EMPLOYEE SATISFACTION AND ATTITUDES WITHIN A MORE SUSTAINABLE COMMERCIAL LABORATORY AND OFFICE BUILDING

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ABSTRACT

A major driver for adoption of sustainable building practices is that they deliver increased employee productivity. This is based on employees being more satisfied with their work environment in green buildings compared with conventional ones. Employee satisfaction at a more sustainably designed laboratory and office building in Auckland, New Zealand, was examined in this study using a multi-method analysis. Three occupant satisfaction surveys were given to occupants over a 3-year timeframe, and a video voice project was run to provide qualitative analysis to enrich the survey findings. Nearly all the more sustainable features of the building (passive space conditioning, daylighting, and composting toilets) show higher degrees of occupant satisfaction than the areas that were designed and built using conventional strategies (kitchen, cafeteria, and mechanically ventilated spaces). The one key exception to this was the use of exposed concrete floors, ceilings, and walls as part of the passive space conditioning strategy – occupants find concrete ugly and noisy. Satisfaction was not immediate; occupants have shown the ability to adapt to the more sustainable features, using processes such as individual and community-driven improvements, humorous and metaphorical expressions of identification, and interest in the building as an experiment. These processes were not observed for conventional features of the building, where satisfaction is decreasing. Observations thus support the arguments that sustainable buildings have potential to deliver increased productivity relative to conventional design, though an increase may take time to develop.

KEYWORDS:

Sustainable building; post-occupancy evaluation; video voice; occupant satisfaction; commercial building

INTRODUCTION

Much has been written about the capability for ecologically sustainable "green" commercial buildings to influence employee productivity positively. The ability for increased productivity to drive green building implementation is shown in Kats et al. (2003), where the financial rates of return for productivity increases attributable to green building were shown to be nearly ten times those of any other benefit (e.g. energy efficiency, water efficiency). Increased productivity can lead to benefits such as financial savings resulting from reduced absenteeism, improved product quality, increased rates of production and increased sales (Romm and Browning, 1994).

These metrics measured by Romm and Browning (1994) are influenced by numerous other market variables besides building design, thus it is necessary to use occupant satisfaction as a proxy for productivity. Increases of productivity attributable to building design occur because ecologically sustainable buildings potentially deliver increased levels of comfort, control, health and overall satisfaction. Findings from the post-occupancy Probe study carried out on 16 commercial buildings in the United Kingdom, showed that comfort, self-control [of work environments], health and productivity were all positively correlated (Leaman and Bordass, 2001). In order to corroborate the claims of design-related increases in productivity made by Kats et al. (2003), it is useful to monitor occupant satisfaction with comfort, health, noise and other building services correlated with productivity.

This study attempts to monitor occupant satisfaction in the Landcare Research building, a more ecologically sustainable[1] commercial office and laboratory building in Auckland, New Zealand, that was first occupied in May 2004. A multi-method analysis approach was used to measure and describe performance related to occupant satisfaction and attitudes. This consisted of three separate occupant satisfaction surveys given over a three-year timeframe and a "video voice" project. The use of the two methods gives both breadth and depth to occupant satisfaction, providing potential benchmark values for comparison with other buildings as well as in-depth stories and experiences.

THE LANDCARE RESEARCH BUILDING

The Landcare Research building, located in the Auckland suburb of Glen Innes, New Zealand, was built in approximately two years between 2002 and 2004. The total floor area, including attached glasshouses, is 4828 m^2. In May 2007, 65 Landcare Research employees and 33 Ministry of Agriculture and Forestry (MAF) employees occupied the building on either a full- or part-time basis.

There are four key functional programmes that occur in the Landcare Research building. Laboratories built to PC1 and PC2 containment specifications occupy 1225 m^2 (25%) of the building. The national collections of arthropods and fungi are housed on site and these archival spaces occupy 668 m^2 (14%). There are climate-controlled experimental glasshouses attached to the building that occupy 395 m^2 (8%). Finally, office space for employees occupies 907 m^2 (19%). The remaining area is used for circulation space and communal servicing (including toilets, mechanical plant, kitchen, etc.).

The demonstration of more ecologically sustainable principles relative to conventional building practices was a key objective in the design of the building (Vale et al. 2006). Rather than using a provisional, checklist-type, design tool (such as Green Star, BREEAM, or LEED), the building focused on achieving the best possible environmental performance metrics while keeping under a budget of NZ$2,000 per square metre (roughly equivalent to the average cost of conventional commercial construction in Auckland) and ensuring occupants could move in before May 2004.

Energy efficiency was one goal of the building design, and actual energy consumption during 2005 was 28% less than what would be expected had it used conventional construction (Vale et al., 2006). Features that achieve this reduction include passive climate control using northern orientation, superinsulation, exposed thermal mass (concrete structural elements and concrete floor construction), and operable double-glazing in occupied spaces. Mechanical space-conditioning and ventilation were designed to service only the spaces where standards require it, such as the laboratories and collections. This restricted servicing regime has led to four separate mechanical servicing components based on varying space conditioning requirements. Control of all these mechanical features is automated through Building Management System (BMS) software. Energy use was also reduced through daylighting, with shallow-plan depths and an open atrium that ensures all offices have access to daylight and natural ventilation. All artificial lighting is done by 28W fluorescent bulbs (2 per ballast) controlled by manual switches located adjacent to the area being serviced. No automatic sensors or controls are used in the artificial lighting system.

Water efficiency was also a key element in the design of the building (Trowsdale et al., 2007a, 2007b), resulting in a smaller demand for mains water and reduced discharge of stormwater and wastewater to minimise its impact on natural waters. Mains water consumption has been reduced by collecting stormwater from the roof for non-potable re-use to flush conventional toilets and irrigate the glasshouse experiments. In addition, low-flow fixtures were used on all domestic appliances and 7 of 12 toilets in the building are waterless composting toilets, which also reduce wastewater discharge. Stormwater that runs off the carpark is treated using a bio-retention unit and raingarden placed in

[1] "More ecologically sustainable" and "more sustainable" are typically used to describe the Landcare Research building in this paper. These terms are to reflect that the building is more sustainable than if it were to be built using conventional design. It is still reliant – to a lesser degree – on unsustainable resources (e.g. fossil fuels).

series. Monitoring results show that less than 6% of annual carpark rainfall volume enters the city stormwater network (Trowsdale et al., 2007b).

In addition to energy and water efficiency, the building aimed for resource efficiency by using materials that were local, durable (the building has a design-life of 100 years) and renewable.

METHODS

Occupant Satisfaction Survey

The occupant satisfaction survey used in this study was taken from the National Australian Built Environmental Rating System (NABERS) pilot version for commercial building owners and tenants (Department of Environment and Heritage, 2004). NABERS is an existing-building assessment tool from Australia that uses environmental performance metrics to rate the in-use environmental impact of a building relative to national Australian averages. Performance areas measured by NABERS are carbon emissions (energy consumption and travel-to-work), waste, toxic material management, indoor air quality, refrigerant usage, water consumption, stormwater runoff (quantity and quality), sewage runoff, landscape biodiversity, and occupant satisfaction. Generally, scores in each area range from 0 to 5 and are presented relative to Australian averages (which represent a score of 2.5).

Occupant satisfaction survey scores must be compared with similar buildings that have conducted the same survey. It is the one exception to the general NABERS rule about Australian averages being scored as 2.5 out of 5 because the new tool has yet to develop a large database of comparable buildings. This survey tool is applicable in New Zealand because there are no Australian context-specific questions. Occupant bias can be assumed constant because this study only compares surveys performed at the same building over three separate time periods. Using a standardised survey such as this one will allow future research that compares this building with others in similar contexts.

The NABERS occupant satisfaction survey has been adapted from the Probe questionnaire (Leaman and Bordass, 2001) to fit a 1 to 5 scoring schedule so that it could work within the NABERS framework (while most NABERS scores range from 0 to 5, the satisfaction survey has a low-end boundary of 1, in line with the Probe questionnaire). Respondents were asked to rate their satisfaction with regard to noise, thermal comfort, ventilation, lighting, and health (Table 1) on a 1 to 5 scale, with 1 being extremely dissatisfied and 5 being satisfied. The survey also allowed each respondent to make open-ended qualitative comments on all of the major topic areas.

Two changes to the original NABERS survey questions were made for this study. In addition to the standardised NABERS questions, the researchers added an additional nine questions specific to the Landcare Research building (Table 1). These questions address satisfaction with the unique and communal aspects of the building, including composting toilets, showers, atrium, kitchen, cafeteria, carpeting, concrete, and library. Second, the researchers felt that satisfaction is a relatively neutral response, thus the opportunity was given to express a greater degree of satisfaction by including a “more than satisfied” option on the third survey. All responses of “more than satisfied” were noted and converted to a response of “satisfied” (score of 5) for use in the comparative analysis.

The scope of the NABERS survey questions was also expanded to fit the unique nature of a commercial laboratory and office building. Many employees have a secondary work area, such as a laboratory, glasshouse or archival collection space, in addition to an office desk. Thus the NABERS questions were asked twice, once for satisfaction at an occupant’s desk and once for satisfaction at an occupant’s secondary work environment. As these other working areas are mechanically ventilated and desk areas are passively ventilated, this study will allow a comparison of occupant satisfaction with different ventilation strategies in a more sustainable building.

Table 1 Scope of the occupant satisfaction surveys given at the Landcare Research building.

NABERS survey questions					Building-specific
Thermal Comfort	**Ventilation**	**Lighting**	**Noise**	**Health**	
Temperature Shifts	Draughts	Glare through windows	Noise from outside building	Sore eyes	Composting toilets
				Headaches	Showers
How cold it gets	Air freshness	Level of light	Office noise (voices & equipment)	Runny nose	Exposed ceilings and walls
				Dry throat	
How hot it gets	Air movement	Glare from lights	Noise from mechanical systems	Dry or irritated skin	Concrete floors
					Carpet tiles
Overall experience	Overall experience	Overall experience	Overall experience	Lethargy	Kitchen
				Dizziness	Cafeteria
				Nausea	Library
					Atrium

The survey has been administered at the Landcare Research building three times since occupancy. The first survey was given in June 2004, 1 month after the building was first occupied. The second survey took place in October 2005, and the most recent survey was conducted in May 2007. Methods of administration varied throughout the three survey periods. The first survey was administered using paper forms that were provided to each occupant and returned anonymously to the researcher. The second survey was given via the internet. The last survey was also given via the internet; but paper copies of the internet survey were made available on request. Responses from all three surveys were completely anonymous.

Video Voice

Video voice is a qualitative research method that not only captures visual and audio data but creates a participatory process, shifting power dynamics between the interviewer and the interviewee (Foster-Fishman et al., 2005; Kindon, 2003). It is a commonly used method in community-based and participatory research processes (Higgins, 2004). This study chose to use video voice in an organisational setting to enhance our multi-method research approach and provide depth to the quantitative data gained though the surveys.

A video camera was made available to staff over a 2-week period in May 2007 (corresponding to the third occupant survey) with a request for people to record the aspects of the building that they enjoy, and those that puzzle and/or frustrate them. Occupants were invited to participate through e-mails and posters and, more effectively, through direct approach from the researcher.

Participants were given the video camera, shown how to use it and then recorded segments according to their own interests. The researcher probed some participants for clarification or to ensure matters previously discussed off camera were captured on camera. In one case, a participant requested the researcher film her while she talked to the camera. Staff had been informed the footage would be used for research and to inform the ongoing management of the building, thus the data and the process were in no way confidential or anonymous.

The process of analysis was in two stages. The authors invited colleagues who undertake research on the building to a group analysis session of the video footage. This process gave breadth to the analysis as diverse backgrounds brought different perspectives into the discussion. Outcomes from this discussion were collated with one author's own observations to describe themes that run through the video footage.

RESULTS

Occupant Satisfaction Survey

Response rates were 71%, 62% and 51% for the June 2004, October 2005 and May 2007occupant surveys respectively. The most recent survey may have had a low response rate because some MAF

employees reported problems accessing the internet-based survey. Although paper surveys were made available to those experiencing difficulties, there was a notable difference between the MAF response rate (30%, 10 out of 33) and Landcare Research response rate (58%, 42 out of 72).[2]

Results over the three surveys are presented for both an occupant's desk and their other working area. To produce findings related to satisfaction with mechanical ventilation, responses in other working areas were controlled to include only mechanically ventilated areas. This meant three responses in May 2007 were removed from the analysis of other working areas because one referred to an occasional event at the respondent's desk and the other two were not mechanically ventilated areas.

Desk responses from the most recent (May 2007) survey were also able to be categorised by floor. Of the 54 responses, 14 were from occupants on the ground floor, 26 from the first floor, and 12 from the second floor. Two respondents did not indicate on which floor they work.

Thermal Comfort

The survey results for thermal comfort (Table 2) present some notable trends. The satisfaction with thermal comfort at desk environments appears to be generally increasing over time, while satisfaction with thermal comfort at other working areas of the building appears to be either decreasing or remaining stable. This has led to the most recent survey showing a large margin between overall thermal comfort satisfaction at desks (3.88 out of 5) when compared with other working areas (2.78). Results from the third survey show that occupants on the highest floor tend to have lower satisfaction with both extremes of temperature and overall temperature satisfaction. Generally, those on the ground floor were more satisfied with thermal comfort than those on the first and second floors.

When compared with other NABERS survey categories (Tables 2 to 6), thermal comfort at other working areas ranks as the highest source of employee dissatisfaction with these other working areas. Using the results from the May 2007 survey, overall temperature experience at other working areas scored 2.78 (out of 5), while overall ventilation experience scored 3.38, overall noise scored 4.03, overall lighting scored 4.22, and all health-related aspects scored greater than 4.

Qualitative survey comments in 2007 on thermal comfort mostly expressed dissatisfaction, with the most common complaints being related to thermal extremes (too hot in summer, too cold in winter).

Ventilation

Scores for ventilation (Table 3) are generally consistent, but do show a few trends. Occupant satisfaction at desks and other working areas is similar – the exception is a higher degree of satisfaction with air movement and overall experience at desks in the 2007 survey. Similarly, ventilation satisfaction is generally evenly spread across the three floors, although ground floor occupants are slightly more dissatisfied with draughts. Over time, satisfaction in all surveyed aspects of ventilation increased marginally, although satisfaction increases were more notable for draughts (other working areas) air movement (desks) and overall experience (desks) in the most recent survey.

There were many qualitative comments on ventilation received in the May 2007 survey; nearly all expressed dissatisfaction. Nine comments were received that expressed dissatisfaction with the lack of air movement; of these, three complained about permanently closed windows in laboratories. Six respondents were dissatisfied because opening windows and doors allowed too much noise to be heard. Other reasons for dissatisfaction were given as poor design of mechanical systems, too high a degree of variability, and incoming air from ventilation systems being too cold. The only two comments expressing satisfaction appreciated the availability of natural ventilation.

[2] The Landcare Research total eligible respondent count of 72 includes 7 employees who do not work in the building but did receive the survey invitation and may have completed a survey.

Table 2 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with elements of thermal comfort over three separate survey periods. The second part of this table shows the May 2007 results by floor.

Survey Questions (Thermal Comfort)		June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
					Ground	First floor	Second floor
Temperature shifts	Desk	3.32	3.23	4.02	3.93	4.08	3.92
	Other areas	2.86	3.04	2.87	-	-	-
How cold it gets	Desk	3.29	3.28	3.56	3.73	3.76	3.00
	Other areas	3.62	3.43	3.11	-	-	-
How hot it gets	Desk	3.75	3.28	3.76	4.20	3.87	3.27
	Other areas	3.43	3.46	2.96	-	-	-
Overall temperature experience	Desk	3.28	3.05	3.88	4.14	3.92	3.50
	Other areas	2.74	2.67	2.78	-	-	-

Table 3 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with ventilation over three separate survey periods. The second part of this table shows the results from May 2007 by floor.

Survey Questions (Ventilation)		June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
					Ground	First floor	Second floor
Draughts	Desk	4.16	4.10	4.38	4.00	4.48	4.58
	Other areas	3.61	4.00	4.35	-	-	-
Air freshness	Desk	3.26	3.23	3.58	3.57	3.44	3.75
	Other areas	3.28	3.33	3.44	-	-	-
Air movement	Desk	3.02	3.10	4.02	4.21	3.92	3.92
	Other areas	3.11	3.13	3.59	-	-	-
Overall ventilation experience	Desk	3.18	3.23	3.94	4.00	3.92	3.92
	Other areas	2.97	3.13	3.38	-	-	-

Table 4 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with noise. No figure is available for satisfaction with noise from outside the building at other working areas in 2007 because responses were not recorded correctly. The second part of this table shows the results from May 2007 broken down by floor.

Survey Questions (Noise)		June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
					Ground	First floor	Second floor
Noise from outside building	Desk	3.92	3.95	4.25	3.79	4.44	4.42
	Other areas	4.05	4.13	n/a	-	-	-
Office noise (people and equipment)	Desk	2.66	3.33	3.19	3.86	2.84	3.17
	Other areas	3.81	4.13	4.06	-	-	-
Noises from air-conditioning and lighting	Desk	3.86	3.60	4.44	4.50	4.60	4.17
	Other areas	3.43	3.73	4.16	-	-	-
Overall noise experience	Desk	2.84	3.20	3.42	3.79	3.20	3.42
	Other areas	3.27	3.61	4.03	-	-	-

Noise

Results from questions about noise satisfaction (Table 4) show a higher degree of dissatisfaction at desk areas compared with other working areas for all three survey periods. When compared with all other NABERS survey categories (Tables 2 to 6), noise at desk environments ranks as the highest source of dissatisfaction with occupants' desks. Using the results from 2007 survey, overall noise experience at desks scored 3.42 (out of 5), while overall temperature experience scored 3.88, overall ventilation scored 3.94, overall lighting scored 4.31 and all health-related aspects scored above 4.

Spatial trends show that ground floor occupants have a higher degree of satisfaction with both office noise and overall noise than occupants of upper floors. Conversely, occupants of the upper floors have higher satisfaction with noise from outside the building than ground floor occupants. It is worth noting that between the second and third surveys, many, but not all, of the ground floor offices were carpeted. The two notable trends over time indicate satisfaction is increasing with regard to both noise from air-conditioning and overall noise. These trends are evident for both desks and other working areas.

Table 5 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with lighting over three separate survey periods. The second part of this table shows the results from May 2007 broken down by floor.

Survey Questions (Lighting)		June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
					Ground	First floor	Second floor
Glare through windows	Desk	3.76	3.36	3.96	4.00	3.88	4.08
	Other areas	3.85	3.57	4.16	-	-	-
Level of light	Desk	4.00	3.93	4.56	4.29	4.76	4.42
	Other areas	4.09	4.17	4.28	-	-	-
Glare from lights	Desk	4.38	4.33	4.65	4.36	4.72	4.83
	Other areas	4.55	4.35	4.66	-	-	-
Overall lighting experience	Desk	3.98	3.73	4.31	4.43	4.20	4.33
	Other areas	4.19	3.83	4.22	-	-	-

Table 6 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with occurrence of poor health conditions associated with the building over three separate survey periods. The second part of this table shows the results from May 2007 broken down by floor.

Survey Questions (Health)		June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
					Ground	First floor	Second floor
Sore eyes	Desk	3.60	3.92	4.06	3.92	4.12	4.00
	Other areas	4.35	4.09	4.06	-	-	-
Headaches	Desk	4.08	4.14	4.06	4.00	4.16	3.83
	Other areas	4.46	4.30	4.28	-	-	-
Runny nose	Desk	4.30	4.06	4.75	4.69	4.72	4.83
	Other areas	4.53	4.48	4.81	-	-	-
Dry throat	Desk	4.18	4.08	4.49	4.29	4.58	4.50
	Other areas	4.31	4.14	4.41	-	-	-
Dry or irritated skin	Desk	4.35	4.14	4.65	4.69	4.60	4.67
	Other areas	4.51	4.17	4.59	-	-	-
Lethargy	Desk	4.20	4.27	4.25	4.31	4.16	4.33
	Other areas	4.49	4.22	4.47	-	-	-
Dizziness	Desk	4.70	4.63	4.71	4.69	4.68	4.75
	Other areas	4.86	4.61	4.69	-	-	-
Nausea	Desk	4.85	4.73	4.80	4.69	4.83	4.83
	Other areas	4.89	4.65	4.81	-	-	-

Qualitative comments from the survey describe many of the reasons for dissatisfaction with noise. In 2007, ten comments indicated that noise from fellow office workers is too loud and distracting. Five occupants complained about street noise. Four occupants found noise from the mechanical systems to be the most notable source of dissatisfaction. Other aspects of the building that led to dissatisfaction with noise include poor design of open-plan areas, workmate behaviour, and the security system.

Lighting

In general, satisfaction with lighting (Table 5) is high compared with other categories, especially thermal comfort, ventilation and noise. In the May 2007 survey, all questions related to lighting scored over 4 (out of 5), except for glare through windows at desk environments, which scored 3.96.

Qualitative comments from the most recent survey tell a similar story. Unlike thermal comfort, ventilation and noise comments, which were almost universally negative, the comments associated with lighting are more evenly balanced between satisfied and dissatisfied occupants. Dissatisfaction is concentrated on glare (9 comments), though noise from blinds generated three complaints. Six comments expressed satisfaction with the availability of natural light in the building. Eight occupants commented on how pleased they were with the overall lighting strategies used in the building.

Health

As with lighting, respondents show a high degree of satisfaction with their health in the building (Table 6). In the most recent survey, all questions related to health scored greater than 4 (out of 5).

Table 7 Average satisfaction (1=extremely dissatisfied, 5=satisfied) with building-specific communal services over three separate survey periods. Responses for the showers were not correctly recorded during the first two surveys. The second part of this table shows the results from May 2007 broken down by floor.

Survey Questions (Building-Specific)	June 2004	Oct 2005	May 2007	May 2007 spatial breakdown		
				Ground	First floor	Second floor
Composting toilets	3.80	3.90	4.54	4.50	4.56	4.45
Showers	n/a	n/a	4.87	5.00	4.67	4.75
Concrete floors	1.41	2.51	2.91	3.71	2.81	2.33
Exposed ceilings and walls	1.80	2.90	3.26	3.86	3.00	3.33
Carpet tiles	2.17	3.61	4.02	4.57	3.88	3.92
Kitchen	3.11	3.05	2.75	2.43	2.85	3.09
Cafeteria	2.98	3.05	2.65	2.14	2.85	3.00
Library	3.27	4.39	4.71	4.71	4.64	4.83
Atrium	3.43	2.83	3.40	4.00	3.44	2.82

Qualitative comments received in the May 2007 survey on health issues showed the majority to be positive reaffirmations of the occupant's high degree of satisfaction with their health. Seven comments were received that reiterated the respondent's general satisfaction. Of the few comments that described states of dissatisfaction, three complained that poor airflow in the building is a concern.

Building-Specific

Satisfaction scores with specific elements of the Landcare Research building are presented in Table 7. In the most recent survey, the highest rated communal services are the showers (4.87 out of 5), the library (4.71), composting toilets (4.54), and the carpet tiles (4.02). Throughout the standardised NABERS survey results (Tables 2 to 6), there were no categories where a notable number of occupants indicated that they were "more than satisfied" with a particular aspect. However, in these building-specific areas, seven respondents indicated they were "more than satisfied" with the composting toilets and five occupants were "more than satisfied" with the carpet tiles. Although past survey data were not available for the showers, there has been a notable increase in satisfaction over time with the library, composting toilets and carpet tiles.

The lowest rated elements of the building were the cafeteria (2.65), the kitchen (2.75) and concrete floors (2.91). Concrete floors and exposed ceilings and walls have historically been the most dissatisfying aspect, but both show increases in satisfaction over time. Conversely, the cafeteria and kitchen show slight declines in satisfaction over time.

From the spatial breakdown, one notable trend is that the ground floor shows higher satisfaction with the concrete floors, exposed ceilings and walls, atrium and carpet tiles than the upper two floors. However, the ground floor occupants show a higher dissatisfaction with the kitchen and cafeteria spaces (which are located on the ground floor) than occupants on the upper two floors.

Comments in the most recent survey centred on four of the building-specific aspects. Sixteen comments expressed dissatisfaction with the concrete floors, most (11) because it was ugly and looked unfinished. The other 5 responses on concrete commented that it was difficult to clean, cold, and noisy. Twelve respondents expressed dissatisfaction with the kitchen: it was poorly designed, and was too small for peak times. Eleven comments expressed dissatisfaction with the cafeteria because it was either too small, unappealing or too cold. The positive comments were mainly on the atrium: 16 occupants expressed their satisfaction with the atrium, mainly because it was aesthetically pleasing and necessary for light and ventilation.

Video Voice

In total, 11 staff members used the video camera. The themes recorded on video were very similar to those captured through the survey, relating to the functions and aesthetics of the building. Key functional issues were lighting, ventilation, use of space, amenities, compliance with regulations

(hazard and emergency) and noise. Some people expressed awareness that functional requirements, such as steady temperatures for collection areas and laboratories plus health and safety regulations were limiting the functioning of sustainability features. For example, the use of blinds to keep an area cool on a summer's day and to stop direct sunlight destroying samples leads to the use of electric lighting. Positive statements about the functioning of the building were also connected to improvements from the previous building in the Auckland suburb of Mt Albert. People expressed a sense of identification with parts of the building through their making places more attractive or comfortable. There are multiple ways people cope with their frustrations or manipulate their environment through adaptations such as artwork or small electric fans that they can control.

Issues relating to the look and feel of the building were concentrated on the untreated concrete floors, white walls, aluminium cladding and exposed cables and pipes. Two metaphors for the building were used negatively, "it's like living in a cow shed", and "I call it the tin can". Another, more positive, metaphor was "it feels like being in a ship". Some participants revealed they were able to influence the aesthetics in their offices and spoke of being able to make changes to communal areas. Others revealed a sense that changing aesthetics was out of their control.

The video footage gave insight as to how people are adapting to the building, how it influences their work and how they are making sense of the building. The atrium, conversation nooks, and outdoor cafeteria area were held in high regard. References were made not only to the aesthetics and function of these places but also to how they came about through the collective efforts of staff. Appreciation was partially due to people's involvement in the creation of places.

For some participants, the idiosyncrasies of the building that frustrated them represented an unfinished or poorly constructed building. There was a sense of failure, also of mistakes being made. Three participants spoke positively of being involved in an experiment of sustainability:

> "I really enjoy being part of this experiment to make a workplace as sustainable as possible."
> "I have great pride bringing people showing them bits and pieces like the composting toilets."
> "Not every thing works well and things aren't perfect, but the cause is a good one".

These comments were made by occupants with knowledge of how the building functions; they had also been involved in adaptations to the building as issues were solved or areas made more 'liveable'.

DISCUSSION

As a more sustainable building, the Landcare Research building combines both conventional and sustainable design strategies. One key theme to emerge from the surveys is that areas of dissatisfaction in the building are mainly with conventional aspects of the building (the concrete floors are a notable exception), and therefore findings are remarkably similar to dissatisfaction in conventional buildings as described by Leaman and Bordass (2001). The lowest scoring areas in the Landcare Research building were thermal comfort (especially in mechanically ventilated areas) and noise (especially at individual desks), while the highest scoring aspects, for both desks and other working areas, were lighting and health. These trends were similarly observed in the Probe studies of conventional buildings in the UK (Leaman and Bordass, 2001). On a building-specific level, increasing levels of dissatisfaction with the small size of the kitchen and cafeteria refer to conventionally designed areas of the building where the only addition to more sustainable design was to use local, durable and renewable materials.

However, the one aspect of the Landcare Research building where the objectives of a more sustainable design are potentially increasing employee dissatisfaction relative to conventional buildings is the extensive use of exposed concrete for thermal storage capacity. As a building-specific feature, the exposed concrete has consistently scored low on the satisfaction survey. From both the survey comments and the video voice project, the dominant opinion was that these concrete floors were

dissatisfying from an aesthetic perspective, as there were comments on the unfinished look of the concrete and its association with poor construction techniques or cost-cutting practices. In addition, the concrete may well contribute to the relatively high dissatisfaction with noise at occupants' desks, since occupants in mostly carpeted offices on the ground floor showed a higher level of satisfaction with office noise than did the upper floor occupants, whose desks have mostly concrete flooring.

This functional reason for dissatisfaction with the concrete – increased office noise – presents a trade-off between two separate, yet intertwined, aspects of occupant satisfaction in the Landcare Research building. The thermal mass is a functional component of passively conditioned spaces, which occupants find to be more satisfying than the mechanically conditioned spaces. Management strategies that would address noise (e.g. carpeting over the concrete) would isolate the thermal mass from the internal environment, potentially decreasing the functionality of passive conditioning. There is therefore an opportunity to use the Landcare Research building for future research to experiment and monitor the performance of alternative floor coverings that are designed to reduce noise disturbance while allowing the internal environment to interact with the thermal mass below.

Besides the concrete, other features specific to objectives of sustainable design, especially passive space conditioning and composting toilets, received relatively high marks for employee satisfaction, especially in the most recent survey. Satisfaction with overall temperature experience shows a notable preference towards passive conditioning, with passively conditioned desks scoring 3.88 out of 5 and mechanically conditioned areas scoring 2.78. A similar gap in favour of passively conditioned spaces exists for overall ventilation experience. Surprisingly, with a satisfaction score of 4.54 out of 5, the composting toilets produced one of the highest measurements of employee satisfaction when compared with other aspects of the building. The toilets also received seven "more than satisfied" responses – more than any other question on the survey.

In the video voice project, which shed more light on the reasons for satisfaction, there were many positive comments and video frames depicting areas featuring daylighting and passive conditioning. This is likely because occupants were able to have a greater degree of control over these features, both as individuals and through collective involvement.

Overall, the multi-method analysis shows that employees can adapt to the sustainable design features of the building. The surveys have shown consistent improvement in satisfaction over time for many of these features, including passive space conditioning, composting toilets, and even the concrete floors. A video voice project expanded on this finding, describing how processes for adaptation vary between occupants and can include individual and community-driven actions towards improvement, humorous and metaphorical substitution ("it feels like being in a ship"), or expressions of identification and interest in the role of the building as an experiment. Stable or declining measures of occupant satisfaction have occurred in conventional areas of the building, where occupants cannot control how they adapt (e.g. the mechanical system is complex and entirely computer-controlled; the kitchen is a fixed size that cannot be changed). They may also have fewer avenues for adaptation to the conventional areas because it is difficult to associate such spaces with an experiment in sustainability when there is little, if any, difference to common practice.

CONCLUSION

The multi-method analysis techniques of using both a series of occupant satisfaction surveys and a video voice project was helpful not only to describe relative degrees of satisfaction, but also to describe some of the reasons behind what occupants found dissatisfying and satisfying. Nearly all of the sustainable features of the Landcare Research building (passive space conditioning, daylighting, and composting toilets) currently show higher degrees of occupant satisfaction compared with the areas that were designed and built using conventional strategies (the kitchen, cafeteria, and mechanically ventilated areas). The one key exception to this was the use of exposed concrete floors, ceilings, and walls as part of the passive conditioning strategy – occupants find them to be

aesthetically ugly and noisy. Much of this relatively high degree of satisfaction with the sustainable features has taken time to develop. Occupant satisfaction appears to be developing in connection with adaptation processes such as individual and community-driven improvements, humorous and metaphorical expressions of identification with the building, plus continued interest in the building as an experiment. These results confirm arguments that there is potential for sustainable buildings to increase employee productivity, though it may take time for this increase to develop.

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