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## **Voices from Tokelau: culturally appropriate, healthy and sustainable extended-family housing in New Zealand**

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**Abstract:** *Tokelauans have more three-generation families living in one household than any other ethnic group living in New Zealand. They are also the most economically-deprived of all Pacific communities and consequently have little choice but to live in crowded conditions in old and relatively small dwellings at the low price end of the rental market. This paper reports on part of a cross-disciplinary study into health, and housing in which the focus is on the design, production and assessment of a purpose-built house for an extended family of Tokelauan origin. It provides an overview of findings from recent research on health and housing among Pacific peoples living in New Zealand, and identifies various architectural issues associated with health-related problems of cold, damp and crowding.*

**Keywords:** *Extended family housing; health, design, sustainable housing, Pacific*

### **Introduction**

Among tropical Pacific island nations the indigenous house design has one open living/sleeping space, and a minimum of solid external walls (Howden-Chapman 2000). This arrangement serves cultural preferences for extended-family living, and the need to take full advantage of sea breezes in hot humid climates. In stark contrast, Pacific Island migrants to New Zealand arrive to a cool humid climate and encounter a housing stock that is highly compartmentalized yet modest in area (being traditionally

built for people of Anglo-Saxon and European origins with a dominant nuclear-family culture and relatively small households). For Tokelauan people, as with many Pacific migrant groups, adaptation to a new physical and cultural environment is problematic, to the point where health and wellbeing are threatened (Wessen et. al., 1992, Pene et.al. 1999). Tokelauans living in New Zealand suffer a disproportionate rate of illness and disease (Howden-Chapman and Wilson, 2000; Baker et al, 2000).

Tokelauans are proportionally one of the smallest Pacific groups in New Zealand and one of the most socio-economically deprived. For migrants from the isolated tropical Tokelau atolls of Nukunonu, Atafu and Fakaofu, extended-family living is not only an important cultural practice, but also an economic survival strategy when living in New Zealand (Baker et al, 2003, Howden-Chapman and Wilson, 2000). The Tokelau community has a higher proportion of three-generation families living in one household than any other ethnic group in the country (SNZ 2007a). Most of these large households find that they must make do with the cheapest housing that is available, which generally means living in an un-insulated (pre-1980s) three-bedroom house. Such 'low end' housing stock is typically cold and damp internally, prohibitively expensive to heat, and practically impossible to adequately ventilate using only operable windows (Gray, 2004).

The housing and health experience of Tokelauan people in New Zealand is part of a broader pattern of poor quality inappropriate housing across various cultural and socio-economic sectors of society (Thorns 1988, Centre for Housing Research 2007a, 2007b, Ministry of Social Development 2008). There are two parts to this issue: one, the problem of cold, damp, poorly ventilated housing, is now widely recognised, if not widely acted on; the second, less recognised but no less important a problem is that a substantial part of the New Zealand's housing stock appears increasingly unsuited to the spatial and cultural needs of a rapidly-changing demographic (Howden-Chapman 1999, SNZ 2007a, Viggers 2008). Although the association between

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poor housing and ill health is known, the lack of compelling quantifiable evidence linking environments and health outcomes has been an impediment, at a political and economic level, to demands for improved housing quality in New Zealand. However, important links in the *causal* chain are now understood, due in large part to research being conducted at the University of Otago Wellington School of Medicine and Health Science WSM (see [www.healthyhousing.org.nz/](http://www.healthyhousing.org.nz/) ). For example, we now know that indoor temperature is causally linked to certain health outcomes (Howden-Chapman 2008). Consequently, it is now possible to calculate the differential costs of house insulation and health.

The research reported in this paper formed part 4 of a He Kainga Oranga/Housing and Health research programme. The aim of the research was to determine the feasibility of the design, funding and construction of a house that would successfully deal with housing problems being experienced by Tokelauan and other Polynesian people living in New Zealand. Adopting a broad definition of sustainability (Agenda 21, see <http://www.un.org/esa/dsd/agenda21/> ) the measures of success can be summarised thus: ongoing economic viability for the owner and occupants; social equity involving a fair use of resources to achieve appropriate and healthy living conditions; and ecological sustainability.

We set out to describe and discuss a ‘demonstration’ house that was designed, built and tested as part of a multi-disciplinary research project coordinated by the Wellington School of Medicine. The resulting ‘Tokelauan House’ project was intended to provide a positive design response to a difficult set of technical, health, cultural, political and economic problems. In essence, this translated to the following challenge: to design and construct social housing that would be culturally and socially appropriate to a three-generation Polynesian extended family (some 10 people); that would remain warm and dry (even if the householders are not always vigilant about ventilation, heating and moisture

control); that could be operated at moderate cost to the occupants; that was within the owner's (i.e. Housing New Zealand Corporation) limits of capital expenditure (NZD 1,450/m<sup>2</sup>), low maintenance expenditure; and that is politically/socially acceptable. The paper concludes with a discussion of the implications and practical ramifications of the research findings for people working in the fields of design, health and policy

## **Relationships between housing and health**

New Zealand has a cool to temperate climate, with mean winter daytime temperatures ranging from 10°C in the south to 16°C in the north. Two thirds of the housing stock comprises three bedroom and four bedroom stand alone wooden houses on wood or concrete piles (see SNZ, [www.stats.govt.nz/default.htm](http://www.stats.govt.nz/default.htm)). Houses usually last about 90 years and about a third has no insulation. Despite the cool temperatures, most people only heat the living room and occasionally a bedroom. Pre-1980's houses in NZ, typified by the 3-bedroom bungalow, still make up the majority of the housing stock of the country (Ministry for Culture and Heritage, 2008). Such bungalows, once well-suited to the lifestyle and size of nuclear European families, are increasingly unsuited to the spatial, functional, cultural and physiological needs of the contemporary households that occupy them (Altman, 1975, Centre for Housing Research, 2007b). The interior of a 1950's house, for instance, could be kept tolerable warm, dry and healthy because in that era someone would more than likely have been at home during the day, 'managing' the house by keeping it aired and heated, putting the laundry *out* to dry, and so on. The same house today is unmanageable and potentially unhealthy in the new circumstances of a large household (more moisture generated by cooking, washing, breathing and heating), with everyone away most days or for most of each day (the house is locked up, windows closed, less ventilation, washing kept inside to dry because of the risk of theft if left outside), and

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with many people in close proximity to one another when the house is occupied (a significantly increased risk of serious sickness) (Gray, 2004).

Many extended families in New Zealand live in crowded three-bedroom houses, in part to lower the rent per person (Baker et al., 2003 Howden-Chapman and Wilson, 2000). Lower incomes also mean that a disproportionate number of extended families are living in state housing. Rates of household crowding for Māori and Pacific peoples are double those for Europeans (Baker and Zhang, 2005). There is strong evidence of a causal connection between humidity, crowding and health. Many studies now attest to the effects of damp and mould on pre-existing asthma and other health problems, while crowding increases the risk of close-contact infections, such as meningococcal disease, rheumatic fever, tuberculosis and skin disease (Baker et al., 2000, Jaine, 2007, Das et al., 2007, Baker et al., 2008).. Crowding also increases the risk of being exposed to second-hand smoke (Howden-Chapman and Tobias, 2000), which irritates the airways and increases the risks of infectious diseases. Tokelauans have the highest prevalence of smoking in any Pacific group (SNZ, 2007a).

There is also a causal relationship between low house temperatures, and occupants' health and wellbeing (Howden-Chapman et.al. 2007, 2008). New Zealand houses are cold, with over a third of the population living in houses below the World Health Organization recommended minimum of 16°C. In one large community based, cluster, single blinded randomised study of 1350 households across seven regions of New Zealand, it was shown (Howden-Chapman et al., 2007) that a relatively modest investment in insulation per house (around NZD1550 excluding taxes, or the cost of *one inpatient hospital admission*) raised the average temperature by about one degree, but led to significant improvements in the population's self reported health and a lower risk of children having time off school or adults having sick days off work. Participants in the

intervention group had significant improvements in their general health, respiratory symptoms, sense of comfort and wellbeing, and in reduced heating costs

### **Experience of extended family living in a ‘standard’ bungalow**

The experiences of the extended family living in a standard New Zealand bungalow were less than satisfactory. The hosting family worked long hours in low paying jobs and as a result were eligible for state housing. The family elders had moved from Tokelau to join their adult children in Wellington becoming permanent members of the extended family household and to assist with child rearing. Figure 1 is a photograph of a house that was occupied by the Tokelauan extended family prior to their move to a new purpose-built house (described later). The house had an area of 84m<sup>2</sup>, comprising three bedrooms, one bathroom, a kitchen, small dining area, laundry and living room. The walls and floor were un-insulated and the roof was under-insulated. There was one solid fuel heater in the living room. The regular household of 10 people comprised two grandparents, two parents and five children, and a niece of the father. Visitors sometimes ‘landed’ on the family for periods lasting some weeks.



**Figure 1 The ‘before moving’ house: a typical 3 bedroom, 84m<sup>2</sup> State house** (Photographer John Gray)

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Preliminary interviews with family members revealed problems of crowding, cold, damp, inadequate bath and toilet facilities, lack of privacy, lack of opportunity for homework, difficulty and embarrassment with hosting, and a general level of stress in the household from the combinations of pressures and problems. The following is a selection of evaluative comments from family members from the interviews held by public health researcher Gina Pene (Pene et al, 1999).

*A problem for me is not being able to sit down together as a family to have a meal (father)*

*The house is very damp and cold, even though the curtains are pulled but it is still cold. Sometimes you can feel the dampness in the air and the air feels heavy and it does not feel right. The condensation on the wall – you can see the mould and I know it is not healthy. (daughter)*

*There are ten in our family and only three bedrooms. (father)*

*Our lounge is not only a lounge but also it is used as a dining room, sleeping area, and study area for the children to do their homework. (mother)*

*I share the bedroom with my Nana and my cousin. This is a single bedroom but because it's a three bedroom house there aren't enough rooms for people in our household (daughter)*

*When we get visitors the problem is worse because sometimes they stay over, but there aren't enough bedrooms so the lounge becomes a bedroom. (niece)*

*I feel we cannot function properly as a family because I want to have family discussion but there isn't the room... the lounge is used as a bedroom...I would love to do traditional Tokelau handicrafts in here but it is not possible because of the lack of*

*space inside the house..... I am very concerned for my grandchildren because of the lack of space for them to do their homework, so they use our bedroom. (grandmother)*

*It is very depressing at times because the room is too small to even have a desk or a table to put my schoolbooks on or to do my school work. I have to sit on the bed to do my study as you can see it is hard to move around in this room because the space is taken up by the two beds. I wish there could be more space for me to do my study or have a desk or table in here. (niece)*

*The ... problem is having only one toilet for our large household. The mornings in our household are very busy, chaotic and very stressful because everyone has to wait in line for their turn. (mother )*

*I sometimes wish that I have my own bedroom... Because we are sharing one, sometimes I don't feel comfortable getting changed in the room. You try to use the bathroom but it's no good because it is too small. (daughter)*

## **Method**

The Tokelau Housing and Health project began with meetings with seven focus groups designed to identify what physical, financial and social aspects of housing, in the view of the Tokelau community, were most likely to affect the health of the household and the wider community. The focus groups consisted of elderly men, elderly women, teenagers, single mothers, community workers, tenants, and owners. The focus group discussions were followed by a survey of 150 households, involving interviews with 600 people. The findings from the survey and focus groups were relayed back to the community and further discussed at an open forum.



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From these initial meetings an action research model developed. While utilising a scientific body of research into health in relation to housing together with professional and technical knowledge of building, a key aspect of the approach is a commitment to partnerships between researchers, owner/providers and the community to develop an applied social science research agenda. In this model, we were looking at 'structural' factors affecting health, pathways through which such material matters influence health, and pathways for realising housing solutions that reduce the hazards to health.

Extending from the broader meetings, a representative Tokelauan working group was formed in order to undertake a study of the habits, preferences, relationships and behaviours of the target household type and culture – a task that clearly required the participation and advice of representatives from (in this case) the Tokelauan community in New Zealand. Given the range of imperatives and constraints involved in social housing, it was also clear that a team approach would be necessary. The key participants, apart from the Tokelau community representatives, were the public health researchers, the design/architectural researchers, various Housing New Zealand Corporation personnel (project management, policy, design, finance and political people), and (eventually) builders and local authorities.

The design process centred on a series of workshops between the research team and the representative group from the Tokelau community in Wellington where the proposed demonstration house was to be constructed. The workshops dealt with three phases in the design of a house: firstly, a briefing phase in which the quantitative and qualitative requirements are established; secondly, an initial design phase involving a free exchange of design ideas (small or encompassing) that would work well; and finally an evaluative phase during which designs developed by the

architects are critically appraised and refined. The review process was aided by the use of large-scale models which could be dismantled and reassembled during discussions.



**Figure 2: Photograph of the completed extended-family demonstration house (Photographer John Gray)**

The demonstration house was completed and occupied in December 2007. As part of the building commissioning, a meeting was held with the building occupants and the architect to explain the house design and strategies for effective use. In preparation for post occupancy evaluation, data-logging equipment was installed throughout the house to record temperature and humidity, cameras were given to household members to record aspects of the building about which they had questions or comments and arrangements were made for interviews and focus group discussions in 5 months. Hence the post occupancy evaluation strategies employed a combination of quantitative and qualitative techniques.

Sixteen *dataloggers* were installed inside and outside the new house to gather reliable evidence of the technical performance in terms of temperature and humidity, throughout the building. The dataloggers collected data at hourly intervals for periods ranging from five months to 18 months. While the official post occupancy evaluation meeting took place at the 5 month interval, the continued

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use of the dataloggers assisted in establishing reliability, limiting any favourable results that might occur from the occupants changing behaviours to assist the researchers in achieving good results. Other records such as electricity and gas consumption were also reviewed to confirm reliability and to better understand the relationship between building fabric, external conditions, and use and management of the house.

To aid occupant memory and to gain perspectives from a wide range of family members, the qualitative aid *Photovoice* was used. *Photovoice* is a tool used in community-based participatory research to enable participants, who are usually 'subjects' of research, to take photos with disposable cameras in order to frame the issues they think are important, and potentially influence or create social change by conveying this to policy makers (Wang and Al, 2004, Macintyre, 2003). In this case, all members of the family were provided with a disposable camera to capture images of the 'old' house and the 'new' house. The resulting images were used as prompts in discussion with a researcher.

*Focus group discussions* (or interview) are tools that enable a free exchange of ideas and points of view among a small group of people. In this case several focus groups were formed from 18 Tokelauan teenagers to discuss their housing and family experiences. The main thrust of these discussions was to do with familial relations, but because they were open-ended discussions there were numerous references to physical factors in the house environment that were reported to influence individual and collective (family) wellbeing.

## **Findings and interpretations**

Building on work by the British Research Establishment, the Warwick School of Law distilled a list of all the potential hazards that could be found in dwellings to those that could be attributable to housing design and conditions (excluding any attributable solely to human behaviour, household equipment, furnishings and furniture). In doing so they found three kinds of health-related problems with housing – first, a group of hazards to *physiological* health, such as allergens, mould, dust mites and poisons; second, a group of cultural and social factors that can affect *psychological* (and sometimes physiological) wellbeing, including privacy, noise and crowding; and finally a group of risks relating to the layout, materials and construction of a house that may affect *safety*, and result in accidents such as fire, or falls [Warwick Law School 2006].

In the predesign stage, working from this list and the health literature (especially Howden-Chapman, 2004) and the Tokelauan community focus group, the relationship between health hazards and physical elements and environments in housing was mapped (Table 1). The table is organised according to seven fundamental sub-systems (Howden-Chapman, 2000, 2007). Against each of these systems we have arrayed pertinent health hazards, the mechanisms (in the form of building parts or elements) that ameliorate the hazards, and the anticipated outcome, in terms of the benefit from providing the mechanism.

**Table 1: Mechanisms used in response to anticipated health hazards in a large household**

System	Health hazard	Mechanism adopted	Expected result
Insulation	<ul style="list-style-type: none"> <li>- Cold</li> <li>- Damp and mould</li> <li>- Stress (financial)</li> </ul>	<ul style="list-style-type: none"> <li>- Extra-insulated floor, walls and roof</li> <li>- Double glazing (habitable rooms and bathrooms)</li> </ul>	<ul style="list-style-type: none"> <li>- Retained warmth</li> <li>- Reduced radiant heat loss (from the body to cold)</li> </ul>

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			surfaces) - Reduced energy cost
Heating	<ul style="list-style-type: none"> <li>- Cold</li> <li>- Damp and mould</li> <li>- Dust</li> <li>- Poisons, pollutants, VOCs, allergens</li> </ul>	<ul style="list-style-type: none"> <li>- Solar gain (sun-facing windows)</li> <li>- Heat pump including filter</li> <li>- Heat transfer duct including filter</li> <li>- Fan heater (bathroom)</li> <li>- Stack effect (chimney + vent)</li> </ul>	<ul style="list-style-type: none"> <li>- Warmth (appropriate air temperature)</li> <li>- Dryness (in conjunction with heat-assisted ventilation, and avoidance of moisture-producing heaters)</li> <li>- Filtration (reduced dust)</li> <li>- Air movement (stack effect, fans)</li> </ul>
Ventilation	<ul style="list-style-type: none"> <li>- Damp and mould</li> <li>- Infections and hygiene</li> <li>- Stress (e.g. psychological/cultural desire for moving air)</li> </ul>	<ul style="list-style-type: none"> <li>- Operable windows with cross-ventilation</li> <li>- Venting “chimney” with wind powered exhaust (to extract moist air from both bathrooms)</li> <li>- Kitchen range hood (exhaust fan to outside)</li> <li>- Operable “trickle” vents in window frames</li> </ul>	<ul style="list-style-type: none"> <li>- Dryness (passive [involuntary] exhaust ventilation, especially from bathrooms, plus active [voluntary] ventilation throughout the house via secure</li> </ul>

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		<ul style="list-style-type: none"> <li>- Fixed vents in bathrooms</li> <li>- Deliberate (occasional) overheating from solar gain to encourage ventilation and purging</li> </ul>	<ul style="list-style-type: none"> <li>windows)</li> <li>- Occasional purging of moisture and pollutants by voluntary opening of upstairs windows in uncomfortably warm indoor conditions</li> <li>- Active (voluntary) ventilation by operable windows and doors, especially in kitchen/dining area</li> <li>- Discernible air movement on demand (operable windows and doors).</li> </ul>
Materials	<ul style="list-style-type: none"> <li>- Poisons, VOCs and pollutants</li> <li>- Infections and hygiene</li> <li>- Noise</li> <li>- Dust</li> <li>- Risk of accident (slips and falls)</li> </ul>	<ul style="list-style-type: none"> <li>- Concrete (polished semi-smooth finish) throughout ground floor, including 2 bedrooms</li> <li>- Stainless steel bench tops</li> <li>- Plywood cabinets</li> </ul>	<ul style="list-style-type: none"> <li>- Minimal off-gassing, VOCs</li> <li>- Minimal dust and dust mites in living areas and</li> </ul>

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		<ul style="list-style-type: none"> <li>(avoidance of MDF)</li> <li>- Prefinished bathroom linings (automotive paint technology)</li> <li>- Carpet (wool, upstairs only).</li> </ul>	<ul style="list-style-type: none"> <li>two bedrooms</li> <li>- Cleanability and hygiene</li> <li>- Dryness (minimal embodied moisture in materials)</li> </ul>
Orientation and Layout	<ul style="list-style-type: none"> <li>- Damp and mould</li> <li>- Stress (psychological/cultural)</li> <li>- Stress (financial)</li> <li>- Intrusion and lack of privacy</li> <li>- Infections</li> <li>- Crowding</li> <li>- Stress (growth environment)</li> </ul>	<ul style="list-style-type: none"> <li>- Separation of wet areas from habitable areas</li> <li>- Zones for privacy control</li> <li>- Doors and buffer spaces for privacy control and access</li> <li>- Openness (no corridors)</li> <li>- Flexibility/adaptability of use</li> </ul>	<ul style="list-style-type: none"> <li>- Dryness in habitable areas</li> <li>- Air movement</li> <li>- Surveillance of children and young adults</li> <li>- Options for sleeping arrangements (influences involving gender, relationship, generation, age, health condition and personality)</li> </ul>
Amenity, space and size	<ul style="list-style-type: none"> <li>- Damp and mould</li> <li>- Stress (cultural)</li> <li>- Crowding</li> <li>- Infections and hygiene</li> <li>- Risk of accident</li> </ul>	<ul style="list-style-type: none"> <li>- Two bathrooms, three toilets (one accessible from outside)</li> <li>- Separate laundry and outside drying facilities</li> <li>- Outside sink</li> <li>- Semi-habitable garage</li> <li>- Bed spaces for every household member, not more</li> </ul>	<ul style="list-style-type: none"> <li>- Dryness in wet areas</li> <li>- Reasonable wait times for bathrooms and toilets</li> <li>- Capacity to accommodate visitors/family over the short to</li> </ul>

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		<p>than 2 adults per room</p> <ul style="list-style-type: none"> <li>- Wide doors</li> <li>- Generous access spaces internally and externally</li> <li>- Space and facilities for special events and gatherings</li> </ul>	<p>medium term (days to months)</p> <ul style="list-style-type: none"> <li>- Capacity to accommodate permanent household members</li> <li>- Capacity for use by large-bodied people, and the mildly disabled</li> <li>- Access for coffins and bearers</li> <li>- Forecourt (before front door) to welcome visitors</li> <li>- Capacity indoors and outdoors to accommodate a crowd of people on special occasions</li> </ul>
Safety and security	<ul style="list-style-type: none"> <li>- Risk of accident</li> <li>- Risk of attack or theft</li> <li>- Risk to personal safety and wellbeing in the neighbourhood</li> <li>- Stress (psychological, cultural)</li> </ul>	<ul style="list-style-type: none"> <li>- Non-slip floor finishes</li> <li>- Limiters on all operable windows (opening too narrow for human body)</li> <li>- Fenced grounds including play area and clothes-drying</li> </ul>	<ul style="list-style-type: none"> <li>- Protection against slips and falls</li> <li>- Protection against intruders</li> <li>- Control of non-approved/secret outings</li> </ul>



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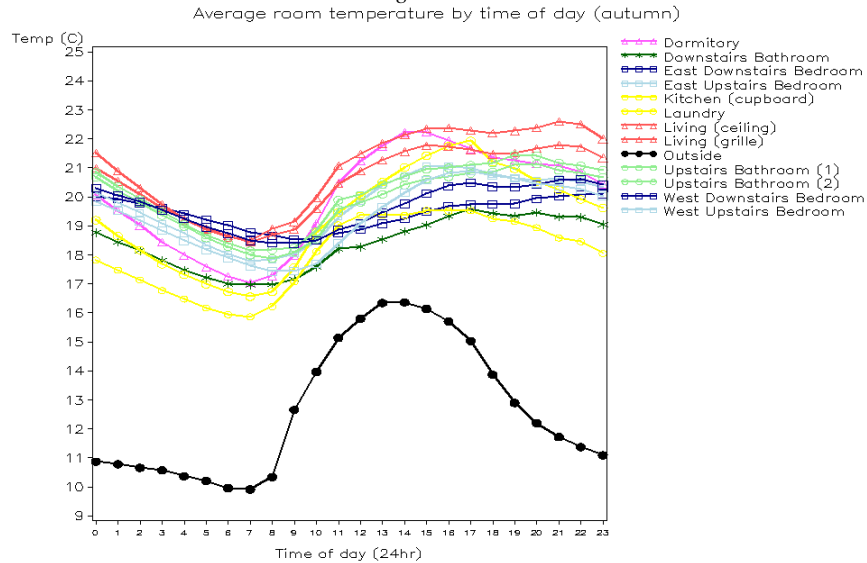
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		<ul style="list-style-type: none"> <li>- area</li> <li>- Surveillance of entry zone</li> </ul>	<ul style="list-style-type: none"> <li>- by young household members</li> </ul>
Household and owner (HNZC)	<ul style="list-style-type: none"> <li>- Stress (psychological)</li> <li>- Stress (financial)</li> </ul>	<ul style="list-style-type: none"> <li>- Long-life lamps, insulation etc.</li> <li>- Simple, intuitively operated systems and components</li> <li>- Robust systems &amp; components</li> </ul>	<ul style="list-style-type: none"> <li>- Ease of management</li> <li>- Low operating costs</li> <li>- Tenure</li> <li>- Low maintenance costs</li> </ul>

**Physiological results**

One of the most important aspects of a building design is its capability to modify the external environment (which is potentially hostile or uncomfortable) and render it habitable and safe. The ecological features of the Tokelauan demonstration house included an increase in building insulation, use of passive solar technologies with heat storage and a heat pump for backup and a passive ventilation system, comprising a vertical chimney-like duct with a wind driven exhaust fan to draw warm moist air from bathrooms by utilising Venturi and stack effects. Control of interior dampness for the highly populated building, in addition to ventilation was achieved through the separation of wet areas from inhabitable rooms.

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**Figure 3 Average room temperature by time of day (autumn)**

The graphs in figure 3 show the average temperatures observed over 6 weeks in the summer and autumn of 2008 over 24 hours together with the average external temperature. Interior habitable spaces are consistently above the minimum 16C recommended by the World Health Organization, despite low external temperatures. Between the seasons the average external temperature decreased by 7°C , but the average living room ceiling temperature decreased by only 1.2°C the average laundry temperature (the room that was perhaps most affected by external temperature) by 3.8°C . The strong downward shift of the black (outside) line on the autumn graph is clearly visible

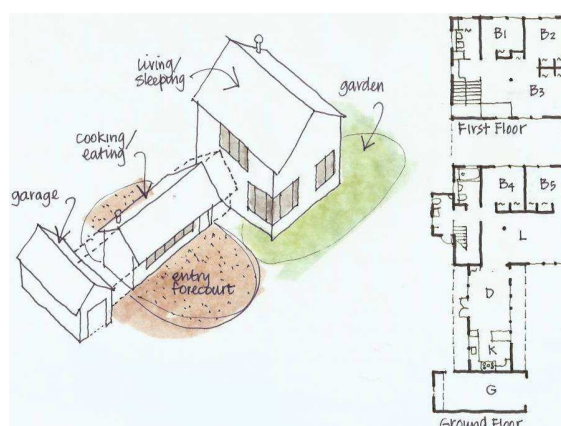
## Psychological results

Socio-cultural demands for privacy regulation and supervision were achieved through the design of the building layout and the relationships between circulation public and

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private areas which allowed the household the flexibility to alter the use of spaces to suit changes in household composition and activity. Crowding concerns were addressed through the design of sleeping areas as well as the provision of a 'garage' space designed for temporary inhabitation.



**Figure 3: Purpose-built extended-family house**

Photovoice enabled the researchers to gather a graphic idea of the frustrations and the pleasures of both inadequate and adequate aspects of housing. Together with the families' explanation of specific design features, which could be prompted by the photos they had taken, the evaluation provided a rich picture of extended family living and how it can be diminished or enhanced by the built environment.

The family's response to moving into the new house was, perhaps not surprisingly, overwhelmingly positive. By the time they were interviewed several months after move-in, they felt their health had improved. The children had room to play. The teenagers had space to do their homework and were doing better at school. The husband had returned to work after five years of unemployment. The family felt proud

in their new home and liked to welcome their relatives and friends. The house had been designed to sleep 11, which meant that they were less crowded and they appreciated the sense of space and light. There were fewer privacy issues and they felt that their family life had improved.

The niece summarised the improvements that she has seen in the family.

*I do enjoy living in a three generation household especially with my Nana. In our old house it was impossible to have a decent conversation with my aunty and uncle because of the lack of space. Now it is really good we can all sit together in the lounge and I can have open discussions with my problems with them. I have noticed a huge difference, everyone is interacting more with each other since we moved to this house – I myself feel a lot happy living here in this house – lots of fresh air and lots of space. In the old house we were so overcrowded and it was quite depressing at times. It's good to see the children get on really well with each other – less fighting and squabbles. There is a huge improvement with everyone health especially my uncle. His health has improved a lot and he seems a lot happier too. On the whole I think it was a positive move for everyone and I am very happy. The only thing that saddens me is I don't have as much time of sharing with my Nana like we use to in the old house because we do not share the same bedroom (niece)*

## **Safety Results**

Physical safety features of the house include the use of grips, non-slip floor finishes, limiters on all operable windows (ensuring all openings are too narrow for a human body) and fenced grounds including the play areas and

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clothes drying areas. Design safety features include a layout that provides opportunities for both external surveillance through the placement of entry doors relative to other spaces and window placement as well as internal surveillance through the relationship of circulation spaces and access to sleeping areas from public parts of the house. While the success of these features will remain to be tested, to date, the family has reported positively particularly with respect to the surveillance aspects of the design.

## **Conclusion**

With a generous budget the goal of a warm, dry and spacious house is not hard to achieve: one has simply to provide a lot of well-appointed space that is well insulated, well ventilated and well heated. But of course budgets for social housing are very constrained, both in terms of capital expenditure and operating expenses. This project met the capital cost limit set by Housing New Zealand Corporation of NZC \$1450 per square metre (2005) while satisfying the main design/health objectives:

*To develop architectural design solutions and mechanisms that can be employed to keep a house warm and dry in the New Zealand climate, even when crowded, without recourse to mechanical ventilation, at minimum operating cost to the occupants and within HNZA guidelines for capital and maintenance expenditure.*

The starting point for the research reported in this paper is the idea that research should do more than understand the world: it should help improve it. Application is the issue here: how might we progress from the health research to the completed healthy house? This sounds straightforward enough – with centuries of house building

behind us, and improved scientific knowledge of building and health, we may reasonably expect good housing solutions to follow. Yet this goal can be frustratingly elusive. One reason is system complexity: a bad choice in any part of the system may lead to failure of the whole (Porteous 1992). Another reason is system sensitivity: a small variation in design, occupancy or context can result in a large unwanted effect – for example, seemingly minor adjustments to room dimensions or shape can affect furnishing arrangements in the room and limit the options for its use. Thus, the task of designing and delivering a healthy house, that meets the political, economic, social and technical imperatives outlined earlier, is one that requires more than a few simple adjustments or the addition of a few features to the ‘standard’ 3-bedroom house design.

The project was devised as a practical way to test and demonstrate that attention to health issues would, and should, influence the design of a house and that a well-designed house would provide a significantly healthier environment (Porteous, 1992, Lawrence, 1995). A key aspect of the approach was a commitment to partnerships between researchers in public health and architecture, owner/providers and the community (Matheson et al., 2005). With these cross-disciplinary and interdisciplinary connections, the participants joined forces in looking at the physical factors affecting health and the pathways for realising viable housing solutions that reduce the hazards to health. The action research model removes the line between research and social action (Sanoff, 2000) for architectural science. The role of the architect (and other professionals and experts) is of particular significance. Expertise, especially to do with technical and procedural matters, is important to the sensible and efficient working of a group engaged in participatory design. While it is important that experts listen more than talk, it is equally important that the expert speaks up, and if necessary argues a position, when he or she perceives that the group is in need of expert advice or information.

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The pre- and post-occupancy evaluation of this extended family house has the limitations and strengths of any single comparative case study. Subjective feelings of well-being can be important predictors of health and life satisfaction but can also be biased in an effort to please the researcher. In this case, the quantitative data for thermal and moisture conditions support physiological health statements; which are also consistent with that called for in the health literature. While too soon to legitimately report on, household members medical records seem to also support the ongoing benefits of healthy housing.

This case-study highlighted that properly designed social housing can achieve multiple objectives. By providing good quality, appropriate housing at a reasonable cost, it can increase the disposable income of families and by allowing extended families to live together who want to, it can maintain minority languages across generations as well as improving the health and social well-being of family members. As our population ages, the care and consideration received by grandparents in these households provides a very positive model of aged care. This project also shows it is possible to have the undoubted benefits of extended-family living, without the burden of infectious diseases and family stress. In these three distinct realms, the economic, the socio-cultural and the ecological, this demonstration house can be seen to have met the requirements of successful sustainable housing.

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