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& UNISEARCH

UNIVERSITY OF NEW SOUTH WALES

STRINGYBARK GROVE

POST OCCUPANCY EVALUATION

and NatHERS Energy Simulation

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EXECUTIVE SUMMARY

In December of 1995, people living in the Stringybark Grove complex in Lane Cove, Sydney were asked to comment on and evaluate the experience of living there. This day-to-day experience is of vital concern to designers of housing, since they do not usually have the opportunity to live in the buildings they design. 'Insider' information of this kind has a logic and credibility of its own, even though residents or 'users' do not usually know how to design a building themselves. Creating successful and satisfying buildings, which have a low impact on the ecological environment while simultaneously providing opportunities for the enjoyment of a high quality lifestyle, is dependent on a synthesis of both designer expertise *and* user experience.

It may seem a simple task to ask people to reflect on the experience of living in their own home, and to estimate the extent of their satisfaction. In reality, however, the interaction between people and the places they inhabit is exceedingly complex. Creating a building that supports the very wide range of activities performed in a house, everyday and night, and satisfies the equally wide range of expectations that people have about what it *should* be like to live there, is no mean task.

Not only do fundamental geographic, locational and climatic conditions need to be taken into account - and the energy efficiency and thermal comfort consequences which flow from these interactions, but myriad other related considerations are also part of the equation, ranging from the nature of the materials with which the house has been constructed and possibilities for recycling water or minimising waste, to solar and renewable energy sources (possibly integrated into the building). Added to this already complex set of *sustainability* criteria are the lifestyle amenity, life quality or *habitability* aspects such as natural daylight penetration, a cool courtyard in summer, the functional relationship of the various rooms to one another and of each dwelling to all others, the aspect or view, the aesthetics or style of the building, the impact of road noise or a perceived sense of security. Both sustainability and habitability expectations and criteria must be resolved in the design.

A correspondingly wide range of disciplinary areas within the general ambit of environmental design need to be integrated into the research methodology and relied upon to

inform the analysis and interpretation of the data. A Post Occupancy Evaluation (or POE) is an interdisciplinary methodology which allows for the evaluation of both the performance of a building and the experiences of the users of the building.

In the POE undertaken at Stringybark Grove, the emphasis was on *user-experience,* evaluated by means of a wide variety of qualitative measures including comparisons with past experiences, assessments of perceived importance, preference, acceptability and motivation, as well as thermal comfort and lifestyle or amenity satisfaction. Nine households were interviewed. The survey technique adopted was a questionnaire conducted as a face-to-face interview in respondents' homes. Building performance, as measured by actual levels of household *energy and water consumption* was monitored separately by Sydney Electricity and Sydney Water. Simulated energy consumption levels were calculated employing the NatHERS (Nationwide Home Energy Rating Scheme) simulation program (see Chap. 5).

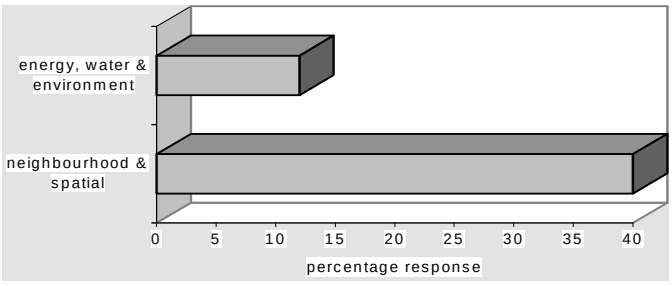
- In general, the results of the survey indicate that satisfaction with the experience of living in Stringybark Grove is very high. A POE, however, also gives residents an opportunity to voice specific *dis*satisfactions These ranged from the functioning of the plumbing system, the solar design, ventilation and energy efficiency aspects, to issues of security, comfort, road-noise, and privacy amongst others. A review of these *dis*satisfactions can produce useful feedback into the design process.

A wide range of salient findings relating to user expectations, experiences and evaluations emerged from this research.

1. Expectations and Motivations

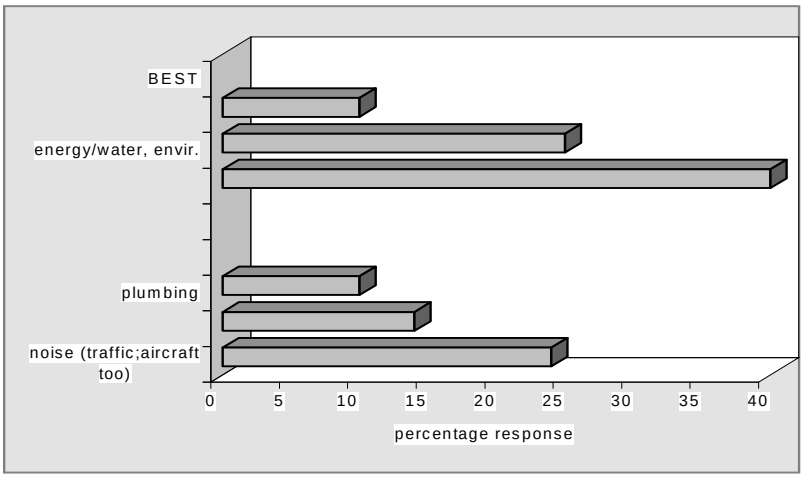
- When residents were deciding on a place to live or rent the major reason why they chose Stringybark Grove was location (26% of the time). Neighbourhood amenities and spatial qualities of the house, together, accounted for more than 40 per cent of purchaser motivations, while only 12 per cent of motivations related to energy, water and environmental issues.

Fig i: Comparative Motivations: Choosing to live in Stringybark Grove



- Locational aspects (proximity to city, in particular) and spatial aspects also represented more than 40 per cent of respondents' evaluations of the *'best things'* about their houses, while satisfaction with energy, water and environmental-impact aspects accounted for about one quarter. Road noise was said to be the major inconvenience or *'worst thing'* about living in Stringybark Grove.

Fig ii: Best and Worst Things About the Houses



2. Energy and Water: Attitudes (Importance) and General Satisfaction

- Respondents were almost unanimous in their agreement about the importance of saving energy and water, and the acceptability of re-using/recycling water. However, only 56 per cent of respondents were satisfied with either their *energy bills* or *water bills*.

3. Thermal Comfort and Sunlight & Daylight Penetration

- Overall satisfaction with comfort (temperature), sunlight and daylight penetration in *livingroom* areas was very high, 100% in the summer period and 85% in winter. However,

satisfaction varied considerably in *bedrooms*. The lowest overall satisfaction level (52%) was recorded for temperatures during summer, specifically related to the problem of overheating in upstairs bedrooms. Conversely, sunlight penetration into bedrooms during winter was considered insufficient, with a correspondingly low satisfaction with winter daylight penetration and comfort/temperature.

- Satisfaction relating to comfort during the summer in the outdoor courtyard area was also low (45%).

- Natural cooling/ventilation of the house was considered successful by 2/3 of respondents.

4. Performance of Energy and Water Appliances/Systems

- Overall, satisfaction with the performance of both energy and water appliances was in the 60% range, which is low, given the emphasis put on these aspects in the design of the Stringybark Grove housing. This can be largely explained by the poor performance of specific elements of each system, which is unfortunate as the conservation features were intended to be non-intrusive.

- 56 per cent of respondents were *dis*satisfied with the low water pressure in the showers (due to a poorly functioning shower head restrictor), and a similar percentage considered the length of time (lag) before hot water reached the taps (particularly in upstairs bathrooms) to be excessive.

  *Dis*satisfaction with the performance of electrical devices centred on the automatic curtains and movement detectors.

- The Quantum heat pump was very well received - respondents commenting frequently on the abundance of hot water.

5. Resident Behaviour: Energy, Water and Comfort

- **One third of the Stringybark Grove households did <u>not</u> need to heat *at all* during the winter**, a reflection of the efficacy of the solar design principles built-in to the houses.

Several other households mentioned that they only heated intermittently, largely in the bedrooms.

- The majority of energy-saving and water-saving household behaviours were concerned with simple day-to-day routines, such as turning-off lights, or using appliances carefully.
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6. Changes Made to the House

- Most modifications pertained to changes made to the courtyard, principally the removal of the white pebbles and their replacement with paving or grass; and also changes to the pergola, and increasing the height of the courtyard wall for privacy.

- Interior changes related largely to modification of doors.

7. Amenity/Lifestyle Aspects

- Overall, the satisfaction rate with lifestyle or amenity aspects was high (71%), while *dis*satisfaction was rated at only 17%. The *dis*satisfactions related to: lack of information about how to run the house and garden efficiently or effectively (78%), noise from aircraft (67%) and from traffic noise in bedrooms (33%), a perceived lack of security in general (44%) and lack of privacy - in both courtyards (45%) and indoors (33%). Outdoor play facilities for children were also found to be inadequate (44%). Generally, the external lighting in the complex was unsatisfactory.

- Value-for-money (*ie* the investment or re-sale value of the house) was considered to be reasonable, although there was some reservation about 'marketability' in the future, due to aircraft noise and the anticipated impact of the M2 freeway.

- Respondents expressed very high satisfaction with the lack of noise between houses and from communal spaces, and with the aesthetics of the complex - in particular the 'urban-village' style architecture and the mix of materials, and also with interior design or the functional relationship of spaces to each other. Accessibility by car and access to bus services were appreciated, although accessibility for the elderly or disabled was found to

be unsatisfactory to some degree. The capacity of the house and housing complex to meet general lifestyle expectations of residents was found to be entirely satisfactory. Similarly, virtually every respondent was satisfied with the medium-density townhouse cluster-type of living.

Conclusion

Information emerging from the Stringybark Grove POE could allow for the adaptation and improvement of the houses, as *feedback*, and could also be utilised as *feedforward*, informing future design, development and policy-making decisions.

Irrespective of how important it might be to *build-in* energy and water efficiency *potential*, it is user behaviour which ultimately determines the extent to which that potential is realised. Accordingly, returning information to occupiers as a post occupancy evaluation report and as regular energy/water consumption feedback graphs and, most importantly, providing an information booklet focusing on efficient ways of using a house - seems to be as important as the dissemination of design implications emerging from this POE, for future reference.

1. INTRODUCTION

History of the Stringybark Grove Project

In 1992 the then Department of Planning initiated a design competition for an energy and water efficient medium-density housing project, which was funded in conjunction with Sydney Electricity, Sydney Water and Pacific Power. The winners of the competition, architects Devine Erby Mazlin and Capitol Apartments, developed and built Stringybark Grove, a group of 10 townhouses with 2-3 bedrooms each, on a 2718m^2 site on Epping Road, Lane Cove. The project had further input and support from the Office of Energy, Lane Cove Council, Professor John Ballinger[1] (School of Architecture, UNSW), and others.

The objectives of the Stringybark Grove project were to promote energy and water efficiency practices to the housing industry and interested public through a demonstration project which combined skilled site planning, medium-density townhouse/cluster design, solar efficient building and landscape design, environmentally sensitive use of materials and construction methods, and recycling of water. One of the units was on public display for 12 months until December 1995.

The design facilitates conservation of energy and water, while allowing the enjoyment of the latest technology and comforts of everyday suburban/city living. The project also addresses noise attenuation along its highway frontage (Epping Road) to meet residential noise guidelines.

The location of Stringybark Grove close to Sydney city and to public transport generates further environmental benefits, by enhancing potential for a ‘low-movement’ society - with implications for reduced greenhouse gas, acid rain and photochemical/urban smog emissions.

Monitoring equipment was built-in to provide detailed data on water and energy consumption and temperature. Monitoring was carried out during 1995 and 1996 by Sydney Water and Sydney Electricity (now Energy Australia). A comparative building cost assessment “Analysis of Costs” was carried out by Landcom (available from DUAP).

[1] who also simulated the energy performance of the houses using the NatHERS computer package.

Post Occupancy Evaluation Research

A Post Occupancy Evaluation aims to evaluate three essential aspects of a building.[2]

- Fitness-for-Purpose — the extent to which a building meets the goals expressed in the design brief;

- User Satisfaction — habitability or liveability experiences and evaluations, in particular thermal comfort and lifestyle amenity; and

- Technical Performance and Costs-in-Use — energy and water consumption, maintenance costs, durability of materials, and standard of services. Ultimately, environmental impact, as an indirect consequence of operational and embodied energy could be measured (related CO_2 and SO_2 emissions, for instance). [3]

User-experience and fitness-for purpose are assessed in this report.

User experience of a building is influenced by a wide variety of precursor or antecedent conditions particular to each individual, embedded in a range of socio-cultural and geo-climatic conditions. This previous experience and context need to be taken into account when interpreting user evaluations of buildings.

Considerations include:-

i) demographic profile (including age, gender, occupation, income)

ii) pre-dispositions, habits, skills (incl. degree of energy literacy and environmental

[2] Bycroft, P.C. and Pegrum, R. (1989), *Quality Down Under: Building Evaluation in Australia*, in W.F.E. Preiser (ed), Building Evaluation, Plenum Press, New York and London.
Presier, W.F.E., Rabinowitz, H.Z. and White, E.T. (1988), *Post Occupancy Evaluation*, Van Nostrand Reinhold, New York.

[3] Operational energy refers to the energy consumed while operating the building (heating, cooling, lighting etc);

awareness, tendency to play an active role in indoor-comfort control)

iii) lifestyle values, expectations and attitudes (incl. importance given to indoor daylight, noise abatement, security, privacy, community, access to public transport)

iv) past experiences (incl. previous buildings, cultures and traditional ways of life)

v) thermal comfort tolerances (prior adaptation to climatic conditions, or 'acclimitisation').

The Post Occupancy Evaluation Survey at SBG (December 1995)

Residents of nine households were interviewed between December 2nd and 7th 1995, by Robert Samuels.[4]

Details of the households' demographic profiles are shown in Table 18. At the time of the survey, none of the households had received information on the energy and water saving features of the development or how to make the best use of them.

Method

The Stringybark Grove survey follows a case-study methodology where, although the total number of respondents is low, the *depth* of the investigation and the experiential and qualitative nature of the responses provide insights about the benefits and difficulties of integrating efficiency and environmental criteria into housing design.

It is usual to allow occupancy of buildings for at least 12 months before conducting a POE, so that occupants can experience at least four. When the Stringybark Grove POE was conducted, seven of the nine units surveyed had been occupied, and monitored, for 10-14 months (units 1, 4, 6, 7, 8, 9) and two units for six months (units 3, 5). This averages out at about 12 months overall.

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embodied energy is the energy consumed in the production of a building material, from its procurement as a mineral to its manufactured state, including transportation.

[4] Urban Planner and Environmental Psychologist; Senior Lecturer at the School of Architecture, UNSW; Director, Environmental-Design Research Pty Ltd; [M.U.R.P; M.Sc; Ph.D].

The survey technique adopted was a standarised questionnaire protocol conducted as a face-to-face interview in respondents' homes (see Appendix 2: The Questionnaire). The interview comprised structured questions, usually accompanied by an appropriate rating scale; the presentation and discussion of water and energy consumption graphs; and open-ended questions. The latter were content analysed and are presented in Appendix 1, as Table 20, while Figures 7 and 8 and a brief discussion are presented in the text as summaries of the most important open-ended categories, overall.

Appliances used in each household (and their energy efficiency ratings) were recorded. No water use ratings were noticed during the house inspection.

The range of aspects evaluated during the interview included: energy and water efficiency, thermal comfort, and lifestyle amenity issues, as well as prior motivations for moving to Stringybark Grove, current behavioural routines, and post-occupancy learning or attitude changes.

Because of the small sample size advanced statistics were not performed on the data. All analyses are thus descriptive and based on frequencies of occurrence and simple measures of proportional representation (such as percentage satisfaction).

Findings emerging from the analysis of the data are presented as Tables and accompanying Figures, where appropriate. A Discussion of the meaning of the findings follows each Table/Figure. The title of each Table refers to the essential elements of the question asked. Where necessary, the full question asked during the survey is also included.

2. ANALYSIS AND DISCUSSION OF RESULTS

In general, the survey indicated that *satisfaction* with the experience of living at Stringybark Grove is very high.

It is quite evident from the POE findings that, over and above the potential energy and water savings and the ecological benefits, the degree of satisfaction with comfort and amenity aspects of such buildings is also significant. In other words, positive consequences of such 'environmentally benign' or 'low environmental-impact' design relate not only to the sustainable use of scarce resources (energy, water, materials...), proportionately reduced greenhouse gas, acid rain and urban smog emissions, and fiscal savings to residents - but also facilitate the achievement of a higher quality of life. This is sustainability in a holistic sense.

The survey also drew out specific *dis*satisfactions, which ranged from the performance of water/plumbing systems, solar design, ventilation and energy efficiency aspects, to amenity or habitability issues such as security, 'how-to-run the house' information provided to residents, road-noise, and privacy.

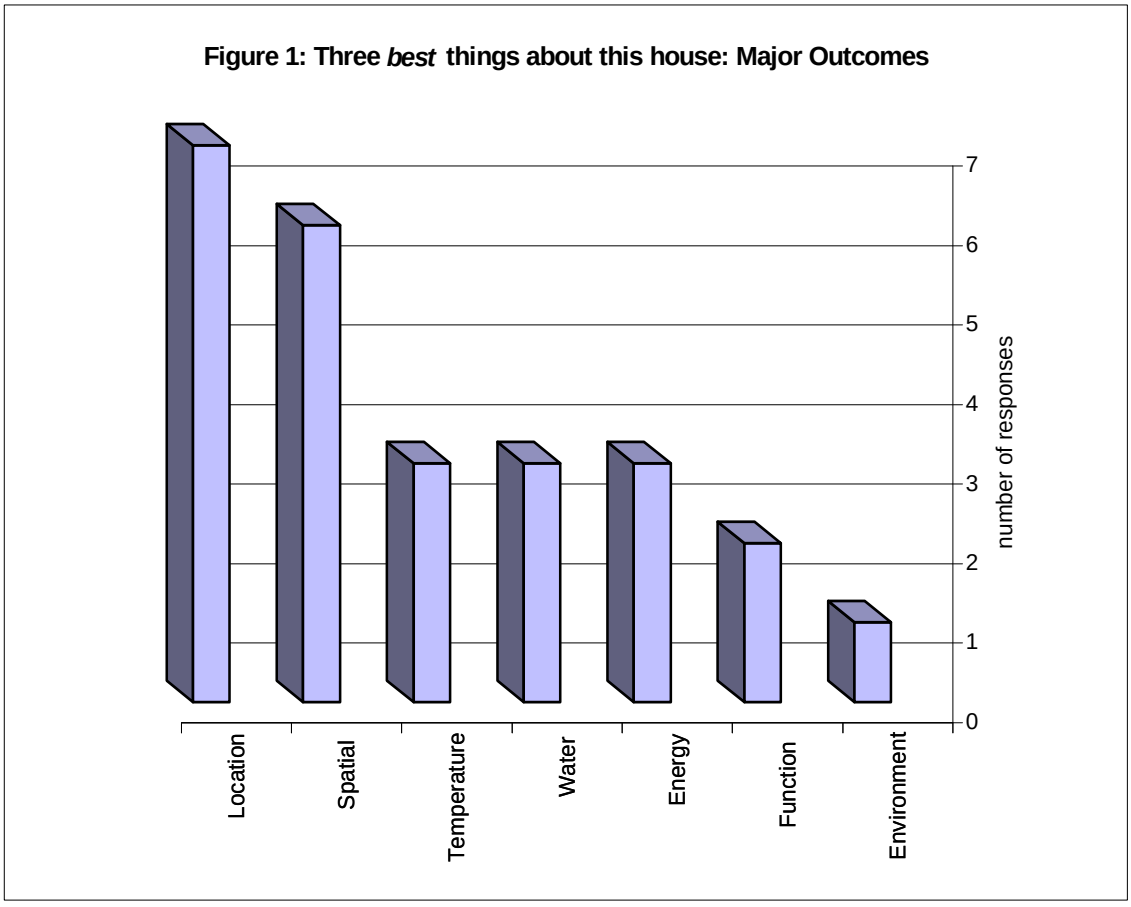
In theory, a POE critique is an evaluation of both pros and cons, and the goal should be to highlight both shortcomings and advantages. In practice, however, respondents often tend to use the interview opportunity as a way to express criticism. The meaningfulness of the data should be interpreted in light of this realisation.

Question 1 ('In your opinion, what are the 3 best *and* 3 worst things about this house') is deliberately open-ended, so as not to 'lead' the respondent in any way. It *elicits* opinions and does not suggest what the focus of the survey is going to be. Tables & Figs. 1 & 2 refer.

Table 1
Three best things about this house

	Issue	*no. resp*	
23%	Location	7	(convenience/proximity to city (5), & to freeway, quiet milieu)
20%	Spatial	6	(small development, house size, kitchen/living & interior layout)
10%	Temperature	3	(comfortable, constant, warm in winter, cool in summer)
	Water	3	(hot water, rainwater recycling)
	Energy	3	(efficient, saving on costs)
7%	Function	2	(storage etc)
3%	Environment	1	(benign or low environmental-impact design)
	Aesthetic	1	
	Quiet	1	(quiet neighbours)
	Price	1	
	Low Maintenance	1	(garden)
	New	1	

Figure 1: Three *best* things about this house: Major Outcomes



<u>Discussion</u>: 'Best things about Stringybark Grove' (Table 1 and Figure 1)

Location and spatial layout together represent 43% of respondents' evaluations of the 'three best things' about their houses. This reflects a similar range of *motivations* indicated as being

of paramount importance to them when looking for a place to live, where 44% of those choices related to aspects such as neighbourhood convenience and amenity including access to public transportation and spatial qualities such as house size (see Table 3). To this extent, residents' expectations and experiences are successfully matched - a measure of fitness-for-purpose.

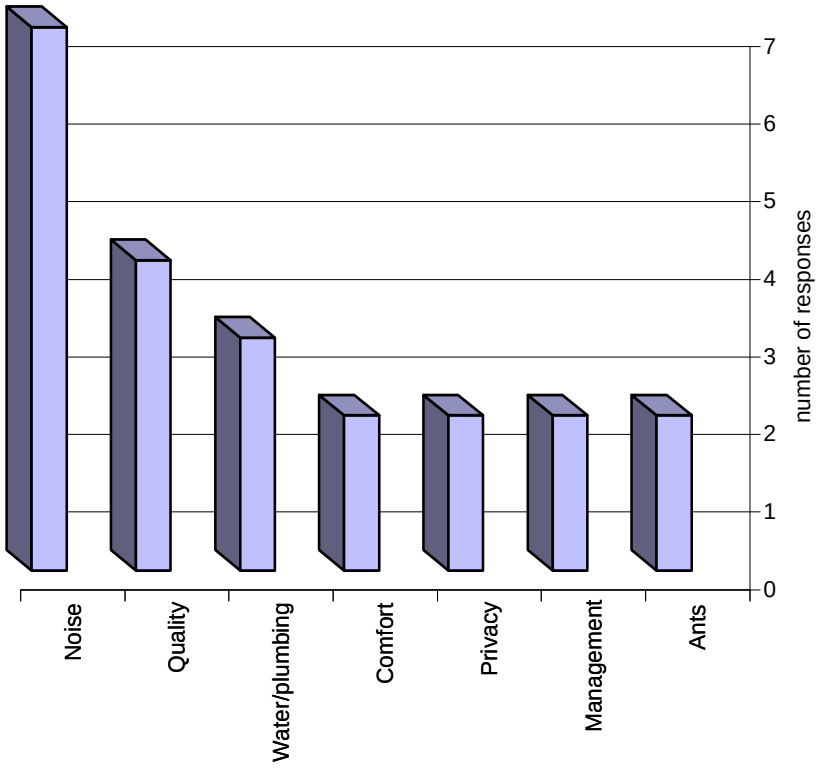
Energy, water and comfort considerations each accounted for 10% of these overall satisfactions, and low environmental impact 3%. Taken individually, each is a minor factor, which is somewhat surprising, given the emphasis put on these aspects in the design of the complex. *Together*, however, they account for 33% of aspects considered to be successful about the Stringybark Grove houses and complex.

Based on these generalised results, the project seems to have reasonably met objectives of the brief to promote energy and water efficiency, and urban consolidation (at least in terms of the importance given to proximity to the city).

Table 2
Three worst things about this house

	Issue	*no. resp*	
24%	Noise	7	(road (5), aircraft)
14%	Quality	4	(***of construction*****:** wood chips, paint marks, walls dent, leaks)
10%	Water/plumbing	3	(drainwater noise, shuddering in walls/low pressure top shower)
	Comfort	2	(temperature - upstairs too hot)
7%	Privacy	2	(lack of - in courtyard, in livingroom)
	Management	2	(high fee, strata limitations, no pets eg)
	Ants	2	
	Fans	1	(noisy)
	Ventilation	1	(lack of cross)
	Orientation	1	(view at back)
	Interior	1	(too tight so difficult to move furniture)
	Size	1	(small house)
	Access	1	(reversing into garage, blind corner)
	Info	1	(none given)

Figure 2: Three *worst* things about this house: Major Outcomes



<u>Discussion</u>: 'Worst things about Stringybark Grove' (Table 2 and Figure 2)

Noise annoyance proved to be the 'worst thing' about living in Stringybark Grove, of which road/traffic noise formed the major inconvenience. Road noise seems to be more intrusive the higher one goes in the house, although only two townhouses have their second bedroom facing the road. The noise of trucks, at night, was mentioned frequently as the most annoying aspect.

The nomination of locational issues as the worst aspect and, simultaneously, as the best aspect (Table 1) may seem contradictory. However, closer examination of responses indicates that different aspects of location are responsible (road noise *vs.* proximity to city).

Well sealed windows were used to minimise noise. This has proved to be insufficient. Double-glazing might have provided better sound insulation, but the added cost was considered to be prohibitive in this category of housing. The problem is nonetheless endemic to the location, the complex being placed alongside a major arterial road (soon to be upgraded to a freeway which will possibly be a 'downgrade' in amenity for residents). Once a window is opened, road noise will inevitably penetrate to some degree, irrespective of the height of perimeter walls or the materials from which they are constructed.[5] The trade-off was the visibility of the development from Epping Road which was considered necessary for marketing purposes, and ease of access to the demonstration unit.

Craftmanship and construction quality, or more precisely, the standard of the interior finishes and materials was mentioned as being the second worst thing, and below expectations. There is also some water leakage under exterior doors during heavy storms.

Residents also referred to lack of privacy. This is a problem frequently found in medium density complexes, due to the proximity of the units and the extent of 'overlook' from one to another. It will need to be addressed before the Australian public is likely to accept and adopt this form of living as a norm. Being able-to-see-out, to survey common or semi-public and semi-private areas of a housing complex is important in terms of territorial control (or a sense

[5] Energy embodiment of materials in 'massive' walls should also be a consideration in the trade-off between amenity (acoustic quality) and environmental quality.

of ‘ownership’ of a place), but *not* being *seen*, whether in one’s livingroom or bedroom, is equally important. Possibilities inherent in ‘photochromic’ glazing materials, which respond to light by darkening, might allow for surveillability[6] whilst maintaining privacy, as well as being energy efficient *ie* reducing heat gain (cost, however, might prove prohibitive). The intention was to screen the houses by the use of landscaping, a ‘low tech’ design solution for privacy, but growth was fairly immature after only one year.

Some aspects of the plumbing system were also nominated as some of the ‘worst things’ about the complex, specifically noisy plumbing and low water pressure in upstairs showers.

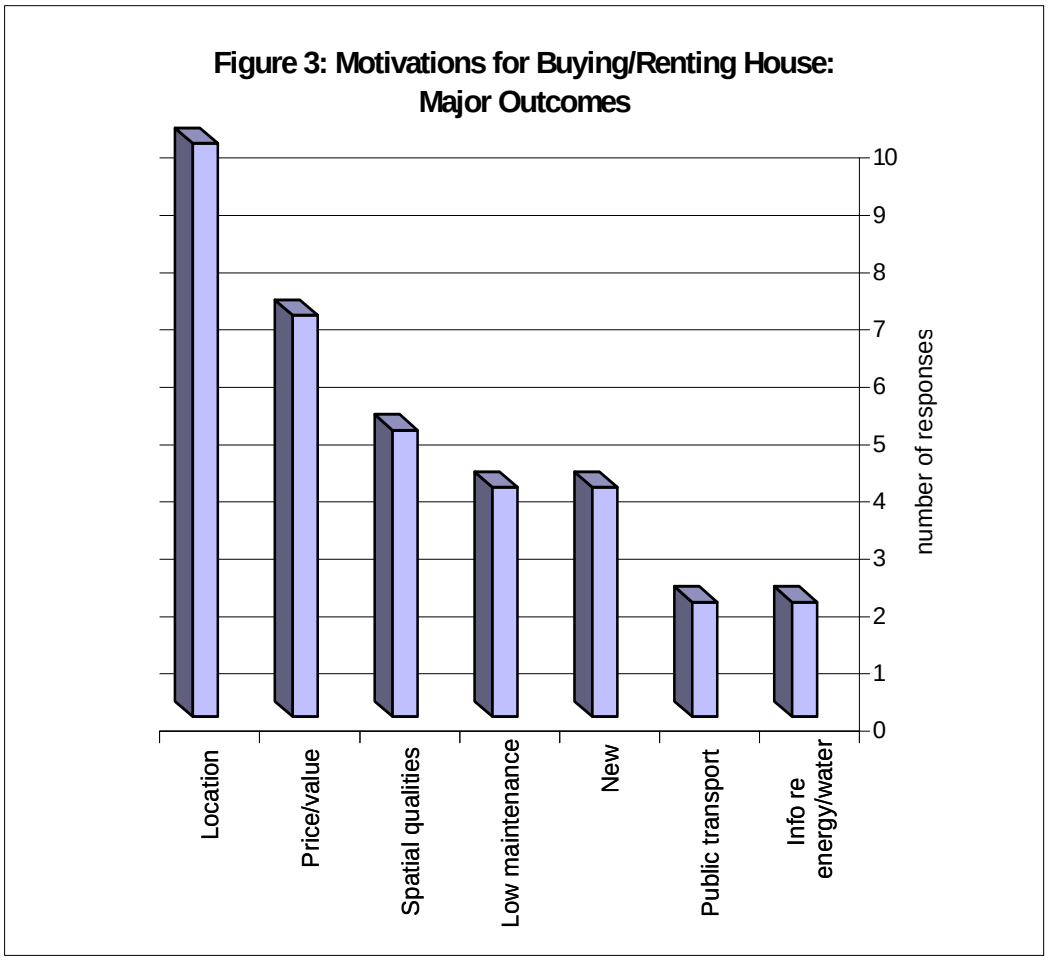
The innovative rain-water recycling system proved to be mostly acceptable and functioning well. Problems such as silting in toilets (at an early stage) and a noisy pump for the rainwater tank caused some annoyance.

Generally, adequate maintenance of the water system is extremely important. Preventing the build up of silt, for instance, may require the installation of filters or a sediment tank, which in turn requires maintenance. Similarly, the water pump for the recycling system requires regular attention to ensure its proper functioning, particularly given that the functioning of the toilets is reliant on this system.

[6] the capacity to survey or observe non-private areas, and thus exercise territorial control.

Table 3
When you were last looking for a place to live,
what was it that made you choose this house

	Issue	*no./resp*	
26%	Location	10	(neighborhood/familiar/convenience; milieu [trees])
18%	Price/value	7	(purchase price & resale value)
13%	Spatial qualities	5	(house size [3]; room arrangement; family cycle needs)
11%	Low maintenance	4	(courtyard garden & watering; & house-in-complex)
	New	4	
	Public transport	2	
5%	Info re energy/water	2	(via demo house/media publicity/etc)
3%	Energy	1	(lower fuel bills/save energy)
	Indoor Daylight	1	(amenity)
	Ideology	1	(save environment/save resources)
	Children's needs	1	



<u>Discussion</u>: 'Motivations when looking for a place to live' (Table 3 and Figure 3)

When respondents were looking for a place to buy or rent, the major reason why they chose Stringybark Grove was location. Twenty-six per cent of responses fell into this general category, ranging from proximity to the city, to familiarity with other people in the area. If accessibility to public transport is included (which *is* a neighbourhood amenity) the proportion of responses rises to 31%.

Locational issues predominate, it seems, when people are both choosing a place to live, and when evaluating the success of their choice after the experience of living there *ie* their post occupancy evaluations. Expectations relating to interior spatial qualities of the dwelling, similarly, emerged as important considerations (13%). Price and value-for money or resale value, as expected, proved to be important considerations, accounting for 18% of responses.

Together, neighbourhood/spatial expectations account for 44% of motivations.

These findings echo those of an earlier post occupancy evaluation - which is not comparable in an absolute sense but contributes to our understanding, since there are very few such studies of this type. This evaluation of 146 Australian houses/households (Ballinger, Samuels *et al*, 1991)[7] was carried out in the Sydney, Melbourne, Adelaide and Perth regions. It did not focus on environmental or water issues, but had the advantage of comparing energy efficient and 'standard' houses. In that study, 36% of the motivations of house owners prior to purchase or construction fell into the neighbourhood/spatial expectation category (in both the energy efficient and standard samples). A further 26% fell into a combined 'energy-comfort-amenity' category, each aspect of which, individually, was <u>not</u> an important reason for choosing a house - except where energy efficient houses were designed/built by the owners or their architect. It is to be expected that people specifically opting for an efficient house over a standard one would have a high level of interest in this regard.

In contrast, in Stringybark Grove, only about 10% of motivations related to energy/water and amenity (daylight), even taking into account the informational stimulus given by the special

[7] Ballinger, J., Samuels, R., Coldicutt, S., Williamson, T. and D'Cruz, N. (1991), *A National Evaluation of EnergyEfficiency Houses*, Final Research Report, ERDC Project No. 1274.

access to the demonstration unit. Environmental concern was almost non-existent, and thermal comfort did not seem important at all.

Generalising from the results of both studies, it would appear that home-buyers who do not already have a special interest in energy efficiency regard it as a relatively minor item to be addressed *after* the major locational, spatial and price needs are satisfied.

It is interesting to note that the *low maintenance* possibilities inherent in the SBG townhouse cluster is of some significance (courtyards rather than lawns which need mowing, and the 'native' garden which requires little or no watering). This possibly reflects contemporary value-systems, and could be exploited if the aim is to encourage people to live in more sustainable medium-density/city-proximate locations rather than low-density suburban areas.

Q 3 & 4: 'How important is it to you (and/or your family) to save energy and water'

Table 4

IMPORTANCE: Save Energy and/or Water

	Energy	Water
Important	8	8
neither	1	1
Not Important	0	0

Table 5

ACCEPTABILITY: Re-use of Rainwater

Acceptable	9
neither	0
Not Acceptable	0

Q 6: 'How satisfied are you with living in a townhouse (rather than a freestanding house)'

Table 6

SATISFACTION: Living in a Townhouse

Satisfaction	8
neither	1
*Dis*satisfaction	0

Reasons Why?

Low Maintenance	7 [50%]
OK if private	2
Feels like a house	1
Cheaper than house	1
Previous experience	1
OK if temporary	1
Management advantage	1

<u>Discussion</u>: Importance, Acceptability & Satisfaction:

Water, Energy and Townhouse/Cluster Living (Tables 4 - 6)

The *very high levels* of importance and acceptability which residents attribute to energy and water efficiency and the similarly high degree of satisfaction expressed with the experience of townhouse living are evidence of the extent to which the fundamental design criteria of the Stringybark Grove project have been met. Again, this indicates a high level of fit between the intentions expressed in the design brief and the actual day-to-day experience of living there.

There is some mention of privacy as an issue which could affect the acceptability of townhouse living; but satisfaction with the low maintenance aspects is of greatest importance, accounting for half of the responses.

Q 7: 'Which type of energy would you prefer to use (and which do you actually use)'

Table 7
Energy Sources

	Elec	*Gas*	*Microwave*	*None*
Cooking				
Prefer		9		
Use		9	7	
Heating				
Prefer	1	8		
Use	6	1		3

Table 8
Has Attitude to saving Energy & Water changed since living in Stringybark Grove

No	4	(always been aware, use little anyway, saving not important)
Yes	5	(from demo [2], house itself reminds and focuses [2])

<u>Discussion</u>: Energy Sources Preferred & Used, and Attitude Changes (Tables 7 and 8)

One third of the households did <u>not</u> heat at all during the winter, clear evidence of the success of the solar efficient design. Several others heated only intermittently, or only at night, and mostly in the bedrooms on the south side of the building.

Respondents would have preferred to use gas rather than electricity for heating, but were discouraged by the high capital cost of gas heaters. There was some indication that if feedback information had been made available on a regular basis, and evidence of the lower cost of gas heating was apparent, residents might have approached the body corporate to purchase gas heaters in bulk. [A bayonet fitting for an unflued gas heater is provided in each livingroom].

It is interesting to note that the effect of moving into Stringybark Grove on attitudes towards saving energy was not significant. Almost half of respondents said they were energy-aware anyway (although as previously noted this did not feature strongly in their motivations to move into the complex), or that saving energy was <u>not</u> important. The latter response could

be taken to refer to either the elasticity effect *ie* where high disposable income determines that comfort and convenience override the desire to save money by reducing energy consumption, or to a low priority accorded to saving energy resources themselves.

Of importance is the highlighting by some respondents of the 'in-built potentiality' (not in those words) of the houses themselves, where the fact of the house being capable of performing efficiently was sufficient in itself to prompt or sustain efficient behaviour on the part of the inhabitants. In other words, the house 'reminded' them, helped focus their activities, and reduced the effort required to save energy and water. The design itself facilitates sustainable behaviour.

The argument for *building-in the potential* for efficiency, as the *sine qua non* before wide-spread conservation behaviour can be expected from the community, is of great importance. While physical determinants, such as design, cannot *cause* behaviour, where an opportunity or potential is inherent in a building, users can readily capitalise on that potential. Where no potential is built-in, or there is an inherent problem in the design (such as a western orientation) it is all the more difficult even for the most committed environmentalist to achieve savings in practice.

Q 10: 'How satisfied are you with the following characteristics of your home'

Table 9: Satisfaction with Climate-Appropriateness of Town House

[* = salient finding; Misc = miscellaneous]

Table 9.1: LIVINGROOMS	***Dissatis***	***n/n***	***Satis***		***Misc.***
amount/direct **sunlight**			9	*Summer*	[*ie* control]
	1	1	7	*Winter*	
amount/natural **daylight**			9	*Summer*	
	1	1	7	*Winter*	
temperature			9	*Summer*	
			9	*Winter*	
Total Response: Livingrooms			27	**Summer**	100% Sat
	2	2	23	**Winter**	85% Sat

Table 9.2: BEDROOMS					
9.2.1: Sunlight	***Dissatis***	***n/n***	***Satis***		***Misc.***
amount/direct sunlight/bedroom 1	1	1	7	*Summer*	
		4	5	*Winter*	*
amount/direct sunlight/bedroom 2		2	7	*Summer*	
	2	1	4	*Winter*	
amount/direct sunlight/bedroom 4/rumpus	1		3	*Summer*	n/a [3]
			4	*Winter*	
Total Response: Bedrooms/sunlight	3	5	21	**Summer**	72% Sat
	4	8	17	**Winter**	59% Sat

9.2.2: Daylight	***Dissatis***	***n/n***	***Satis***		***Misc.***
amount/direct daylight/bedroom 1			9	*Summer*	
		2	7	*Winter*	
amount/direct daylight/bedroom 2			9	*Summer*	
	2	2	5	*Winter*	*
amount/direct daylight/bedroom 3			7	*Summer*	n/a [2]
	2		5	*Winter*	
amount/direct daylight/bedroom 4/rumpus			4	*Summer*	n/a [3]
			4	*Winter*	
Total Response: Bedrooms/daylight			29	**Summer**	100% Sat
	4	4	21	**Winter**	72% Sat

9.2.3: Temperature	***Dissatis***	***n/n***	***Satis***		***Misc.***
temp/bedroom 1 (master/upstairs)	6	1	2	*Summer*	22% Sat *
		1	8	*Winter*	
temp/bedroom 2	1	2	6	*Summer*	
	1	2	6	*Winter*	
temp/bedroom 3	1	2	4	*Summer*	n/a [2]
	1	2	4	*Winter*	
temp/bedroom 4	1		3	*Summer*	n/a [3]
			4	*Winter*	
Total Response: Bedrooms/temperature	9	5	15	**Summer**	52% Sat
	2	5	22	**Winter**	76% Sat

<u>Discussion</u>: Sunlight, Daylight and Temperature/Comfort in Livingrooms and Bedrooms (Tables 9.1, 9.2.1, 9.2.2, 9.2.3, and Figures 4, 4.1, 4.2)

Resident satisfaction with sunlight control, daylight penetration and comfort/temperature *in livingroom* areas is very high - 100% in the summer period and only marginally less in winter (85%), reflecting the successfulness of the solar efficient design. However, satisfaction with sunlight, daylight and comfort/temperature varied considerably in bedrooms.

The lowest level of satisfaction was recorded for summer temperature in upstairs bedrooms, especially in the master bedroom (often on the highest level). Rising heat is the cause of this

high *dis*satisfaction (88%), possibly due to inadequate ventilation provisions (see Table 9.3). Cross-draft ventilation does not seem to be sufficient. Possibly what is required is thermal chimney-type ventilation, a skylight on the southern side which is openable, for instance. If located on the south it is unlikely to cause overheating *ie* its sloping glass will face away from the equator. One respondent successfully used the fan in the stairwell to dampen the heat rise. Instructions on how to use the fans in both hot and cold periods need to be included in future information to residents.

Other possible solutions could be to provide thermal zoning doors at the base of the stairs, which might, however, prove to be inconvenient for use on a daily basis.

The issue of next highest importance is the low satisfaction with sunlight penetration into bedrooms in the winter (only 59% satisfaction). Respondents mentioned that bedrooms were the rooms they tended to heat. When they are located on the southern side of the building this is not unexpected. The National Evaluation study cited earlier (Ballinger, Samuels et al, 1991) also found that winter discomfort in bedrooms was a major *dis*satisfaction with householders. Standard energy efficient housing guidelines tend to suggest that bedrooms can be located on the south, separate from living quarters located on the north, which are naturally heated. User experience, however, clearly suggests that bedrooms located on the north with adequate shading for summer are preferred to south facing bedrooms which tend to be cold and dull in the winter.

Overall, the bedrooms in these townhouses function better in the summer period (75% satisfaction) - apart from the overheating problem. The experience of winter in the bedrooms has only an average 69% satisfaction rating. Both of these ratings are lower than the averages for livingrooms (100 and 85% respectively), suggesting that bedroom design is an area which requires attention (and again confirming the National Evaluation study's findings). The use of north-facing clerestory windows could help alleviate the cold in southern rooms, for instance, and a narrow east-west axis orientation of a building can allow many if not most rooms to face north.

Figure 4: SATISFACTION - Summer/Winter x Livingroom/Bedrooms

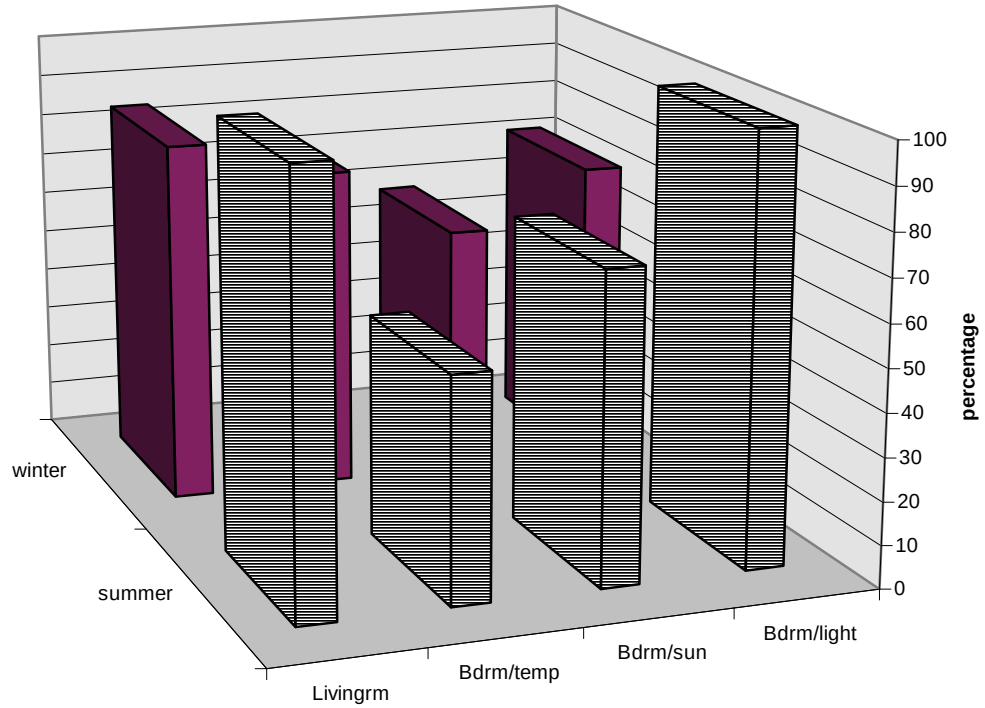


Figure 4.1: Summer Satisfaction

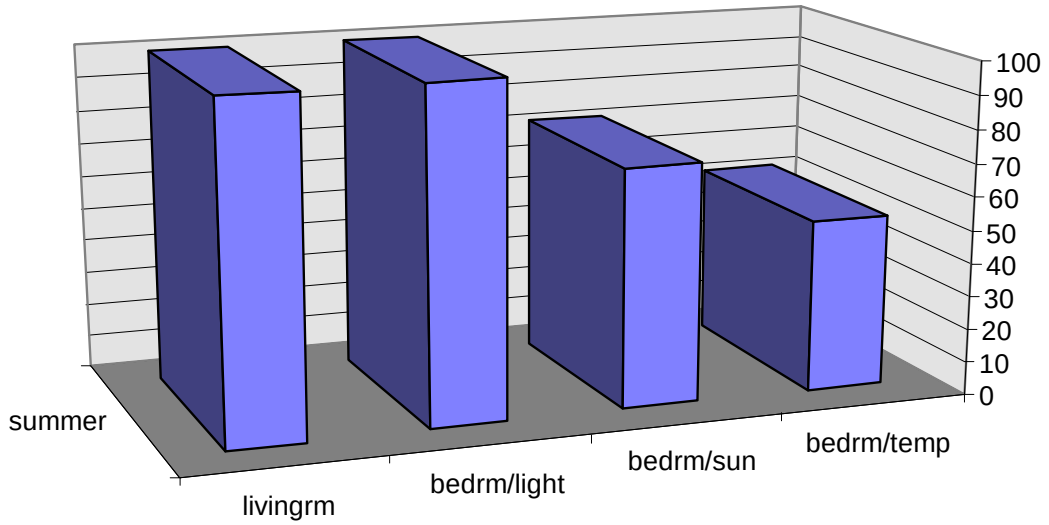
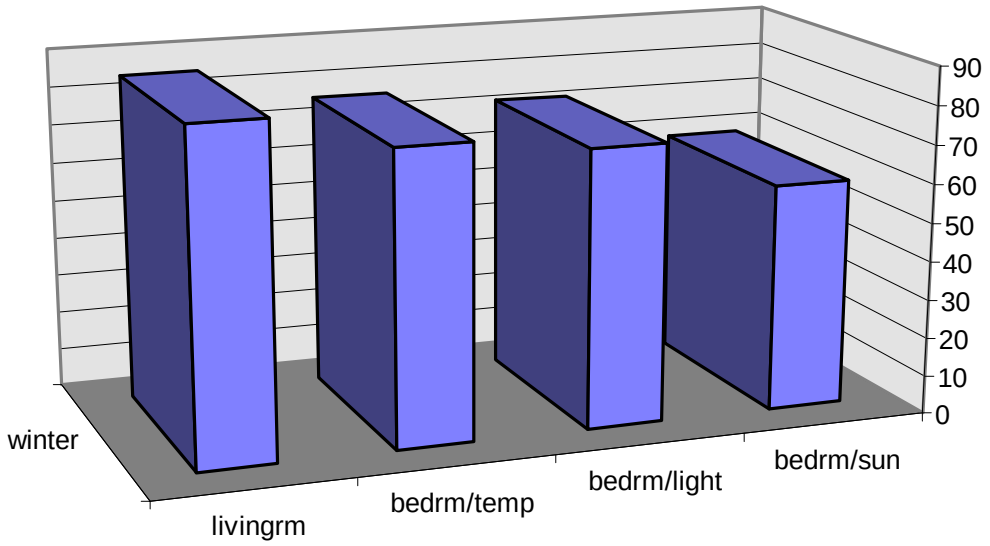


Figure 4.2: Winter Satisfaction



Questions relating to air movement, ventilation, cooling: extracted from *Q 10*

Table 9.3: Ventilation & General Issues **** = salient finding***

	Dissatis	*n/n*	*Satis*		
natural cooling of house		3	6	*Summer*	*
amount of natural heating/solar energy		1	8	*Winter*	
circulation of air indoors	1	1	7	*Summer*	
	2		7	*Winter*	
cooling effect of fans			9	*Summer*	
warming effect of fans		6	3	*Winter*	33% Sat
freshness of air		2	7	*Summer*	
	1		8	*Winter*	
stability of temperature in house		1	8	*Summer*	
	1	2	6	*Winter*	*
general level of glare indoors		1	8	*Summer*	

Table 9.4: Comfort/Mid-Season

Comfortable	4
No problems	5

<u>Discussion</u>: Ventilation, Indoor Air, Glare (Tables 9.3 and 9.4)

Natural cooling/ventilation of the houses is considered successful in 2/3 of cases, the remainder falling into the 'neither/nor' category. It is interesting to note that a significant minority of residents were uncertain about the issue, yet most of the positive responses in the open-ended comments made by residents referred to ventilation (Table 20.3/Appendix 1).

Circulation of air indoors, either warm air in winter or cool air in summer was perceived as more successful overall (78% in both cases).

The high rate of 'neither/nor or don't know' cases referring to the efficacy of the fans as warming devices in the winter indicates that information is required on their effective use.

Finally, perceived comfort during the mid-season periods (autumn and spring) is very high - 100% satisfaction. This is further evidence of design success, indicating that the houses adapt well to changing weather conditions.

Q 11 & 12: 'How satisfied are you with your energy and water bills'

Table 10 **=salient finding*

1: SATISFACTION: Energy Bills

Satisfied	5	56%
neither	1	
NotSatisfied	3	*

2: Comparison/previous home

Better	4	
Same	1	
Worse	1	
n/a	3	(previously in Hong Kong)

3: Important changes re energy use

Demographic	
new baby	2
extended family	2
appliance change	1
functional change (no pool)	1

[Unit x: actually uses less but expectations high (told to expect 1/4 of previous bills)
not aware of savings (have offpeak & no pool) = 50% less on previous bills, actually]
[Unit y: estimates consumption would be 65% less without elec heater with fan (new baby)]

Table 11:

1: SATISFACTION: Water Bills

Satisfied	5	56%
neither	1	
NotSatisfied	3	*

2: Comparison/previous home

Better	2	
Same	0	
Worse	1	
n/a	6	(previously in Hong Kong, or renting)

3: Important changes re water use

Demographic		
new baby	2	
extended family	2	
appliance	2	(no sprinkler; front loader)
functional change (no pool)	1	
conscious of water now	1	(attitude)
brush teeth/not running water	1	(behaviour)

[Unit x: uses less and are aware of it - from 83kl to 40kl now = 50% / no pool]

Discussion: Satisfaction with Energy and Water Bills (Tables 10 and 11)

The low sense of satisfaction with both *energy bills* and *water bills* is striking - only 5 of the 9 units (or 56% of respondents) in both cases.

The houses were designed and equipped to save energy and water. The intention was to build-in certain functions and capacities which could result in savings without resident input or knowledge being required - naturally heated or cooled spaces, and re-use of rainwater, for instance. It was decided early in the development process not to make energy and water saving information available to residents at the outset, in order to be able to gauge the differences in consumption after a 'residents' user manual' is eventually made available.

The residents' relatively low sense of satisfaction is possibly a confirmation of the importance of expectation and perception. Where people are led to believe or expect that they will make substantial savings, they might tend to underestimate the extent and value of the real savings. One respondent was surprised when comparing past electricity bills with current bills, for the first time, in the presence of the interviewer. His household was indeed saving about half of their previous outlay for electricity but it had not felt like it. He was more satisfied with the water bills, in the sure knowledge that having no pool must have influenced his water consumption.

Here again the power of regular feedback, including comparisons with standard housing, could help put residents 'in the picture', and encourage them to achieve more or consolidate their current practices where they are shown to be actually having an effect. There is an opportunity for both water and electricity authorities to redesign their accounts and perhaps include comparisons of individual households with average consumption levels.

Where people had either recently arrived in Australia (from Hong Kong in the main) or had previously rented, comparison with previous bills could not be made. However, some respondents from HK found the price of electricity here to be considerably higher, in general, which might well have influenced their responses.

Demographic changes might also have influenced bills for several households, either with new babies or an extended family living-in at least some of the year; while obvious changes, such as not having a swimming pool, would be expected to have a noticeable impact.

The monitoring systems installed in each townhouse made it possible to generate graphs for both electricity and water consumption for each house, on which individual electrical consumption by fridges, washing-machines/dishwashers/microwaves, lights and hot water could be identified; as well as water consumption from bathing, gardening, toilets, kitchen and laundry.[8]

Graphs of a typical day and a high usage day were presented to respondents at this stage of the interview, and their evaluations elicited. Most expressed surprise at seeing electricity being consumed in the early hours of the morning, until it was explained that this was due to water heating. All householders were able to identify particular habitual usage patterns and explain peaks and troughs, and expressed a clear desire to have information of this sort on a regular basis - to allow them to learn from their past behaviours (see Table 20.4.1/Appendix 1).

[8] Privacy requirements do not permit the publication of the graphs here. The graphs and the monitoring data are available for consultation in the DUAP Library.

Q 13 d, e & f: 'How satisfied are you with the following'

Table 12 * = *salient finding*

Water	**(performance of water appliances)**		***Dissatis***	***n/n***	***Satis***
	taps	56% *	5	1	3
	showerhead	56% *	5	1	3
	toilet flush/roof water			1	8
	garden watering/roof water		2	1	6
	low watering/native plants	*	2	2	5
	Quantum heat pump/hot water		1		8
	aware that heat pump generates the hot water ?				
	yes = 6 no = 3 (all tenants)	*T*	*15*	*6*	*33*
			28%	*11%*	*61%*

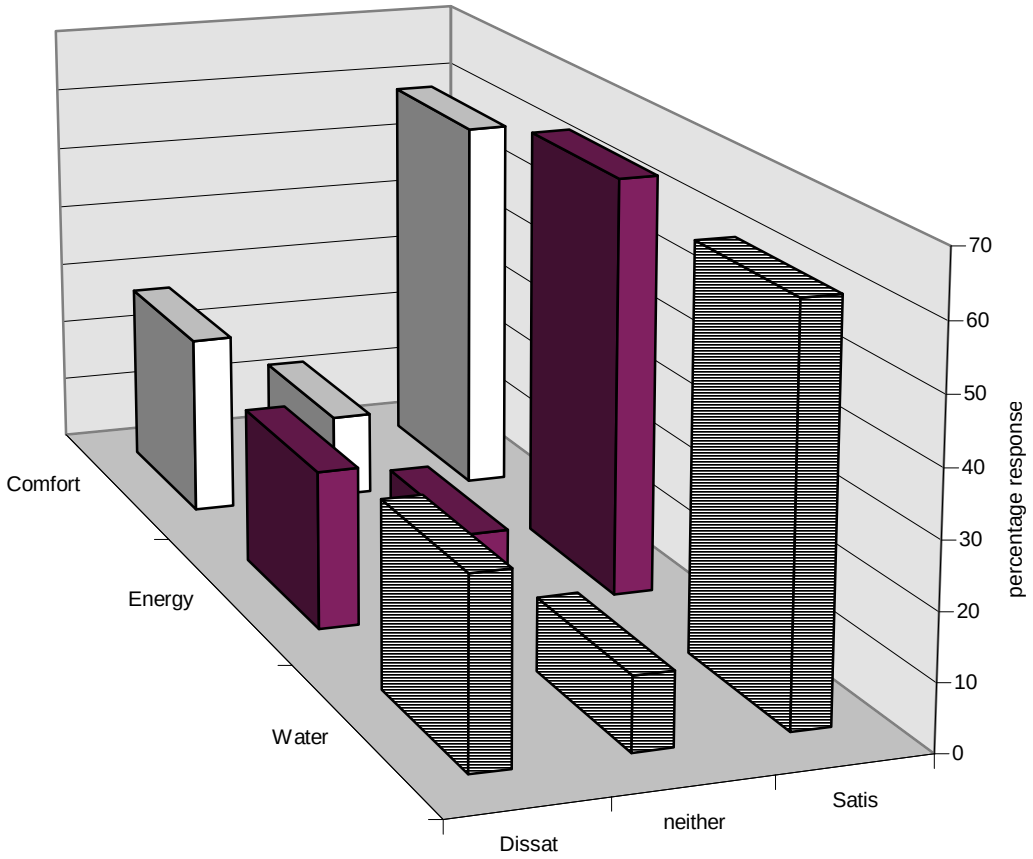
Table 13

Energy	**(performance of built-in energy-appliances)**		***Dissatis***	***n/n***	***Satis***
	cooktop				9
	combined convection/microwave oven				9
	ceiling fans				9
	energy-saving lighting			1	8
	power-operated curtains	44% *	4	2	3
	[adjustability]	56% *	5	2	2
	movement detectors & lighting control	56% *	5	1	3
	[adjustability]	*	3	3	3
		T	*17*	*9*	*46*
			24%	*12%*	*64%*

Table 14

Comfort/Temperature		***Dissatis***	***n/n***	***Satis***
tiles in livingroom area			1	8
pergola shading efficiency	*****	2	3	4
house/protection from winter winds		1		8
house/exposure to summer breezes		1	1	7
	T	*4*	*5*	*27*
		11%	*14%*	*75%*
Comfort: temperature/bedrooms				
bedrooms on the south: temperature/winter	*	3	1	4
bedrooms upstairs: temperature in summer	*****	8	1	
	T	*11*	*2*	*4*
	*****	*65%*	*12%*	*23%*
Comfort/overall		*28%*	*13%*	*59%*

Figure 5: Satisfaction/Dissatisfaction:- Water, Energy, Comfort



<u>Discussion</u>: Satisfaction/Dissatisfaction: Water, Energy and Comfort

(Tables 12-14; and Figure 5)

Overall, satisfaction with the performance of energy and water appliances, and with thermal comfort was in the 60% range, which is relatively low, given the emphasis put on these aspects in the design of the housing. This is explained by the poor performance of certain elements. For instance, 56% of responses regarding the performance of individual water appliances and plumbing relate to *dis*satisfaction with low water pressure in the showers and at taps on upper floor bathrooms. The poor performance of the former was apparently due to

the functioning of the shower head restrictor; and five families removed it, after which time they were no longer dissatisfied. Better (and more expensive) models of shower head restrictors are now available which were not standard at the time.

The roof-water electric backup-pump had been turned off due to excessive noise at night, which may explain the low pressure at the garden taps (recycled rainwater only).

Another source of *dis*satisfaction relates to the length of time before hot water reaches the top bathrooms, which also results in water wastage as taps are left running unnecessarily. The positioning of the water-tank in the garage rather than in the roof might be the cause of this lag.

Leaking taps - another complaint - are a maintenance problem but can affect water consumption significantly.

The Quantum heat pump was very well received - respondents commented frequently on the abundance of hot water; although several questioned the use of electricity at night to top-up temperature in the tanks.[9] Again, better information might help explain the functioning of novel technology to lay users.

*Dis*satisfaction regarding electricity devices centred on the automatic curtains and movement detectors, roughly equally disapproved of (44 to 55% *dis*satisfaction ratings/see Table 13).

The automatic curtains were found to be complicated to use, poor on adjustability, inflexible, and unreliable. One respondent explained that he would not like the curtains opening of their own accord while he was away from the house. Another had found a way to adjust the degree of openness by sheer chance. Only one respondent used the curtains to advantage and was satisfied. Yet even here, his wife said she did not use them because of lack of knowledge about how they work.

[9] The Quantum system was chosen over solar-thermal panels since it showed a much greater efficiency over a whole year.

It would seem that the expense of installing this system is not justified, the cost unnecessarily raising the price of the housing for doubtful efficiency returns. The investment could be better placed in other shading devices, possibly an adjustable pergola or a more sophisticated system where exterior blinds are co-ordinated via a photo-sensitive cell.

The movement detectors were said to function erratically, leaving lights on when they should be off, or turning them on when they shouldn't (one respondent suggesting that a electronic 'spike' at a certain frequency in the fluorescent lights is capable of turning the detectors on or off at random). Apparently there is no override system. The units are either switched on or off. Many households had turned them off. Similar problems were experienced with the outdoor detectors, over the garages, where they would behave erratically - stay on, or not come on.

Again, theoretically a good idea, in terms of energy saving potential, but proper quality control must be administered - or such 'high tech' devices will simply be turned off by residents, or overridden as in the case of the curtains, or removed like the shower restrictors. People *intervene* to ensure that their standard of living is not diminished by ill-functioning technology. In this way the in-built potential is lost.

Comfort *dis*satisfaction relating to the performance of pergolas was also high or in the uncertain range, together accounting for the majority of responses. Specifically, respondents mentioned that the gaps between the slats were too wide (in some houses), or that the pergola did not shade enough of the outdoor space, or needed shade-cloth in the summer. No creepers were visible at the time of the interviews - early December, mid-summer. More careful landscaping, including fast-growing, deciduous climbing vines could overcome this problem.

Table 14 again confirms the discomfort experienced in bedrooms upstairs in summer and in south facing bedrooms in winter - together accounting for 65% of *dis*satisfactions.

It should not be forgotten, however, that overall *satisfaction* with the performance of water and energy appliances, and with comfort, still predominates by a large measure - as an examination of the Figure 5 clearly indicates.

Table 15
Householder Behaviour

1: Do you do anything to try to save <u>energy</u>

No	4
buy efficient appliances	1
potential exists, live normally, still save	1
change behaviour	7
(eg:	
turn lights off, use microwave, careful use of dishwasher & fridge door…)	

2: Do you do anything to try to save <u>water</u>

No	4
change behaviour	15
(eg:	
watering garden, use of dishwasher & washing machine, toilet flush…)	

3: What do you do to keep the <u>temperature</u> inside your house at a comfortable level

		summer	winter	
don't do anything		1		
check weather forecasts				
set curtains to auto before go out		1	2	
go outdoors		1		
stay indoors				
change clothing	16%	**6**	3	
change activity				
move to another room		2		
open windows	18%	**7**	1	
close windows……	11%	**4**	**6**	23%
change cooking/dietary habits				
close off rooms (thermal zoning)		2	3	
isolate upstairs from downstairs			1	
open curtains (night)		1		
close curtains (day)		2		
open curtains (day)			1	
close curtains (night/day)			3	
close blinds		2		
use heater		n/a	**6**	23%
use cooler (fans)……	24%	**9**		
use electric blanket/water bed				
open up house				

<u>Discussion</u>: Household Behaviour (Table 15)

Previous discussion has focused on aspects such as expectations and attitudes, perceptions and experiences. Table 15 contains information relating to the actual behaviour of respondents in their attempts to save energy and water and keep themselves comfortable in winter and summer conditions.

The majority of these activities are of the 'self-monitoring' type *ie* simple, daily habit/routine changes such as turning lights off, or careful and rational use of appliances and devices. Where these changed behaviours become gradually incorporated into a household's repertoire of behaviours, they can ultimately have an important impact on consumption patterns. Small savings accumulate over time.

Information provided to residents as a booklet or small poster, which focuses on ways in which to save water and energy, without diminishing standards of living, would help establish such behaviours - which ultimately become habits.

Similarly, behaviours intended to maintain comfort prove to be quite simple, adjusting clothing, and opening and shutting windows principally. For cooling, the built-in fans are also used, and found to be satisfactory; for heating, mainly oil-column heaters are used.

Table 16
Modifications Made or Intended

1: Changes made to the house		
Exterior		
	Changed courtyard (plants, stones [grass & paving]) *(habitability)*	4
	Pergola (shade-cloth, polyester, size) *(comfort)*	3
	Extended wall height/courtyard *(privacy*)	2
	Electronic garage-door opener *(inconvenience)*	2
Interior		
	Doors (front:security grille, glazing & bell; zoning/living, deadlocks) *(security, light, comfort)*	5
	shelves in laundry *(function)*	1
	gas connection in front *(aesthetic)*	1
2: Changes you would like to make in the future		
Exterior		
	courtyard (replace stones) *(habitability)*	3
	extend pergola *(summer comfort)*	1
	awning over family room *(summer comfort)*	1
	more landscaping in courtyard, heighten walls *(privacy)*	1
	balcony facing forest *(amenity)*	1
	covered walkway from garage to house *(convenience)*	1
Interior		
	air conditioner/upstairs room *(summer comfort)*	1
	change locks *(security)*	1

Discussion: Modifications Made or Intended (Table 16)

Following on from the previous discussion (where daily behaviour patterns were mentioned), respondents also intervene to physically change aspects of their homes, in order that they should more closely match their expectations.

Such changes are indicative of satisfaction or, rather, *dis*satisfaction with a dwelling, directly or by inference.

The majority of the modifications pertain to changes made to the courtyard, principally the removal of the white pebbles and their replacement with paving or grass. The pebbles are disliked because they make it difficult to use the courtyard. Tables and chairs do not stand comfortably on them, they get hot, children put them in their mouths, weeds grow up through them, and so on. Changes were also made to the pergola, adding covering and in one instance doubling its size. The wall height in the courtyard was extended in two cases, in order to enhance privacy.

Interior changes relate largely to modification of doors - adding a security grille to the front door, or increasing glazing to enhance light in the passageway. In one case, a folding semi-glazed door was added to the livingroom, allowing for it to be closed off from the rest of the house, stairwell etc. An upgrade of locks was also undertaken. Respondents mentioned a perceived lack of security associated with the glass doors leading onto the courtyard (Table 17.5), although no break-ins had occurred.

Changes intended or at least hoped for, in the future, again pertain to the courtyard, the pebbles and pergola in particular, and also adjusting landscaping, principally for privacy.

Valuable lessons can be learnt from these indicators. The focus of attention on the courtyard is indicative of a level of *dis*satisfaction that, for whatever reason, prompts action or intention. This is important to take into account. Here the changes actually made by households, or intended to be made, should be acknowledged by designers and developers, and built-in to future projects.

Table 17
Satisfaction with Amenity Aspects of the House

1: Noise		***Dissatis***	***n/n***	***Satis***
traffic noise penetration/intrusion: livingrooms		2		7
traffic noise penetration: bedrooms	33% *	3		6
noise intrusion between houses				9
noise penetrating from communal spaces				9
noise from any other sources (aircraft eg)	67%*	6	1	2
T		*11*	*1*	*33*
	*	*24%*		*73%*

2: Privacy		***Dissatis***	***n/n***	***Satis***
degree of privacy in courtyard garden	44%*	4		5
degree of privacy indoors	33%*	3		6
T		*7*		*11*
	*	*39%*		*61%*

3: Community Spaces		***Dissatis***	***n/n***	***Satis***
provision of community spaces		1	4	3
behaviour in community spaces			3	6
outdoor play/facilities for children	44%*	4	5	
internal streets/boardwalk				9
T		*5*	*12*	*18*
		14%	*34%*	*52%*

4: Interior Design		***Dissatis***	***n/n***	***Satis***
room sizes		2		7
room location/placement			1	8
open-plan living areas				9
T		*2*	*1*	*24*
		7%	*4%*	*89%*

5: Security		***Dissatis***	***n/n***	***Satis***
in complex grounds: sense of enclosure		2	2	5
in complex grounds: lighting	44%*	4		5
in complex grounds :parking			1	8
in house: doors	44%*	4		5
in house: windows	44%*	4		5
in house: internal parking				9
courtyard: control over accessibility		3	1	5
T		*17*	*4*	*42*
	*	*27%*	*6%*	*67%*

6: Aesthetics		***Dissatis***	***n/n***	***Satis***
look of the house/complex (bays/Juliet's/facade)			1	8
mix of materials/ wood and brick				9
'urban village' style architecture				9
T			*1*	*26*
			4%	*96%*

continued, next page

Table 17 *contd.*

7: Accessibility		***Dissatis***	***n/n***	***Satis***
access to public transportation : busstop location			1	8
access to public transportation: pedestrian bridge			2	7
accessibility to complex by car for residents				9
accessibility to house for elderly &/or disabled people		2	1	6
	T	*2*	*4*	*30*
		6%	*11%*	*83%*

8: Monetary Value		***Dissatis***	***n/n***	***Satis***
marketability: value for money/resale later		1	2	6
affordability: value for money/now		1	2	7
	T	*1*	*4*	*13*
		6%	*22%*	*72%*

9: General		***Dissatis***	***n/n***	***Satis***
courtyard garden, in general		2	1	6
recycling facilities: worm farms	*		6	3
recycling facilities: council facilities (paper etc)		3		6
imageability: special identity of Stringybark	*		4	5
for lifestyle requirements, generally				9
information provided to: run house/garden efficiently	*	7	1	1
other people living in complex				9
	T	*12*	*12*	*39*
	*	*19%*	*19%*	*62%*

Amenity	Overall/Average		***Dissatis***	***n/n***	***Satis***
		*	17%	12%	71%

Discussion: Satisfaction/Dissatisfaction with Amenity Aspects of the Houses (Table 17 and Figure 6)

Generally, the greatest *dis*satisfaction related to lack of privacy (39% overall). This was experienced in both the outdoor courtyard area (44%) and indoors (33%).

Lack of information about how to run the house and garden efficiently was the highest single *dis*satisfaction issue (78%).

*Dis*satisfaction with noise from aircraft was second most important (67%), and accounted for just over 50 % of annoyance from all noise sources, the other half being attributable to road noise penetrating into both livingrooms and bedrooms.

On the positive side, there was complete satisfaction with the lack of noise between houses and from communal spaces.

Outdoor play facilities for children were found to be inadequate by about half the respondents, while other respondents had no real opinion about it (possibly because they do not have children). Indeed, this 'intermediate, neither/nor, don't know' category was mentioned 34% of the time in relation to community spaces - reflecting the highest state of non-committal, or perhaps indifference, of all the amenity aspects investigated. Simultaneously, the overall satisfaction rate with community facilities (only 52%) is low, possibly due to the high degree of 'neutrality' about the issue. These results are indicative of outdoor communal spaces requiring considerably more thought in the design of medium density complexes.

The 27% overall *dis*satisfaction with security was related to the external lighting in the complex and to the quality/nature of the doors and windows in the houses. Failing fluorescent lights account for the outdoor problem. Many lamps were either out or functioning at reduced luminance, giving a general impression of gloominess to the outside spaces. Possibly water leaking into fittings is responsible for this unnatural rate of failure. The glass doors accessing the courtyards are perceived as potentially unsafe, easily breachable by a motivated intruder.

The aesthetics, or 'look' of the complex was rated highest in terms of satisfaction. Some 96% of responses were positive, in particular relating to the urban-village style architecture, and the mix of materials.

Accessibility, in general, also scored well, with access to the bus-stop being appreciated. Only accessibility for the elderly or the disabled proved to be unsatisfactory to some degree, mention being made of the slope of the boardwalk, and the lack of handgrips, especially relevant in wet weather.

Value-for-money is considered to be reasonable, although some minor reservations were mentioned with relation to marketability in the future, possibly because of the aircraft noise (which was not prevalent at the time of purchase), and uncertainty about what impact the M2 might have on the complex.
Overall, the satisfaction rate with all amenity aspects was high, some 70%, while *dis*satisfaction was rated at only 17%. Figure 6 clearly shows this, the best aspects being

aesthetics, then interior design and accessibility; the worst, although to a much lesser degree, being privacy, security and noise, in that order.

Figure 6 summarises the percentage of satisfied and dissatisfied responses with regard to Amenity issues.

Figure 6: Satisfaction/Dissatisfaction :- Amenity

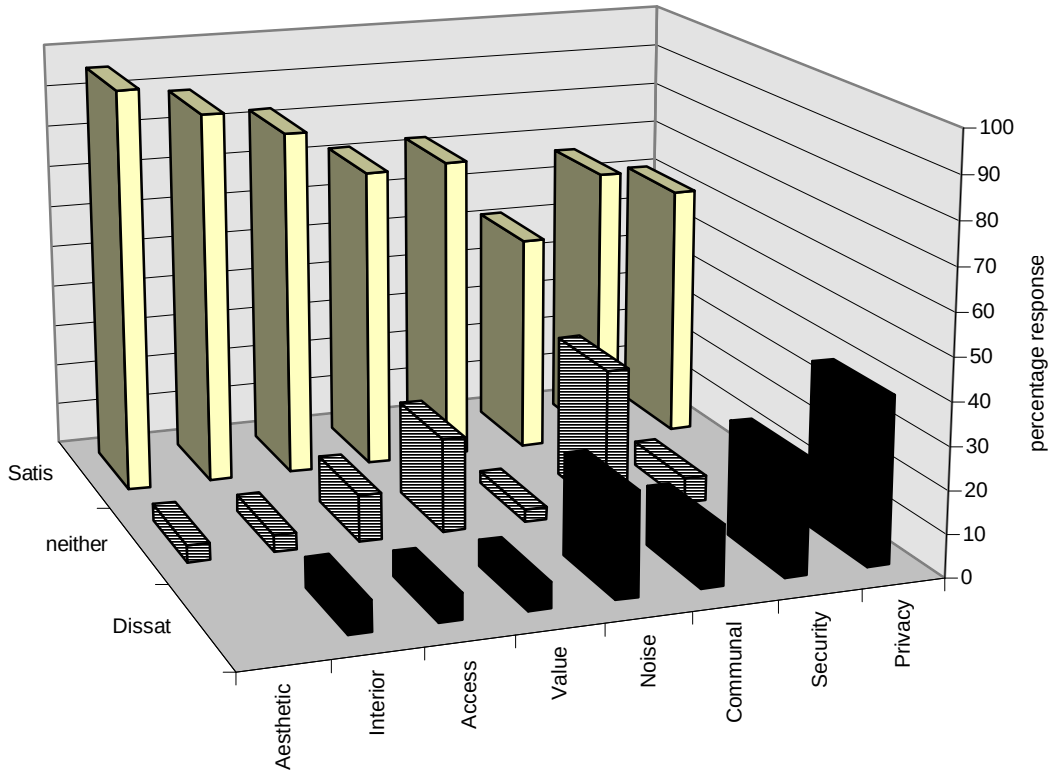


Table 18
Demographics and Occupancy Pattern

Age	*Males*	*Females*	*at home day*	*work at home*	*what activity*		
0-3	1	1				2	
4to12							
13-19		1	1			1	
20-29	3	2	1			5	
30-39	5	5	2			**10**	44%
40-49	2			1 (50%time)	computing	2	
50-59	2	1	1			3	
60-69		1	1			1	
70>							
	13	10	6				

<u>Discussion</u>: Demographics and Occupancy Patterns (Table 18)

The majority of residents (44%) are in the age group between 30 and 40. Only two children (aged 3 or less) and one teenager live in Stringybark Grove, and all of the elderly residents are members of extended families of ex-Hong Kong residents, and do not necessarily live full-time on the complex.

This is possibly indicative of population mixes which will be found in city-proximate and inner city medium-density housing complexes in the future. Smaller households, less children, more aged people. The number of people working from home is expected to increase in the future, but there is little evidence of this trend amongst this particular cohort of residents at Stringybark Grove.

Facilities appropriate for different age groups are required - accessibility for the aged; secure, proximate and visible outdoor play spaces for young children; and community meeting places such as a BBQ area[10], where residents can partake of communal activities should they so wish.

[10] At the time of the interview, a BBQ area had been designated but not yet fitted out or used.

Table 19
Expert walkthru: appliances

		Efficiency of appliances					
1: Electric		***5Star***	***4Star***	***3Star***	***2Star***	***None***	*Power*
	Fridge	2	1	4		5 42%	
	Washing Machine		1	3		4 50%	
	Dryer				2	1	
	Heater						3 (1-1.5kw)
	Garage door						2 (3.5amp)
	Rice cooker/Herb cooker						3 (400w)
	Microwave (additional)					2	
2: Water							
	Fishtank (30l)					1	
3: Gas							
	BBQ (small/2 burner)						
	Heater (never used)						

<u>Discussion</u>: Appliances (Table 19) [11]

The purpose of the appliance survey was to identify any additional items which might significantly affect the energy or water use figures. Only a small number of low power appliances were recorded as additional in the nine units (garage door controls, rice cookers, and a second microwave oven).[12] Only 3 heaters were recorded.

Roughly 40% of fridges and 50% of washing machines in the 9 units surveyed were <u>not</u> of the energy efficient kind. Of the Star Rated appliances, the majority were at the 3* level.[13]

Water efficiency ratings have been available for some time. Since October 1994 the scheme included dishwashers, washing machines and tap outlets. No water-efficient rated appliances were recorded during the house inspection, although most dishwashers and washing machines now have low-water-use capacity as standard. Just over half of the households had changed the showerhead, removing the restrictor.

11 A list of appliances were recorded for each unit but are not available here, for reasons of security and privacy.

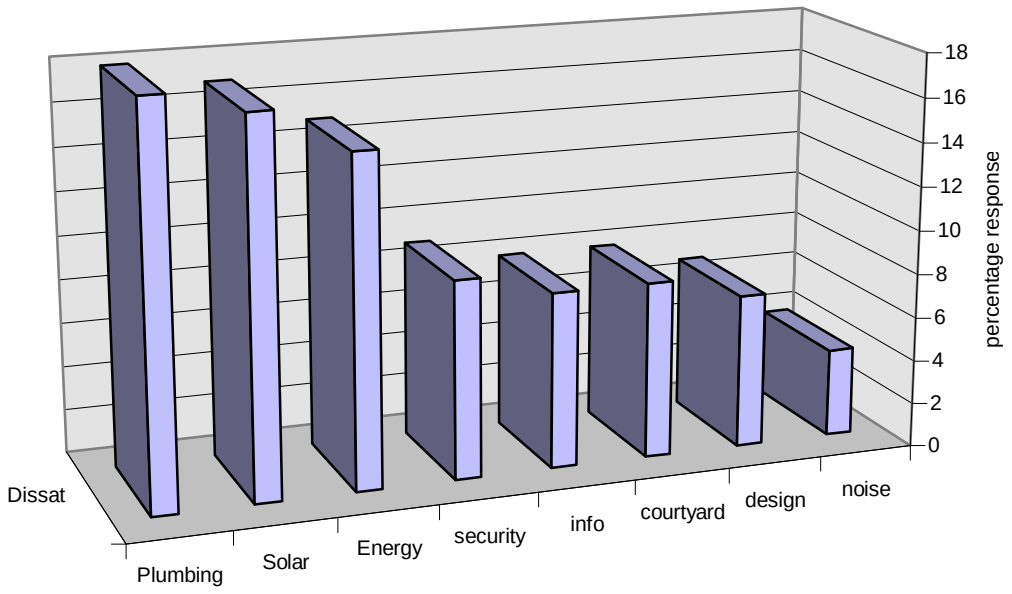
12 Dishwashers were built-in, as were microwave ovens. Several residents mentioned the inadequate size of the microwave oven, but none had installed a standard oven.

13 Although a gas point is provided in each unit, the use of electric appliances is predominant.

Table 20: 'Open-Ended Responses' is a synthesis of all the open-ended responses made by respondents. These comments were made either in response to specific queries such as: 'Is there anything else you would like to add', or as 'Other' responses to the structured questions, or as unprompted recollections of related events or circumstances.

Table 20 can be found in Appendix 1. Below is a graphic representation of the major response categories. Almost all of the 237 open-ended responses recorded were *dis*satisfactions.

Figure 7: Open-ended Responses: Overall *Dis* satisfaction



<u>Discussion</u>: Open-Ended Responses (Table 20/Appendix 1 and Figures 7 & 8)

Figure 7 summarises only the major ***dis*satisfaction** components detailed in Table 20/Appendix 1.

From Figure 7 it is evident that comments made by respondents about their house and/or the complex related in the main to plumbing (17% of the overall responses), solar design (also 17%) and energy issues (15%).

Thereafter, amenity aspects relating to security (9%), lack of information and/or feedback (8%), courtyard functioning (8%) and interior design (7%) were mentioned.

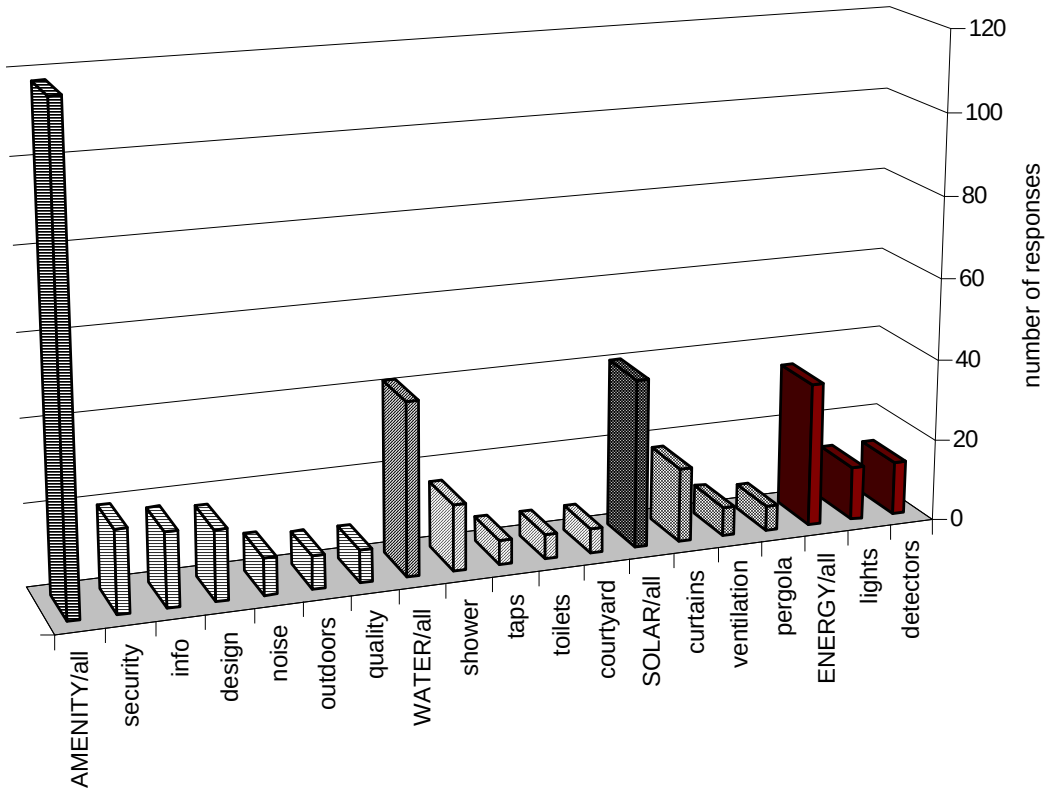
Noise was a minor complaint, here, presumably because respondents had already commented about this aspect sufficiently in the structured part of the interview.

Overall, *dis*satisfaction with *amenity* aspects predominated, representing some 50% of the total open-ended *dis*satisfaction responses.

Only 15 responses related to positive issues. The majority of positive responses related to ventilation issues *eg* good cross ventilation, and the ability to open windows at night. Other satisfactions related to the convenience of the split-level design for people renting, the value of people other than residents using the through-path to the bus and Epping Rd (more people being equated with more security), the 'endless' amount of hot water provided by the Quantum water system, and the capacity of the stairwell fan to keep heat from rising upstairs during the summer.

As a form of overall summary of Table 20, Figure 8 is presented. Depicted are the four major categories relating to *dis*satisfaction only (Amenity, Water, Solar and Energy), with their respective sub-categories indicated.

Figure 8:
Open-Ended Responses: Major Outcomes
Dissatisfaction



3. CONCLUSION

Post Occupancy Evaluations allow policy makers and designers to get a measure of the success of buildings from the users' point of view - through an appraisal of the *experiences* of living or working in a place, day-to-day and at different seasons of the year. Such knowledge is functionally different from the expertise which drives design and policy guidelines.

The information gained from the Stringybark POE allows for some assessment of the perceived benefits and drawbacks of energy and water efficient housing design for residents with no particular predisposition towards a conserving lifestyle. The information is also useful for designers of future projects at the policy, development and implementation levels.

However important it might be to build-in energy efficiency potential, it is user behaviour which ultimately determines the extent to which that potential is realised. When knowledge about user expectations/attitudes, behaviours/experience and satisfaction/evaluations *and* data about a household's actual energy and water consumption levels are combined, the synthesis provides a potent and empirical basis for the design and development of low-environmental-impact buildings as standard in the housing market. When user preference, acceptability and consumption habits are better understood, this research-based information can become part of the design process.

Given the importance of attitudes and behaviours to the realisation of in-built design potential, it would be useful to give consumption feedback to occupiers. A user-guide to the efficient and environmentally sound use of their dwelling would further assist the optimum use of the houses.

It remains only to reiterate that, by nature, occupant evaluations have some tendency to focus on aspects and elements considered to be *un*satisfactory, but that overall levels of satisfaction were very high.

All things considered, the Stringybark Grove development is a notable success, and with the benefit of hindsight future complexes could incorporate insights gained from this research, and be an advance on this initial project.

This is the ultimate aim of a POE, not so much to critique a complex of houses isolated in space and time, but to provide holistic guideline information to enhance future design, quality of life and environmental sustainability.

4. SUMMARY LIST:
Major Issues emerging from the POE
for consideration in the design of future complexes

Bedrooms

- noise penetration/annoyance (double glazing?)
- overheating/summer/upper levels (ventilation/shading/landscaping)
- underheating/winter/south-side (orientation/clerestory)
- privacy (off-set/medium density; glazing/landscaping)

Courtyard

- pebbles x paving/grass - amenity
- pergola/shading - comfort
- privacy (landscaping/walls) - amenity
- noise abatement - amenity
- choice of plants

Water/Plumbing

- shower restrictors x pressure upstairs, and tap sensitivity
- lag period/hot water
- dripping taps
- water pressure in courtyard (pumps)

Energy/Electricity

- external lamps failing (water-proofing?)
- automatic curtains (adjustability, reliability, ease of use)
- movement detectors (reliability, control)

Security

- lighting levels in complex grounds
- glass doors
- locks

Communal spaces

- play-spaces for children
- for community gatherings

Information Booklet and Consumption Feedback

- efficient and economic management of houses
- modification of behaviour patterns

5. SIMULATION OF ENERGY CONSUMPTION AT STRINGYBARK GROVE

using the NatHERS Software (version 1.08) [14]

Introduction

This report presents the simulated annual energy consumption of the main house types in the Stringybark Grove project. It attempts to evaluate some of the design and construction features by removing them from the designs as simulated. The report shows that as built the buildings are potentially quite energy efficient when compared to other housing in Sydney.

NatHERS Simulation Package

A new Nationwide House Energy Rating Scheme (NatHERS) is being developed for all States and Territories in Australia. At the time of writing, the star rating values had not been finalised as each state and territory had yet to finish testing their house ranges against simulation values. The 5 star rating values are anticipated to be resolved early in 1997. It is expected that a procedure will be established to allow rating assessors to be accredited. There will also be opportunities for interested parties, such as the building industry and utilities, to use the scheme to promote energy efficiency.

The Australian NatHERS is designed to enable the energy efficiency of dwelling design and construction to be rated on a scale of 0-5 Stars in a way which is informative and useful to the public. This is the first nationwide initiative of this type in Australia, although there have been attempts to develop similar schemes in the past, such as the Five Star Design Rating developed by the GMI Council. Furthermore, this scheme is required to deal with both summer and winter conditions over the wide range of climates in Australia; from Darwin to Hobart including the Australian Alps.

[14] By Professor John A. Ballinger, Solarch (National Solar Architecture Research Unit), UNSW.

NatHERS is also the name of the computer based software simulation package designed to provide an energy rating for houses in any location in Australia. It can be used for houses at the design stage or for houses that have been built. It is intended to be used by building approval authorities and house designers.

The NatHERS software forms part of the Nationwide House Energy Rating Scheme and as such will in time show each house being simulated as being rated in the range of 0-5 stars (as stated earlier), which shows the potential of the house to have low energy requirements for heating and cooling (at present only the values of energy consumption are presented in $MJ/m^2.pa$). The house is assumed to operate under a standard occupancy schedule appropriate for the given location and each (as described by postcode) is assigned an appropriate climate data file. The resulting rating is based on a detailed computer simulation of the house using hourly weather data.

Simulation Studies

The 10 houses in the project group were all designed to be solar efficient and included a wide range of energy efficient features, some of which are able to be evaluated by energy simulation. Features such as ceiling fans, energy efficient lighting, the automatic control of curtains *vs* manual control for example cannot be simulated by building performance software.

At the present stage of development, the NatHERS software simulates curtains and blinds on a set schedule where they are opened and closed at specific times. This can be modified by an experienced user of the software and so the author did make some adjustments to better simulate specific conditions. The simulation reported in Table 21, item 15 was a case where the curtain input data was modified so that they remained closed all day. In item 16 they were set so that they were never closed. The software version 1.08 however cannot accommodate a situation where the curtains open and close according to a solar intensity schedule (or for whatever the electrical control system was set up).

The ceiling fans cannot be simulated in an energy calculation using version 1.08. It is planned to introduce this as an option in later versions so that the occupant can first attempt to achieve comfort with ceiling fans before turning on the air conditioning.

It is hoped that a future version of the software will also be able to simulate the daylighting levels and hence the energy benefit gained by not needing to resort to electric lighting.

The software is not designed to take into account any airflow between different levels in a house. It therefore is assumed that the house is operated with doors at the top and or bottom of any stair (that is, there is only conducted heat flow between floors and no convection). However, the houses are built for this airflow to occur. Whilst this is not strictly true at all times of occupancy, it does give a useful approximation of what happens with regard to the building fabric and an accurate assessment of the conduction of heat between floors. The software is able to model three zones of conditioned space as well as a zone of unconditioned space. In this house situation, an assumption was made that the stairwell was part of the lower level living zone. The garage under the house was assumed to be what is called a 'neighbour' in the software *ie* it is not considered to be a heat loss path. Given that the garage is closed-off this is a reasonable assumption as the floor above is carpeted. More importantly, that part of the house floor to the north & connected to the ground was modelled as ground connected.

There are 6 individual designs, some of which are repeated in mirror image with their northern facade still facing north.

For simulation purposes it was then only necessary to simulate 4 different dwellings to develop a clear picture of the overall performance of the group. The four dwellings simulated were Nos. H, J, A and B. Dwellings H and J being of the same design but mirror imaged east to west as noted before.

The simulations studied in this exercise addressed the following items and features:

- weather stripping
- wall insulation (upper and lower levels)
- ceiling insulation

- curtain operation
- double glazing as an option
- impact of the high front wall to the north
- variations to roof overhangs
- sheltering effect of medium density designs

Results and Discussion

The basic as-built house was modelled as follows:

- External walls of lower floors in brick veneer construction + R1.5 insulation
- external walls of upper floors in weather board + R1.5 insulation
- the roof with R2.5 insulation on the ceiling
- floors at ground floor level and on ground, concrete with tiles in living area and bath rooms and carpet in bedrooms
- floors to upper floor, timber with carpet to bedrooms and tiles to bathrooms
- windows single glazed in timber frames
- eaves overhang to living areas assumed 750 mm + pergola as shown on drawings
- windows fitted with medium weight curtains and pelmets
- acoustic front wall to highway assumed to be 6m from facade and 5m high above living floor level was tested (in the case of Unit H only).

The results of the simulations conducted are shown in Table 21 below and can be summarised as follows:-

1. The dwellings as built have an average heating and cooling load of 72 MJ/m^2.pa which is substantially lower than other conventional houses. If one assumes medium density houses of this design (which other than orientation is not particularly unusual) but uninsulated and lacking weather stripping, then their energy consumption (heating and cooling) could be assumed to be in excess of 340 MJ/m^2.pa *ie* an energy saving of 79% on a typical (but uninsulated) dwelling of the same type.

2. The effect of not providing gaskets and adequate seals to doors and windows (weather stripping) would be to increase the heating load by 37% of the total load for heating and cooling.
3. The value of energy savings as a result of insulating the dwellings is in the order of 75% compared to an uninsulated house of the same design.
4. The ceiling insulation makes the greatest savings - 65% over no ceiling insulation.
5. If the ceiling insulation were reduced to R2.0 the increase in energy during the winter would be quite small; approximately 4%.
6. The impact of having a common party wall on the eastern side of dwelling no.H results in a saving of approximately 19% compared to a free standing unit of the same design.
7. The front wall built along the highway for acoustic purposes, results in a small increase in energy consumption during winter; 7% of the total consumption.
8. The effect of reducing the eaves overhang from 750mm to 300mm is minimal in overall terms but would increase overheating slightly in summer whilst reducing heating in winter.
9. Double glazing is shown to be of little value in terms of savings in heating and cooling. The added savings over the basic building design would be approximately 15%, mainly in winter heating usage. Such a change would however improve comfort levels by reducing traffic noise and reducing the winter chill effect from the windows.
10. With curtains closed all day the energy consumption rises by approximately 38% compared to a managed program of operation. In absolute terms however the savings are not significant as the automatic operation of the curtains is really only needed for approximately 2 months of the year. It is clear that *mechanically* operated curtains could not possibly be cost effective (an annual saving of approximately 2400 MJ.pa in the worst case).

Observations on Energy Related Design Features

There are a number of features that were chosen for the project that must be considered to be of dubious energy/cost saving value. There are a number of items that seem to have been included for “passive solar design” reasons. The author’s comments here are based on many years of experience and interpolation of the simulation results where appropriate.

- **Pergolas:** On most north facing windows there is a small area of pergola, presumably to provide shade to the windows. Unfortunately it only covers about 1/3 of the facade and so has next to no effect on the building performance. It can however be said that it enhances the quality of the outdoor spaces by provided a small shaded area for summer outdoor living as an extension of the indoor living spaces.
- **Flyscreens:** In the valuation report it is suggested that flyscreens are provided for "direct energy savings". Most purchasers of a quality house such as these, would surely expect flyscreens as a standard fitting. Flyscreens reduce the flow of air through the window quite substantially; generally in the order of 30% or more. Further they also reduce incoming solar energy by as much as 30% and so it might even be better if they were not fitted.

- **Roof venting through the eaves:** This feature is of no value in roofs with an adequately insulated ceiling as is the case in these houses (R2.5 batts). The introduction of such a feature has value only for removing moisture, if that is a problem.

Conclusions

The main conclusion drawn from this exercise is that the overall designs have been very successful in potential energy consumption terms. Future work will look at comparisons of the recorded energy consumption and these results. The occupants recorded that the upper part of the houses tended to overheat during the summer and that the southern side rooms were cold in winter. NatHERS is not yet able to explore temperature within two storey houses and so there can be no computer evaluation of this problem.

Table 21 (over)

Table 21 RAW DATA FROM NatHERS SIMULATIONS

Run	Description	Heating Load MJ/m^2.pa	Cooling Load MJ/m^2.pa	Total Load MJ/m^2.pa
1	Unit H as built with R2.5 ceiling insulation and R1.5 wall insulation	58	19	77
2	Unit J as built with R2.5 ceiling insulation and R1.5 wall insulation	58	20	78
3	Unit A as built with R2.5 ceiling insulation and R1.5 wall insulation	55	14	69
4	Unit B as built with R2.5 ceiling insulation and R1.5 wall insulation	55	14	69
	Simulations based on Unit H			
5	delete weather stripping	87	19	106
6	delete wall insulation (all levels)	138	32	170
7	delete wall insulation upper floor only (weather b'd)	88	24	112
8	delete wall insulation at lower level (BV walls)	109	27	136
9	delete ceiling insulation and foil to tiles	163	57	220
10	delete all insulation	238	72	310
11	decrease ceiling insulation to R2.0	61	19	80
12	sheltering effect of party wall (expose to east with	72	23	95

	insulation)			
13	shading effect of front fence to highway (delete)	52	20	72
14	reduce eaves from 750mm to 300mm plus increase height of eaves to improve winter sun penetration	53	25	78
15	curtains closed all day (normal operation, curtains closed when indoor air temp exceeds 25^{o}C)	92	14	106
16	curtains never closed during day	63	34	97
17	double glazing + curtains normal usage	48	17	65

APPENDIX 1

TABLE 20: OPEN-ENDED DATA
'Other Experiences and Evaluations'

Anything else you would like to mention ?			
20.1: WATER (Plumbing)			
Shower			
Shower restrictor removed (affects pressure in upstairs shower, particularly)			4
Takes twice as long to have shower with restrictor, so end up using twice as much water			1
Shower too slow, too light			3
Takes ages for hot water to get to top shower			3
Back pressure at shower head = taps too sensitive/can't balance not/cold			2
Shower taps too sensitive = dangerous with young kids - suddenly gets hot			1
Pressure useless			1
Water heater in garage = pressure drop - why not in roof?			1
	7%	*Sub-t*	*16*
Taps			
Bathroom taps drip			2
Taps drip - cleaned, and now OK			1
Takes 3/4 min for hot water to reach kitchen			1
Kitchen taps too sensitive			1
Kitchen taps get loose all the time			1
	3%	*Sub-t*	*6*
Toilets			
Management' problems initially, silted up - now OK			2
Water smells - possibly stagnant ?			1
Hear neighbours flushing			1
Noisy flushing action			1
Cistern button sticks and water continues to run			1
	3%	*Sub-t*	*6*
Washing Machine			
Would like to use recycled water to wash clothes - why not?			1
Would like to use water recycled from washing machine to water garden [soap?]			1
		Sub-t	*2*
Courtyard Garden			
No garden tap (or not found/units 5 & 8) - carry water in bucket			2
Pressure too low to water garden			2
Drumming' of rain water in downpipes			2

	3%	*Sub-t*	*6*
Bills/Cost			
Water usage: fixed $80 but only use $30			1
Overseas for 6 weeks, but received excess water charges on bill			1
Erratic water bills			1
Gas water heating is cheaper - surprised by high electricity bills			1
		Sub-t	*4*
General			
Monitoring equipment under sinks takes up valuable space			1
Recycle communal water tanks not big enough for complex			1
		Sub-t	*2*
	18%	***T***	***42***
Positive Response/water			
Endless hot water available from Quantum system = excellent		*(Sub-t 1)*	

20.2: ENERGY

Energy Efficient Lighting			
Outside EE lights fail frequently			4
Difficult to find where to buy to replace (ordered from Leura; 2 weeks to arrive)			3
Expensive to replace			2
Exterior lights vandalised, not replaced			1
[Low lux levels observed by interviewer, nighttime in complex]			
Interior EE light dropped out/failed			2
Swapped EEs for incandescents in some places			1
	6%	*Sub-t*	*13*
Positive Response/lights			
Colour of lights liked		*(Sub-t 1)*	
Power points			
No power point in hall			1
Have to crawl under beds to get to power points			1
Power points and light switches in middle of room, so often behind furniture			1
		Sub-t	*3*
Fans			
Noisy: switching to offpeak at night - can't sleep with on			2
Only one bedroom has quiet fan - go there to sleep when hot			1
		Sub-t	*3*
Positive response/fans			
Fan in stairwell keeps heat from rising upstairs in summer		*(Sub-t 1)*	
Microwave			
Too small (if only oven provided)			2
Need info on how to use it			1
		Sub-t	*3*
Movement Detectors			
Indoors:-			
Inside = no good			3
Good idea but works badly (not stable, long lag)			2
Stairwell - lights just stay on all the time			1
Needs manual override			1
Fluorescent lights 'spike' detectors and turn them on at random			1
Outdoors:-			
Outside = good initially, now stays on so turned it off			2

Garage sensor no good			2
Outside = OK but EE lights fail all the time, so neutralised			1
	6%	*Sub-t*	*13*
Positive Response/detectors			
Outside = OK		*(Sub-t 1)*	
	15%	***T***	***35***
20.3: SOLAR EFFICIENT DESIGN			
Heating			
Not enough in winter			*2*
OK in livingroom but not rest of house			1
		Sub-t	*3*
Comfort/Temperature			
Doesn't cool down fast enough after long hot period [insulation retains heat]			1
Mass wall in courtyard between houses gets hot and radiates heat into living room			1
		Sub-t	*2*
Ventilation			
Not enough in summer			1
Upstairs :-			
Humidity on a warm day is problematic upstairs			1
Living room is OK, gets worse as go higher in house			1
Upstairs no good for natural ventilation			1
		Sub-t	*4*
Opening of windows conflicting with ventilation requirements :-			
Cannot open windows because of road noise			1
If open windows dirt from road comes in			1
Have to close windows at night because of security			1
		Sub-t	*3*
			7
Positive responses/Ventilation			
Can leave front door ajar at night because of installation of security grille door			1
Good extractor fan in kitchen			1
Very good cross ventilation, because of side windows			1
Open windows and blinds at night in summer			1
Pergola slats are effective			1
	33%	*(Sub-t 5)*	
Pergola			
Needs creeper/shading			3
Slats ineffective			2
Not big enough			1
	3%	*Sub-t*	*6*
Thermal Mass/Tiled Livingroom floor			
Furnishing in livingroom blocks sunlight falling on mass floor			1
Prefer wooden floor			1
Too cold in winter			1
Grouting gets dirty			1
Reflects glare			1
	2%	*Sub-t*	*5*
Automatic Curtains			
Override manually			6

Don't use			2
Often go away, and don't want curtains opening and shutting while away, so override			1
Had repaired 3 times, still no good, so now override			1
Doesn't work			2
Don't know how to work			1
Don't know where on dial is on/off			1
Need information on how to work them			1
Needs variable setting (not open or closed)			1
Found setting switch in centre, by chance			1
Too sensitive/too odd			1
	7%	*Sub-t*	*18*
Positive Response/curtains			
On auto = good/maintains stability of temperature		*(Sub-t*	*1)*
	17%	***T***	***41***

20.4: AMENITY

1: Information and Feedback

Feedback			
Feedback required to residents (to learn re habits x consumption, change behaviour)			3
Feedback on electric heater consumption (body coop could buy gas appliances/bulk)			1
(or decide whether to change to gas or not)			1
Feedback on water required (when recycle tanks are full, one could water, wash car)			1
Comparative feedback needed re: other residents, state average, other complexes etc			1
Cleaners influence consumption/good to know how much (time chart)			1
Use a lot of water - would like to know pattern of use (to economise, change)			1
	4%	*Sub-t*	*9*
Information			
Only demo unit available for information - inadequate			2
Agent gave a booklet (tenant)			1
Only by word of mouth			1
Would have liked a booklet before (more than feedback after)			1
Took private lessons on how to use microwave			1
Helped neighbours re running house, and microwave			1
Misinformation: pressurised watertanks upstairs and not the case			1
If don't know how to use house it can get very hot			1
	4%	*Sub-t*	*9*
	8%		***18***

2: Privacy

Close curtains a lot, for privacy [may conflict with climate-appropriateness ?]			2
People across way can look into living room (west end of complex)			1
Upstairs bedrooms are not private enough (people across way)			1
	2%		***4***

3: Courtyard

Privacy			
Not enough privacy (visual)			3
Can hear other people talking in their courtyards (aural)			1
		Sub-t	*4*
Planting/Landscaping			
Changed plants			2
Want to choose own plants			1
Even natives need watering in drought conditions experienced			1
		Sub-t	*4*

General			
Pebbles: weeds grow thru; too hot to walk on, can't balance table/chairs, get dirty, dangerous for young kids (swallow) unattractive			6
Heat trap in summer			1
Pergola = wrong gaps, angle OK, so gets too hot			1
Too noisy to sit out there (traffic noise)			1
Washing line in courtyard conflicts with entertaining			1
Washing line should be hidden and taken out/extended when no visitors			1
		Sub-t	*11*
	8%		***19***
4: Security			
Interior			
No deadlocks on glass doors leading onto courtyard			3
Fly screen on courtyard doors = not security			2
Glass doors onto courtyard could be easily breached			2
Couldn't get contents insurance (no deadlocks/glass doors)			2
Garage door can be forced (easy access to house)			1
No window locks			1
Locks could be better			2
	6%	*Sub-t*	*13*
Exterior			
Driveway has bad sightlines (curves)			1
Driveway surrounded by bush and lighting is erratic			1
Outside lights are not good enough			1
Vandalism of lights by neighbourhood kids			1
Runaway kids camp in bushland behind (vandalism?)			1
People can get into courtyard and not be seen by people once in			1
Gate at Epping road should be locked/ stop non-residents taking short cut			1
	3%	*Sub-t*	*7*
	9%		***20***
Positive Response/security			
People from neighbourhood using path to Epping Rd = more people around = better		*(Sub-t 1)*	
5: Noise			
Aircraft: only after moving in/wouldn't have bought if had known before			2
Wood slats on road = noisy at night as cars cross			1
Music from neighbours bounces off concrete courtyard wall into house			1
Courtyard wall too low for sound reduction			1
Single-glazing cannot mask sounds of trucks			1
Upstairs, at night, sound of trucks penetrates/noisier			2
M2 will make it worse			1
	4%		***9***
Positive Response/noise			
Water running in courtyard (fountain eg) could help mask road sounds			1
Separate slabs means no vibration transmission between houses			1
		(Sub-t 2)	
6: Gas			
No flue so difficult to use gas heaters			1
Gas heater uses so little, but still charged $14 minimum rate			1
Gas heater too expensive so have to use electricity/already have a heater			1
Gas cooktop: low quality, buttons difficult to use, difficult to clean			2
			5
7: Common Spaces and Parking			
BBQ area promised but not there yet			1

Other resident's visitors take up all spare parking			1
Inadequate parking overall			1
Children cannot play ball in common spaces (too small)			1
Concrete gets very hot			1
If many kids were to play in common spaces could become a problem			1
Speed humps are too high			1
Not enough greenery in complex itself			1
	3%		***8***
8: Design			
Should be all brick			1
Rooms are too small			1
Livingroom and diningroom are too small			1
Family room and kitchen connection is bad			1
Family room directly below master bedroom = noisy			1
Open plan: Chinese cooking = smells in house (extractor too weak)			1
No front door bells			1
Tight corners inside: difficult to manoeuver furniture (double beds, eg)			1
Bannister at base of stairs too far out: had it moved			1
Entrance hall too dark			1
Upstairs bedrooms/rumpus room: too hot in summer			1
Heat rises up the three levels			1
Bedrooms cool down too fast in winter			1
Bedrooms on south side: too cold in winter			1
Bathroom on south: too cold, even after a shower, in winter			1
Garage doors too heavy			1
4X4 wagon too high to park in garage			1
	7%		***17***
Positive response/design			
4 people renting = split level design is convenient			1
In winter, cook, eat and go upstairs where its warm			1
		(Sub-t 2)	
9: Craftmanship/Construction Quality			
Paint marks easily			1
Wood chips easily			1
Leak on 2nd floor			1
Tiles in living room not even			1
Glass doors are not square, so flies get past			1
Door on south bedroom: water floods past in big storms			1
Towel rack pulled out			1
Feels cheap inside			1
	3%		***8***
10: Accessibility			
Elderly, rainy days = no good (no handles on steps)			1
Steps no good for elderly			1
From bus = steeply down/up			1
	1%		***3***
11: General			
No pets so dogs had to go to kennel			1
Storage no enough			1
Solar drying in garage=no air movement clothes smell damp (can't open doors/security)			1
Recycle bins need lids			1
Recycle facilities inadequate			1

Don't use worm farm			1
Need more worms			1
	3%		***7***
	Amenity	***T***	**118**
		***Dis*satisfaction**	**236**
Overall Total	**Satisfaction**	**15**	

APPENDIX 2

INTERVIEW/QUESTIONNAIRE[15]

DEPARTMENT OF URBAN AFFAIRS AND PLANNING

STRINGYBARK GROVE POST OCCUPANCY EVALUATION, DECEMBER 1995

INTERVIEW SCHEDULE

1. In your opinion, what are the *3 best* and *3 worst* things about this house

best

1.....

2.....

3.....

worst

1.....

2.....

3.....

2. When you were last looking for a place to live,

what was it* that made you *choose this house

[15] Note: Respondents do not see the question or checklist. Whenever *rating scales* are used in the *interview* format, they are referred to an appropriate rating scale provided in a separate booklet**.**

(Open-ended format = Motivations/Expectations/Previous Experience **CHECKLIST** ***for interviewer use***:

eg interviewer checks ⌦ all items mentioned by respondent - no cues/prompts)

price/value for money/resale value

media publicity/info re house via demo house/etc

lower fuel bills/energy efficiency/save energy

lower water bills/save water

re-use of water

ideological/save environment/save resources ⇳

prior interest in solar efficient/sustainable housing

negative past experience of traditional house

previous experience (climate)

personal control/intervention possibilities

plenty of indoor sunlight

plenty of natural daylight

courtyard garden/little maintenance/minimal watering

liked design generally/aesthetic qualities

open-plan design

spatial qualities: room size, number, arrangement, location, double storey

windows to north

garage

roof preference(pitched)

insulated walls and ceilings

brick construction

indoor/outdoor integration

size of house

family cycle requirements

children's requirements

friends/ family proximate

prefer medium density living

privacy expectations met

community opportunities

noise abatement

views

neighbourhood/location (familiar/ facilities/status/convenience/schools etc)

milieu/surrounds/trees/ bush/pleasant/

public transportation facilities

Other

3. How *important* is it to you (and/or your family) to save *energy*

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Important			Nor			Important

4. How *important* is it to you (and/or your family) to save *water*

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Important			Nor			Important

5. How *acceptable* is it to you(and/or your family) to <u>re-use</u> *water*

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Acceptable			Nor			Acceptable

6. How *satisfied* are you living in a *townhouse* (rather than a free-standing house)

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Satisfied			Nor			Satisfied

6.1 Why?

7.1 Which type(s) of energy source would you prefer to use for *cooking*

Electricity

Pyro-Ceramic

Gas

Microwave

Other

7.2 Which type(s) do you actually use ?

Electricity

Pyro-Ceramic

Gas

Microwave

Other

8.1 Which type(s) of energy source would you prefer to use for *heating*

Electricity

Gas

Other

8.2 Which type(s) do you actually use ?

Electricity

Gas

Other

9. Would you say that your *attitude* towards saving energy and water has *changed* since living here ? *How/Why?*

10. Could you tell me how *satisfied* you are

with the following characteristics of your house

(interviewer asks each question; respondent to focus on summer and winter, one at a time)

-3 -2 -1 0 +1 +2 +3
Not at All Satisfied — Neither Nor — Very Satisfied

	Summer	***Winter***	*Mid-Season*
amount/direct ***sun***light/living room areas			
amount/direct sunlight/bedroom 1			
amount/direct sunlight/bedroom 2			
amount/direct sunlight/bedroom 3			
amount/natural ***day***light /living room areas			
amount/natural daylight /bedroom 1			
amount/natural daylight /bedroom 2			
amount/natural daylight/ bedroom 3			
general level of glare indoors			
amount of natural heating from solar energy	**n/a**		
circulation of air indoors			
natural cooling of house		**n/a**	
cooling effect of fans		**n/a**	
warming effect of fans	**n/a**		
temperature in living room areas			

temperature in bedroom 1			
temperature in bedroom 2			
temperature in bedroom 3			
stability of temperature in house			
freshness of air			
10.1 PROMPT: ***Any problems in Spring or Autumn ?***			✓

11. How *satisfied* are you with your <u>energy</u> bills

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Satisfied			Nor			Satisfied

11.1 How do these bills compare with those from your last home ?

Worse Same Better Don't Know

11.2 Have there been any important changes (eg: new baby, other family changes, new appliances...) which might have changed the way you use energy now and then ?

12. How *satisfied* are you with your <u>water</u> bills

-3	-2	-1	0	+1	+2	+3
Not at All			Neither			Very
Satisfied			Nor			Satisfied

12.1 How do these bills compare with those from your last home ?

Worse Same Better Don't Know

11.3 Have there been any important changes (eg: new baby, other family changes, new appliances...) which might have changed the way you use water now and then ?

13. Would you now tell me how *satisfied* you are with these other characteristics of your house and the Stringybark complex

(interviewer asks each question)

-3 Not at All Satisfied	-2	-1	0 Neither Nor	+1	+2	+3 Very Satisfied
a.i	traffic noise penetration/intrusion: livingrooms			.....		
a.ii	traffic noise penetration: bedrooms			.....		
a.iii	noise intrusion between houses			.....		
a.iv	noise penetrating from communal spaces			.....		
a.v	noise from any other sources (aircraft eg)			.....		
b.i	courtyard garden, in general .			.....		
b.ii	degree of privacy in courtyard garden				.....	
b.iii	degree of privacy indoors			.....		
c.i	provision of community spaces			.....		
c.ii	behaviour in community spaces			.....		
c.iii	outdoor play/facilities for children			.....		
c.iv	internal streets/boardwalk			.....		
d.	*performance of water appliances*					

d.i	: taps	.....
d.ii	: showerhead	.....
d.iii	: toilet flushing from roof water	.....
d.iv	: garden watering from roof water	.....
d.v	: low-watering/native planting in gardens	.....

performance of <u>built-in</u> energy-appliances:

e.i	: cooktop	.....
e.ii	: combined convection/microwave oven	.....
e.iii	: Quantum heat pump/hot water	.....
	[aware that heat pump ? Y N]	
e.iv	: ceiling fans	.....
e.v	: power-operated curtains	.....
	[adjustability	.....]
e.vi	: movement detectors and lighting control	.....
	[adjustability	.....]
e.vii	: energy-saving type of lighting	.....
e.viii	: tiles in livingroom area	.....
e.ix	: pergola shading efficiency	.....
e.x	: house/protection from winter winds	.....
e.xi	: house/exposure to summer breezes	.....
f.i	bedrooms on the south: temperature in winter	.....
f.ii	bedrooms upstairs: temperature in summer	.....
g.i	room sizes	.....
g.ii	room location/placement	.....
g.iii	open-plan living areas	.....
h.i	recycling facilities: worm farms	.....
h.ii	recycling facilities: council facilities (paper etc)	.....

i.i	access to public transportation : busstop location	.....
i.ii	access to public transportation: pedestrian bridge	.....

j.i	security: in complex grounds: sense of enclosure	.....
j.ii	security: in complex grounds: lighting	.....
j.iii	security: in complex grounds :parking	.....
j.iv	security: in house: doors	.....
j.v	security: in house: windows	.....
j.vi	security: in house: internal parking	.....
j.vii	security: courtyard accessibility	.....
k.	accessibility to house for elderly &/or disabled people	.....
l.	accessibility to complex by car for residents	.....
m.i	aesthetics: look of the house/complex (bays/Juliet's/facade)	.....
m.ii	aesthetics: mix of materials/ wood and brick	.....
m.iii	aesthetics: 'urban-village' style architecture	.....
n.i	marketability: value for money/resale later	.....
n.ii	affordability: value for money/now .	.....
n.iii	imageability: special identity of Stringybark	.....
o.	for lifestyle requirements, generally	.....
p.	information provided to: run house/garden efficiently	.....
q.	other people living in complex	.....

r. Any other amenity issue which respondent raises

14. Do you *do* anything to try to save ***energy* ** (show consumption/graphs, ask to explain) [16]

15. Do you *do* anything to try to save ***water* ** (show consumption/graphs, ask to explain)

16. What do you *do* to keep the temperature inside your house at a *comfortable level* (during the different seasons)

(Open-ended = Behaviour/Intervention CHECKLIST for interviewer. No cues/prompts, except for season *****

ie summer and winter only*;* *then* when they stop *prompt* for other things}

	Summer	***Winter***	*Mid-season*
don't do anything			
check weather forecasts			
set curtains to automatic before going out			

[16] Notice cultural differences, eg in cooking x water/energy use. Graphs provided by Brian Phipps and Charles Essery

go outdoors			
stay indoors			
change clothing			
change activity			
	Summer	***Winter***	*Mid-season*
move to another room			
open windows			
close windows			
change cooking/dietary habits			
close off rooms			
open up house			
isolate upstairs from downstairs			
open curtains			
close curtains			
close blinds			
use heater (type/energy source)			
use cooler (type)			
use electric blanket/water bed			
Other **16.1 PROMPT: anything *in particular* that you remember doing in Spring or Autumn**			➢

17. What changes (if any) have you made to the house ?

17.1 Why?

18. Are there any changes that you would like to make in the future ?

18.2 Why?

19. Is there anything else you would like to tell me about your experience living in this house/complex

20. Demographics and Occupancy Pattern

Age	*Males*	*Females*	*Is anyone usually at home during the daytime ?*	*Does anyone work from home ?*	*What kind of activity does this work involve ?*
0-3					
4-12					
13-19 (teens)					
20-29					
30-39					
40-49					
50-59					
60-69					
70>					

21. Expert walkthru: appliances

(Check for changes/additions to initial installations (esp washing machines; showerheads, lamps eg)

Electric

Water

Gas

thank you for taking part in this survey