference between the two directions is not due to external factors. It is possible to compare the differences quantitatively by summing the number of logins for all PCs on one side. In room 243, a total of 18169 logins were made on PCs on the left side of the room, and 17377 on the right. Likewise, in room 259 there were 5506 logins on the left side compared to 4530 on the right. In both cases an analysis of variance shows there to be no difference.

Anchoring to room elements

The computer laboratories were established in rooms with no architectural features, dividers or other entities that could act as 'anchors' in the sense as described in the literature (Robson 2002, Kimes & Robson 2004). Thus this effect cannot be fully investigated. The only anchoring we can take into consideration is the seating with one side of the seat bounded by a wall or window (cf. Figure 1a-b, seats 5 and 12; figure 1c-d seats 6 and 14 etc). None of these seats, however, show statistically significant over use and many are in fact statistically under utilised.

Effects of change in lay-out

One of the most popular laboratories at Bathurst was refurbished during the study period (at the end of 2002), and the layout was completely altered (figure 4). In 2001–02 all four walls of the room were lines with computers, with one side being reserved for Macintosh machines. This design was changed in a peninsula design in 2003. While the utilisation in 2001-02 was diffuse in the room, with two terminals, one close to the door and one central along a long wall, were statistically over-utilised, the new design saw a very clear preference for terminals close to the door. This allows us to look at the changed user behaviour in the same physical space. A comparison of the proportions of the usage of lab 302 for 2001, 2002 and 2003 with that of other Bathurst labs shows that the change in layout did not affect the overall usage of the lab. However, as with the removal of the Macintosh computers the number of PC machines was increased from 12 to 18, the average utilisation per machine declined. Any negative or positive effect caused by the change in lay-out should have been reflected in a decrease or increase of room utilisation. That this did not occur suggests that room functionality prevails over other considerations.

Spatial Proximity of Computer Labs

The overall frequency of lab usage is shown in table 3. The column ‘distance’ ranks the laboratories, with the laboratory closest to the entrance being ranked ‘1.’ The frequency figures shown in table 3 speak for themselves. The frequency with which laboratories are used is based on distance from the entrance. This can be demonstrated in Albury and Thurgoona where otherwise identical laboratories exist. In the Albury setting the usage of the ‘front laboratory’ is 40% higher than that further back. In the Thurgoona setting the usage is 37% higher. In the Wagga setting we have to be careful not to confuse the usage figures of the 24 hours laboratories with those labs which are open only for a shorter time. Among the three 24hrs labs, Room 244 is the closest lab to the entrance door, followed by Room 243 with Room 242 the furthest away, the usage rate drops continually with the first lab (Rm 244) having a 110% higher utilisation compared to the lab furthest away (Rm 242), while the second lab (Rm 243) still has a 29% higher utilisation. Among the three labs that are only open during (extended) working hours, the lab closer to the door (Rm 225) has a higher lower utilisation rate than the lab further away (Rm 227). Not surprisingly, room 259, literally out of the way, has by far the lowest utilisation rate. If we consider the lay-out of the laboratories, however, the reason for the anomaly becomes clear (Figure 1). The enclosed internal courtyard forces students to navigate around it. Given the observation that the utilisation rate declines the further we go from the door, a student would first check room 224, then 243 and finally 242. All being unsatisfactory the student would head across past the court yard, first

encountering lab room 227. Intriguingly, a spatial analysis of the seating pattern in rooms 225 and 227 has shown that the terminals closest to the door have the highest utilisation rate, with the exception of terminal n° 1 in lab 225—the terminal that is the furthest to walk in the circuit described above.

The lay-out of the labs in Bathurst is more complex. All are located in the same building, with the 24 hours lab being on a lower floor. There are, however, several entrances to the lower floor on which the computer labs are located thus allowing a student different points of access however for the analysis carried out for this research a decision was made to only use the distance to the nearest entry point. It is worth noting that one lab, Rm 302, is closest to a catwalk to an adjoining building and thus sees the most passing traffic (ranked 1). All other access points have access from below close-by. They are ranked by distance from the catwalk, with distance the nearest staircase given in brackets. As the number of terminals in the Bathurst labs varies, the analysis has to switch to average logins per machine.

Again, the lab closest to the main access point (catwalk) has the highest utilisation rate, being 69% higher than the next popular lab and 179% more popular than the third closest lab. Even the difference between the second and the third closest labs was still significant, being 66% higher.

In view of the above, students clearly vote with their feet. The proximity of the labs to the entrance, and the proximity of the terminals to the door are the prime drivers in terminal selection.

Discussion

The pattern of use of computers in student laboratories is important for resource planning. In this study, we have examined the spatial factors of computer use. We have posed the question of whether or not computers in laboratories are over or under used depending on their location relative to each other, and to other objects in the room such as doors, and anchor points such as walls. To our knowledge, this is the first published investigation of this issue.

Seating arrangements in this research mirror that in an office seating arrangement (Tripathi 2002) rather than that of a library environment (Fishman and Walitt 1972). Similarly the work completed by Leather *et al* (1998) does not translate directly to a university computer seating arrangement as our research could not demonstrate that students naturally sit near windows or views. In contrast to findings by Pause (2004), there was no evidence to suggest any preference for right or left side of the room in any of the laboratories studied Likewise there was no evidence of any effect of windows, whiteboards or security cameras.

In interpreting our observations it appears that the overriding rationale for a choice of terminal was one that was primarily driven

by rapid access to a terminal—but a terminal where the user was not exposed to prying eyes from the door and where the user's back was not close to entering traffic. Indeed, labs that were closer to the building's entrance were more frequented than labs that were further to walk to.

The generally diffuse seating preferences also suggests that there is no fixed or preferential pattern of seating that could be attributed to territorial control over the whole or part of a room. Likewise there is no systematic occurrence of over and underused terminals next to each other than could be attributed to comfort zone bubbles and similar concepts of situational territoriality.

It is possible that the length of use of a machine, on average only one hour (Spennemann *et al* in press) is a contributing factor. It would be worth assessing whether there is a length of use difference between the computer terminals. Would those (few) users who 'settle in' for the day, to complete an assignment or a project, choose different terminals compared to those who come for a short while only?

Future research should consider to assess the conscious or subconscious motivations of students in their choice of seating.

Implications on Asset Management

Uneven use of computers across a laboratory may lead to some machines producing more faults, leading to replacement of the entire batch even when such faults are associated with a few computers. The implications of this are that resources provided at some expense to universities may be under used because of the design of the rooms in which they are situated. Furthermore, we suggest that studies to identify alternative layout arrangements could result in more even use of these facilities, which could in turn allow universities to provide smaller rooms, with reduced associated costs. It is clear from this research that the computer terminals closest to the door are more likely to be overused compared to those furthest to an entrance. Further research needs to be conducted to determine whether these finding correspond to a higher number of breakdowns of these terminals closer to the door. Existing computer laboratories may be able to achieve greater life by rotation of machines.

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Table 1. Gender and age breakdown of the on-campus CSU student population in 2003 (Spennemann 2004, mixed mode students added)

Campus	Total	Percent		Average Age (years)	
		Women	Men	Women	Men
Albury-Wodonga	1649	67.6	32.4	23.3	24.3
Bathurst	3063	63.0	37.0	22.0	23.3
Dubbo	363	79.1	20.9	26.1	29.7
Goulburn	1562	32.7	67.3	26.3	27.2
Wagga Wagga	3199	31.8	68.2	22.9	23.5
Other	959	58.1	41.9	29.4	28.4

Table 2. Student Access Computer Infrastructure (machines)

	Business Hours Only		24-Hour Access	
	IBM	Apple	IBM	Apple
Albury	8	–	30	15
Thurgoona	49	–	20	–
Bathurst	191	45	21	7
Wagga	96	16	48	16
Total	344	61	119	38

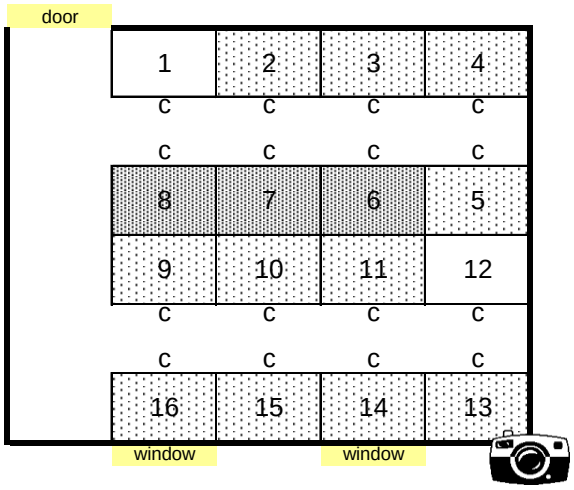
Table 3. Characteristics of laboratories and laboratory usage (nº of logins) for 2001–2003. Macintosh terminals shown in angular brackets.

Campus	Lab	Type	Access	Distance	Terminals	Number of logins			
						2001	2002	2003	Total
Albury	Lab 1	Peninsula	24 hrs	2	16	14016	26978	14343	55337
	Lab 2	Peninsula	24 hrs	1	16	17651	36295	23871	77817
Thurgoona	Lab 1	Peninsula	work 1	2	20	3373	6515	2341	12229
	Lab 2	Peninsula	work 1	1	20	4470	8074	4212	16756
	Lab 3	Peninsula	24 hrs	diff building	19 [1]	2681	9303	6390	18374
Wagga	Rm 225	Lecture	work 3	4	16	3884	6579	4948	15411
	Rm 227	Lecture	work 3	5	16	4777	8000	4907	17684
	Rm 242	Island	24 hrs	3	16	7992	13335	8963	30290
	Rm 243	Horseshoe	24 hrs	2	16	8403	16206	14612	39221
	Rm 244	Island	24 hrs	1	16	13770	28229	21724	63723
	Rm 259	Horseshoe	work 3	6	16	3138	5282	4142	12562
Bathurst	24hr lab	Anchored Row	24 hrs	diff floor	21 [7]	14177	28046	18637	60860
	Rm 302	Horseshoe	work 2	1	12 [6]	10013	20027		
		Peninsula	work 2	1	18			12630	42670
	Rm 305	Anchored Row	work 2	3	20	3797	8045	5093	16935
	Rm 306	Irregular	work 2	2	16	5506	10998	5988	22492
	Rm 309	Anchored Row	work 2	2	12	2138	4473	2689	9300
	Rm 312	Anchored Row	work 2	3	21	2831	8169	3964	14964

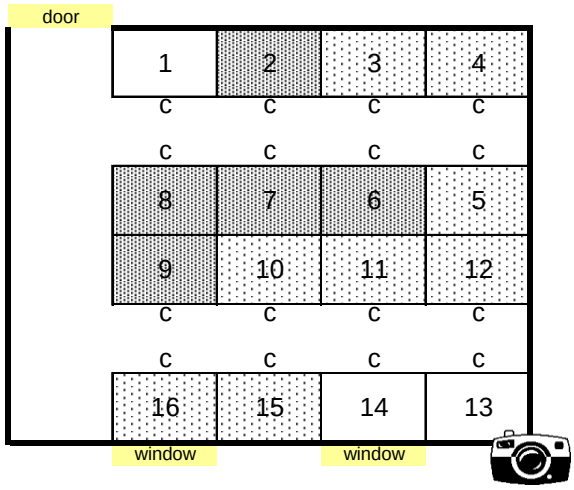
Legend: WORK 1: Mon-Fri 8:00–18:00; Sat 13:30–17:00.—WORK 2: Mon–Fri 9:00-22:00; Sat-Sun 10:00–16:00.—WORK 3: Mon–Fri 9:00–21:00; Sat 13:30–17:00.

Table 4. Comparison of average log-ins per computer 2001–2003 (Macintosh omitted)

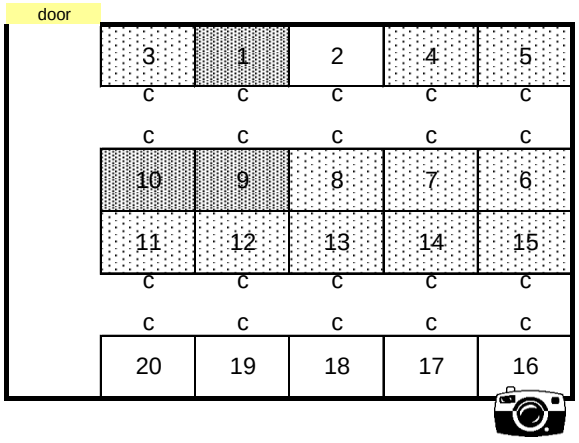
Bathurst			Average of logins			
Lab	Distance	PCs	2001	2002	2003	Total
Rm 302	1	12	834	834		
		18			702	2371
Rm 305	3 (3)	20	190	201	255	847
Rm 306	2 (2)	16	344	344	374	1406
Rm 309	4 (2)	12	178	186	224	775
Rm 312	5 (3)	21	135	195	189	713



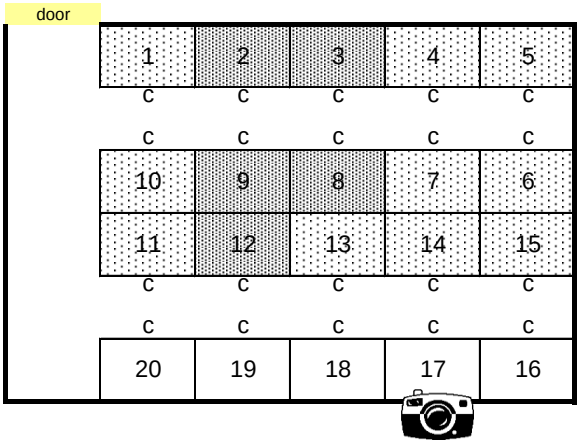
a) Albury laboratory 1



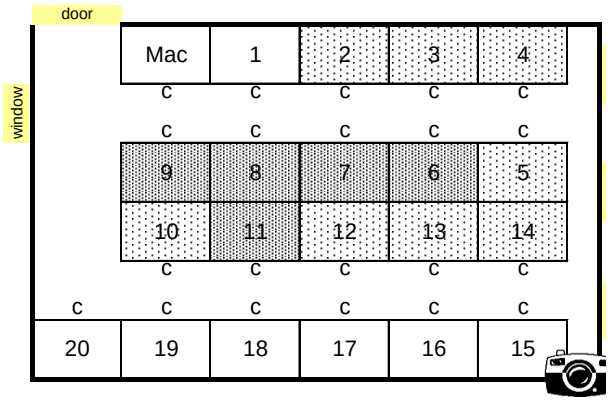
b) Albury laboratory 2



c) Thurgoona laboratory 1



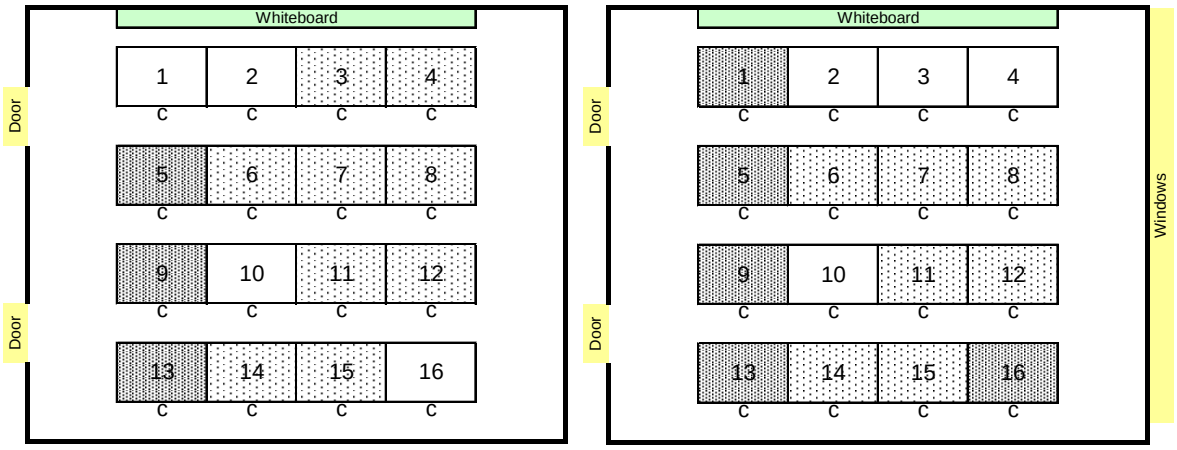
d) Thurgoona laboratory 2



e) Thurgoona laboratory 3

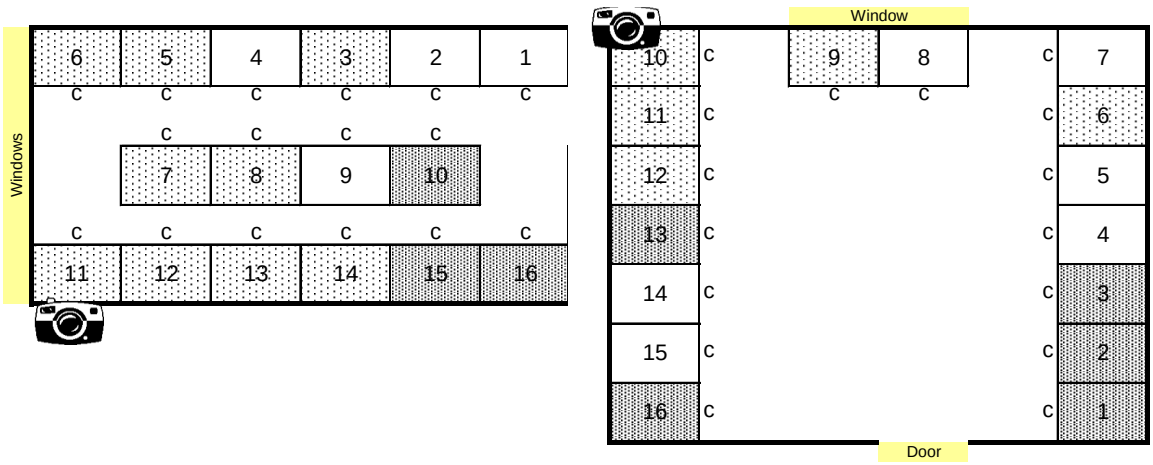
Figure 1. Schematic laboratory layout and usage at Albury and Thurgoona. Boxes indicate the positions of computers, and "c" indicates the position of a chair. Boxes are unshaded to indicate low use, heavily shaded to indicate high use, and lightly

shaded to indicate no significant deviation from the mean number of logins for this room. The camera symbol indicates the position of the security camera.



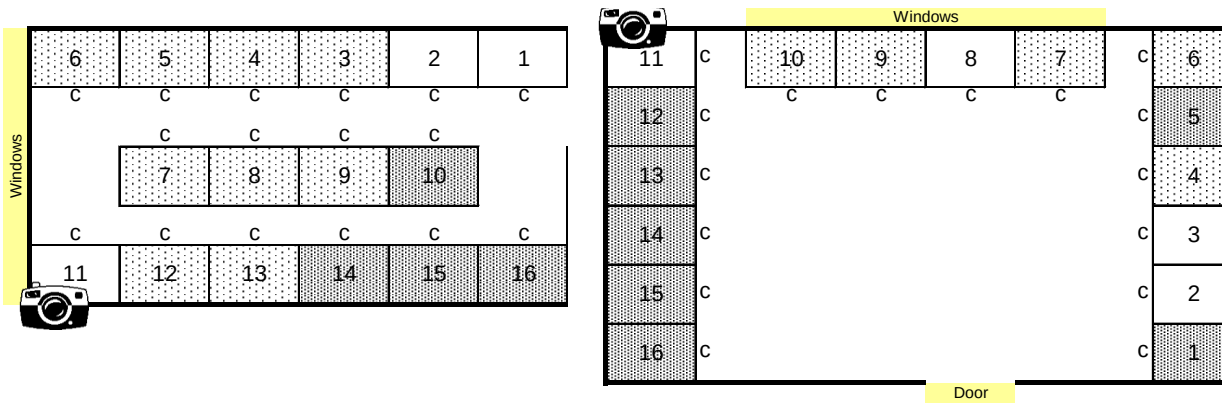
a) Wagga room 225

b) Wagga room 227



c) Wagga room 242

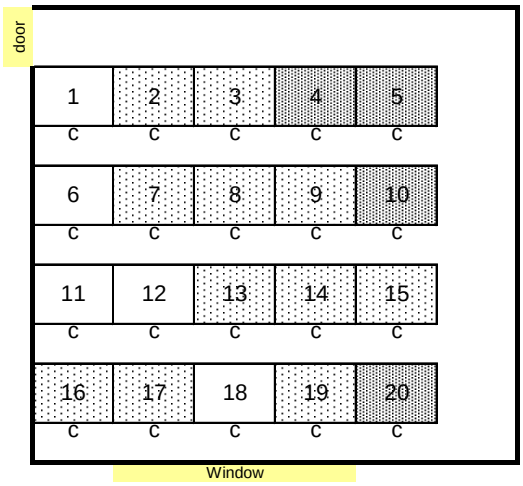
d) Wagga room 243



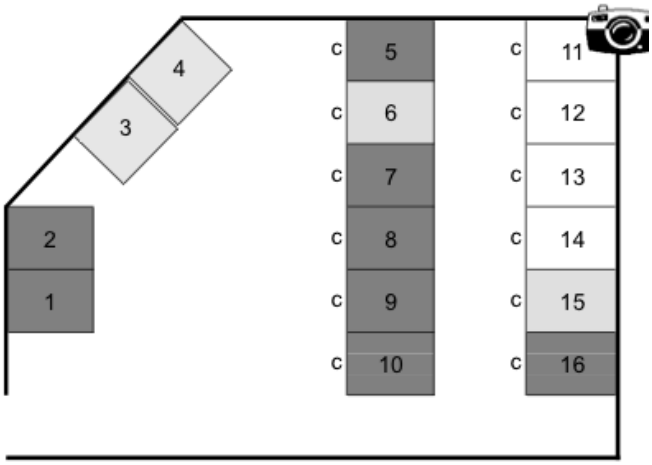
e) Wagga room 244

f) Wagga room 259

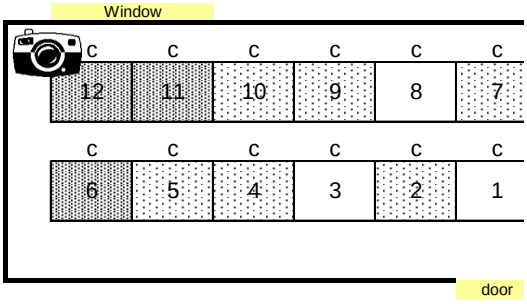
Figure 2. Schematic laboratory layout and usage at Wagga. Symbols are the same as used in figure 1.



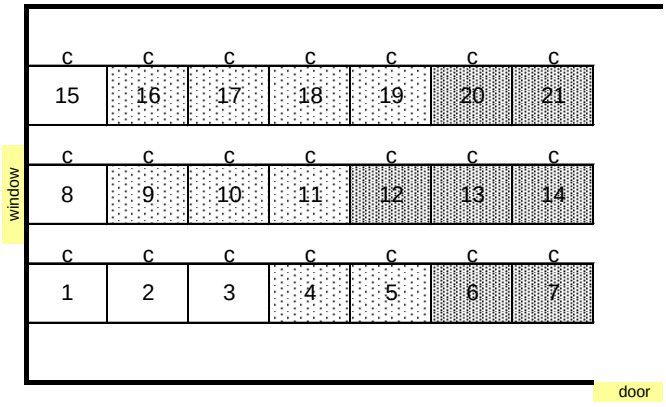
a) Bathurst room 305



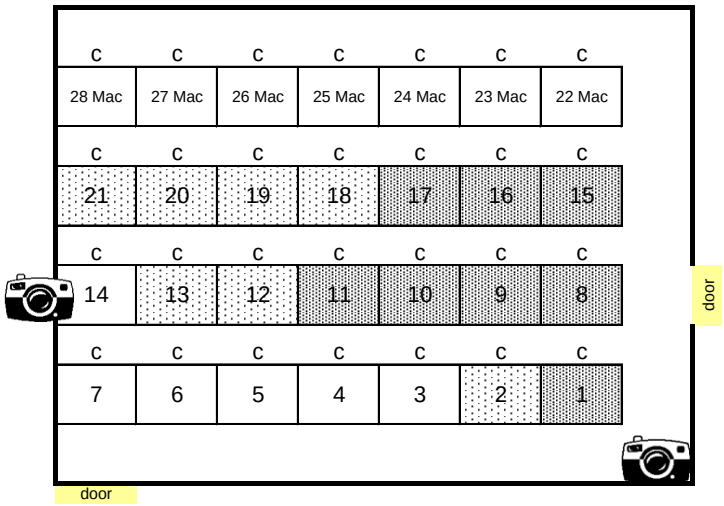
b) Bathurst room 306



c) Bathurst room 309

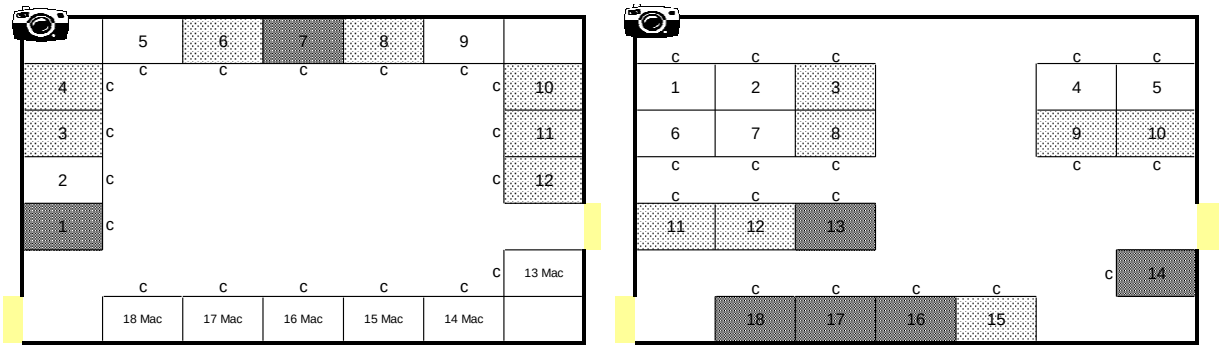


d) Bathurst room 312



e) Bathurst 24 hour lab. The top row indicates the position of Macs, which are not included in this study.

Figure 3. Schematic laboratory layout and usage at Bathurst. Symbols are the same as used in figure 1.



Pattern 2001-02 *Pattern 2003*

Figure 4. Schematic laboratory layout and usage at Bathurst room 302. Symbols are the same as used in figure 1.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Figure 1. Lay-out of the Wagga Wagga Computer Centre (Source: CSU website).
The 'Exit' signs demarcate emergency exists only)