Warm house in winter, cool house in summer

Australian Research Council Linkage Project. A joint project between The University of Sydney, Healthabitat and Justine Hill

HEALTHABITAT

Temperature Control: Warm house in winter, cool house in summer

Recent research has found that internal house temperatures during summer and winter, in rural and remote Australian Indigenous housing, can vary by up to 20ºC outside acceptable temperature ranges that promote well- being of people living in the house.[1]

People experience thermal stress when there are extremes in temperature. This can contribute to dehydration in extremely hot climates, or pneumonia in extremely cold climates. Indigenous children from the age of 0-5 are particularly susceptible as it worsens existing health problems such as diarrhoeal disease or chest infections.

Poor thermal performance of housing can result in reliance on 'active' and expensive-to-run heating and cooling systems. (Active heating and cooling involves the input of energy to the house, eg. Air conditioners, electric heaters, evaporative coolers, and fans). People living in the house may not be able to afford high energy and water bills, which can lead to disconnection of services to the house. They will then not have access to essential health hardware[2] required to perform the nine healthy living practices[3] that are necessary to maintain or improve health. Poor temperature control in houses and expensive active heating and cooling systems can also lead to overcrowding of the one room that people can afford to heat or cool. Crowding promotes the spread of infection.

Temperature control projects in four different climate zones in Australia were analysed. These projects address how to make houses warmer in winter and cooler in summer, in climates where people experience thermal stress due to extremes in temperature. Temperature control projects involve recording and gathering information on thermal performance of existing

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[1] Thermal comfort in the workplace (and in houses) is a combination of environmental and personal factors. An accepted temperature range in the workplace is 20ºC to 26ºC. (Australian Government National Occupational Health and Safety Commission. http://www.nohsc.gov.au) The variation from this range increases the likelihood of people experiencing thermal stress.

[2] The expression 'health hardware' was "originally used by Dr Fred Hollows to describe the physical equipment necessary for healthy, hygienic living. The equipment must have been designed and installed so that it can function and be maintained to assist people to improve their health status. In a water supply system, health hardware includes both the bore and the basin plug, as well as the shower rose, taps and drain." The system also includes other factors such as the basin and hot and cold water supply pipes etc. (*National Indigenous Housing Guide improving the living environment for safety, health and sustainability*, (NIHG) second edition, Commonwealth of Australia 2003, Department of Family and Community Services. p x)

[3] *The nine healthy living practices, in order of importance, after life threatening urgent safety works (eg. electrical hazards) are*:
1 Washing people; particularly children
2 Washing clothes and bedding
3 Removing waste safely
4 Improving nutrition
5 Reducing the impact of crowding
6 Reducing the impact of animals; insects and vermin
7 Reducing the impact of dust
8 Temperature control
9 Reducing trauma or minor physical injury
(Pholeros, P. Rainow, S. and Torzillo, P. *Housing for Health*, Healthabitat, 1993, p vii)

houses, analysing information and providing recommendations to change the existing house and design new houses.

Temperature control projects are complimentary, but run separately to Housing for Health projects. The Housing for Health methodology was developed by Healthabitat P/L.[4] Healthabitat were Industry Partners in this temperature control research.

The core objective of Healthabitat is to improve the health of Indigenous Australians by improving their immediate living environment. The work particularly targets the well-being of children (0 to 5 years). Over the past 19 years, Healthabitat, assisted by federal and state housing and health agencies, community housing organisations and a large number of Indigenous people working on survey fix teams, have been responsible for improving over 4000 houses occupied by over 40,000 Indigenous people living in suburban, rural and remote environments. This has occurred in five states, the Northern Territory and the Torres Straits. These projects are called Housing for Health or Fixing Houses for Better Health projects.

The benefits of the Housing for Health methodology are[5]:

- Assessment of the function rates of health hardware in all houses in a community; (ie. how much of the health hardware works in a community, not just in 1 house)
- Immediate fixing of urgent and other minor health hardware items in houses
- Production of data that can be used by communities to assist in housing management and maintenance as well as by governments for policy development and evaluation and program planning
- Involvement of the community in the projects (paid employment)
- Provision of training in health hardware assessment and basic repairs
- Raised community awareness of the relationship of functioning houses and good health

Temperature control projects use a similar methodology used in Housing for Health projects. ie. Identification of a primary issue affecting poor health of Indigenous people (temperature control), development of a rigorous methodology for collecting data on this issue (data measurement tools and techniques), immediate feedback to the householder, “no survey without service” (modifications to houses, recommendations for new house designs.)

The interest of the community management and householders in temperature control projects, stems from the capacity for change to their living environment displayed as a result of Housing for Health survey and fix work. Householders would not be involved in temperature control projects if they could not see a tangible outcome of the work.ie. Modifications to their houses to minimise extremes in temperature and the likelihood of experiencing thermal stress.

The focus of this temperature control research project was:

- That much of the existing housing in Indigenous communities in Australia does not provide an acceptable internal living environment with internal temperature ranges that promote well being of occupants

[4] The Directors of Healthabitat are Paul Pholeros, Stephan Rainow and Dr Paul Torzillo

[5] *National Indigenous Housing Guide improving the living environment for safety, health and sustainability*,(NIHG) second edition, Commonwealth of Australia 2003, Department of Family and Community Services. p 180-181

- That improved design and retro-fitting of housing can greatly improve the internal environment and reduce the long term running costs of temperature control, which will leave occupants with more money to spend on other essential living costs, such as rent, food and clothes

Data collected by data loggers during temperature control projects included shaded external air temperature (ambient air temperature), relative humidity and internal house temperatures from existing houses. (A data logger is an electronic device that can record information over time, eg. temperature, humidity, wind speed and direction). Energy and water use data was also analysed. Collection of 'real world data', as opposed to desktop or computer modelled studies, recorded actual conditions experienced by people living in a house. The analysis of data demonstrated the link between design of housing and poor thermal performance experienced during extremes in temperature.

A methodology and prioritised recommendations aimed at improving temperature control in existing and new housing in a range of climatic areas in rural and remote parts of Australia was developed. The recommendations examined the design of passive heating and cooling parts of new houses as well as retrofitting options for existing houses and selection criteria for active heating and cooling systems. (Passive heating and cooling is any heating or cooling method that requires no energy input either by the house resident or a mechanical device. ie. a verandah roof may shade a wall and window reducing the inside temperature of the house, a concrete slab that can be warmed by the sun during the day in winter may keep the house warm at night.)

Key findings of the study were, that existing housing had poor thermal performance when there were extremes in ambient temperature (eg. over 40ºC and below 5ºC). The houses were not providing thermal benefit and were not designed to suit the climate. Occupants often relied on active heating and cooling systems to reduce extremes in temperature. High costs of running these heating and cooling system sometimes led to disconnection of utility services to the house, due to non-payment of bills. The implementation of passive design modifications to the existing houses should improve health outcomes of occupants and contribute to substantial savings in running costs of active heating and cooling systems.

It was also found that active design solutions should not be retro-fitted to existing houses until after passive modifications are made, otherwise running costs of these systems will be unaffordable for occupants.

In new housing in the hot/dry climate zone, it was found that by addressing temperature control in the design of the house and yard areas, (as well as other high use energy and water using parts of the house such as hot water systems, cooking appliances and tapware design) energy costs and water use, were less than a theoretical model "ideal future house". Internal house temperatures were at an acceptable range to promote health of people living in the house. The "ideal house" figures were based on using energy and water efficient appliances. The design of the new houses included yard fencing and mounding to encourage planting, deep eaves, wall and roof insulation, roof ventilation to exhaust hot air and installation of ducted evaporative cooling systems. It was demonstrated that improved design of social housing could provide a comfortable internal environment and reduce the long-term maintenance and running costs of temperature control. It also clearly demonstrated that if the

basic hardware of a house is well designed and installed it could be well managed by the residents.

The methodology developed in this study has been collated into a Data Logging Toolkit, that can be used by housing providers or managers, on future temperature control projects in different climatic zones. The Toolkit includes equipment specification and method for installation in new and existing houses, discussion of where data loggers should be installed in a house, what other important information should be collected on each house, forms for recording information, methods for analysing data and a Householder Project Information Sheet. This Sheet explained the project to the householders where monitoring equipment was installed, including method of data collection, equipment used, type of data gathered, method of feedback and project outcomes. Discussion of the Information Sheet assisted in gaining the householder's approval for the project to proceed.

Prioritised recommendations to improve temperature control in new and existing houses were developed from an analysis of the climatic profile and house design aim for four climatic zones in Australia. These zones were cool temperate, tropics, warm temperate and hot/dry. In each of these zones, the following were discussed:

- The poor thermal performance of existing Indigenous social housing during climatic extremes
- Principles of design for new houses and recommendations for modifications to existing houses to make them warmer in winter and cooler in summer.

Passive design principles included shading of the building fabric, insulation, isolation of underfloor spaces, venting, thermal mass and minimising heat loss. Active design principles included active heating and cooling. As previously discussed, active heating and cooling systems should only be considered, after passive design has been addressed as they can be very expensive to run in a house with poor passive design (eg. no wall or roof insulation, gaps around doors and windows).

The application of each principle in the four climatic zones was analysed and issues of how Indigenous people live in these climates was addressed. eg. how the issue of large populations (often brought about by either a shortage of housing or a shortage of housing that is able to be occupied due to failure of essential hardware such as water supply, hot water or cooking facilities) is dealt with in the use of yard areas or verandah spaces, impact of large populations on selection of robust window systems not adversely affected by dust, issues of security and privacy for people living in an Indigenous community, and how site specific conditions should be addressed (eg. use of evaporative cooling systems in areas where water quality is poor) . Consideration of issues experienced particularly by occupants of social housing, eg. little money to spend on running and maintenance costs of housing was also an issue in developing the principles. While this study has researched Indigenous social housing, due to availability of data, the issues and recommendations are applicable to all social housing in the particular climatic area.

This study differs from existing studies in that it is based on monitoring of 'real world' conditions, rather than a desktop computer modelled study of how a sealed 'box' performs. It is therefore not controlled data but acknowledges variables of how people use houses, eg. opening and closing of windows and doors, heat generated by people, condition of wall fabric

and draughts around windows and doors. Rather than being a limitation of the study, this is seen as a benefit as it is recording real world conditions.

This study also differs from existing studies in that it provides specific recommendations for particular houses in identified climatic areas, rather than generic house design aims. It also provided recommendations, not only for designs of new houses, but also for modifications to existing houses. Numerous existing studies make recommendations for new houses.

It was also found that differences in design of houses could contribute to the variation between thermal performance of houses and that it was not possible to state that the variation is due to one particular factor. eg. that shading of the house will make a house cooler. One of the houses monitored in the hot/dry climatic zone, had extensive planting shading the house and recorded cooler ambient and internal temperatures than the other houses monitored during the same project. It cannot be said that shade caused the difference in temperature, but rather it contributed to the cooler temperatures. Other factors affecting the temperature may have included slightly different orientation to other houses, shading from trees on neighbouring properties, occupants opening or closing windows. This study identified design elements in existing houses that contributed to variation in thermal performance. The relative impact that modifications to these elements would have, in improving the temperature control of the living environment was examined.

This research is significant in that:

- It has led to the development of a temperature control project methodology for use in future projects. The methodology, or Data Logging Toolkit, can be used by housing providers or managers in different climatic zones to address temperature control issues, to enable change to be implemented on a greater scale in Indigenous social housing and in social housing in general
- It has defined a range of low energy, low maintenance principles for the design of social housing in a range of climatic regions around Australia. These design principles and sustainable technologies can be used to improve living conditions for Indigenous and non-indigenous people living in rural and remote areas. The principles are a set of prioritised recommendations for the design of new houses, modifications to existing houses and selection criteria for sustainable active heating and cooling systems
- The principles of design, and detailed references will be incorporated into the next edition (3rd) of the National Indigenous Housing Guide

In future, if internal temperatures in existing houses are very hot or cold when there are extremes in temperature, or if occupants cannot afford to run expensive active heating and cooling systems, then the following methodology could be used to address temperature control:

- Monitor thermal performance of existing houses (the Data Logging Toolkit can provide a guide to a methodology)
- Determine factors in the design of the house that are impacting on the thermal performance (prioritised recommendations developed in this research could be used as a guide)
- Specify modifications and retro-fit the house
- Continue monitoring after the modifications have been made to determine the thermal impact of the modification and the energy & cost saving to the householder

The design principles developed could then be incorporated into new house designs.

The desired outcomes of improved house design are that:

- Internal house temperatures promote well-being when there are extremes in external temperature and occupants will be less likely to experience thermal stress
- Occupants will spend less money on heating and cooling the house and can afford to pay their energy and water bills allowing them access to essential health hardware that is necessary to maintain or improve health. They will also have more money to pay for other living expenses such as rent, food and clothes.

Work will continue to be required in temperature control in social housing, until occupants can afford to live in a house that promotes their health and well-being and minimises their exposure to extremes in temperature.