INNOVATIVE, AFFORDABLE AND SUSTAINABLE HOUSING

JOHN GRAY, HENRY SKATES AND WERNER OSTERHAUS

Centre for Building Performance Research, Victoria University of Wellington, Wellington, New Zealand

ABSTRACT

New Zealand and the Pacific Nations, like many other areas worldwide, have a problem providing affordable and sustainable housing that also meets occupants' needs. Low cost housing often equates with under-performance. In the minds of many people, building performance that meets real needs is something that they simply cannot afford. This paper argues that with good design, appropriate use of innovative materials, and the innovative use of traditional materials, it is possible to design and deliver good quality housing that is affordable.

The factors governing building performance in relation to affordable housing are examined. The paper addresses issues relating to quality, reliability, flexibility and sustainability in terms of building performance. Principles of best practice are established.

KEYWORDS:

Building Performance, Affordable Housing, Sustainability, Serviceability, Innovation

INTRODUCTION

Many countries, including New Zealand and other Pacific Nations, have problems providing affordable housing. Increases in the costs of materials, labour, land, finance and costs in use all mitigate against low-income groups. In a global context, the most serious housing problems exist in third world countries but poverty and homelessness is not only a third world phenomenon. Each nation has its own unique and complex mix of economic, social, political, ecological and demographic characteristics that influence housing problems. According to United Nations estimates, half the population of most Asian cities live in slums or squatter settlements; most African cities have a high proportion of inadequate housing, estimated to affect between a third and 90% of the population; in the United States, between 3 and 4 million people are homeless and up to 10 million live close to the edge of homelessness (Hamdi, 1991). In Britain, an estimated 130,000 households were homeless in 1987 (*Economist*, Dec. 26, 1987).

Figures like these are as hard to grasp as they are out of date already. What is clear, however, is that wherever one looks, the problem worsens annually as new housing fails to keep pace with demographic and social changes. These changes include population growth, migrations between countries, migration from rural to urban centres, changes in the composition of household units, de-institutionalisation of people with psychiatric and intellectual disabilities, and ageing.

The Affordability Problem

Over the past ten to twenty years many governments around the world have moved away from state involvement in housing, favouring a private sector/market forces approach. In New Zealand, privatisation may have reduced the tax burden but it cannot be said to have made housing more available, more suitable or more affordable. It has been estimated that the number of households in New Zealand experiencing serious housing problems doubled during a five-year period around the early 1990s when the government's housing reforms were being implemented. 'Serious' problems

include homelessness, overcrowding, poor health and illness, family and individual stress, violence or the threat of violence, effects on children's growth and education, transience and ethnic and other forms of social discrimination. In 1993, an estimated 49,000 New Zealand households (about 5% of all households in the country) were in desperate need of housing that they could afford, with about a third of that number 'squatting' with friends or finding accommodation in boarding houses, at overnight shelters, in caravans, garages, tents or in parks (Waldergrave, 1994).

Obviously, a much larger percentage of our population, while not classified as being homeless or in substandard accommodation, is nevertheless experiencing considerable stress due to the high cost of housing, or its unsuitability, or both. Typically, financial stress arises when people pay a disproportionate amount of their income on housing – often in excess of 50%. To cope, many people in such circumstances take multiple jobs, and/or crowd into houses – factors which themselves cause psychological, social and cultural problems, and ill health.

Many commentators and researchers worldwide have come to the conclusion that government intervention alone does not work as a strategy to deal with housing problems. The *Worker*s' *Dwellings Act* of 1905 heralded the first New Zealand government attempt to house working class people. Described as 'profiteering and patronising' (Fill 1984 p16), the scheme had little appeal to working people because the government of the time insisted on achieving market rents. Over the next 90 years, successive governments in New Zealand constructed state houses and/or indirectly financed housing, but without breaking the back of the problem. The opening paragraph of Hamdi's book sums up the universal dilemma:

"Almost everyone reasonably familiar with housing issues agrees on the most pressing problem facing the industry today insofar as housing the poor: the shortfall in supply to demand, in both the first and third world countries, is getting worse, not better, despite all the innovations and investment so far. Most also agree that old paradigms are unworkable, formal channels hopelessly inadequate, and most conventional approaches largely irrelevant given the magnitude of demand. There is no such unanimity regarding solution". (Hamdi, 1991, p3).

The Sustainability Problem

The search for affordable housing is complicated by the problem of sustainability. To make new dwellings on a scale necessary to solve housing deficits around the world would demand further massive use of resources in the earth's crust, and result in further serious production of waste and pollution. Responsible house design must be not only affordable for the occupants in the short term, but also affordable for the planet in the longer term. Many of the processes and products commonly used in residential construction, particularly processes and products prevailing in the more affluent nations, utilise non-renewable or non-biodegradable resources, and result in pollution that is seriously damaging to people and the environment. The sustainability issue extends into the ongoing operation of houses, as householders use energy and other resources, and continue to produce waste. Thus, design choices impact significantly on sustainability, both in construction and during the life of a building.

The Serviceability Problem

Affordable and sustainable housing should perform according to the specified functions and reasonable needs of the owners/occupants. A building that is also desirable and serviceable will often have to be one that exceeds the standards set by minimal building codes. Too often, builders and owners equate code compliance with good practice. What it often means in reality is that the building fails in part, or is only just fit enough to be used for occupation. Recent trends in the housing market in New Zealand serve to illustrate the problems that can occur when developers work to minimum performance standards set out in the Building Code. Multi-unit dwellings have recently come to attention due to a trend to convert commercial buildings into inner-city apartments. Developers find it convenient (and profitable) to adopt the minimum code requirements instead of taking appropriate steps to ensure serviceability. For example, some have attempted to avoid placing outside windows in

bedrooms, with the argument that most inner-city dwellers are working away from their homes during daylight hours and therefore do not require daylight access for their bedrooms. This standard of development may comply with the limits of statutory requirements, but it is certainly not desirable or serviceable. In addition, statutory requirements often do not even attempt to address social and cultural issues that are so crucial in achieving desirable housing.

Designers and managers are familiar with the effect that sub-optimising can have on the total performance of a complex system. In the housing field, it is not enough to *separately* solve problems of affordability. We have to solve problems of sustainability and serviceability as well. Furthermore, all three factors have to be seen in a broader societal context. Sub-optimal design misses the point that holistic, creative and innovative thinking is essential to the solving of problems characterised by a multitude of interacting variables. Housing provision based on lowest capital costs and basic code compliance also overlook the broader technical, political and cultural in which housing decisions should be made.

We have characterised the problem of housing as being made up of three interacting factors: affordability, sustainability and serviceability. We suggest that these three factors are at the core of defining and solving housing problems in New Zealand and nearby Pacific Nations (and possibly elsewhere in the world). Next, we further define these three terms.

DEFINING AFFORDABILITY, SUSTAINABILITY AND SERVICEABILITY

At the most basic level, 'affordable' means within the capacity to pay. Affordable housing for the individual occupant (or household) means that the housing is within their capacity to pay initial costs, (or an appropriate ongoing rental) and operating costs.

A similar concept applies to groups, nations, and the planet. Affordability for the planet means that the cost to the planet of consumption and production of waste, particularly toxic waste products, is within the capacity of the planet to provide the resources from the earth's crust, and convert the waste back to the earth's crust in a natural (original) state, at a rate corresponding to consumption. Thus, "sustainable" means the sum of human practices that leave a planet capable of providing for future generations, while meeting the needs of the present. Sustainable construction is capable of providing for future generations, at a quality and quantity reasonably required, through the creation and responsible tenure of a healthy built environment based on resource efficient and ecological principles (Kilbert, 1994).

Except in the case of emergency and short-term shelter, housing also has to serve occupants' needs over years and generations. To be "serviceable", a house should be capable of performing as required, but the demands on a house change over time as householders' needs change, or as the occupancy changes. Serviceability is a broader term than performance. Performance is actual behaviour at a given time, whereas serviceability takes into account the capability to perform as needed in the future. This inevitably means that a house, to be serviceable, should meet the range of (reasonable) requirements of its initial owner/occupants, and be capable (with only the minimum of adjustments) of performing as well for future occupant households and/or owners. What is required in housing design is an approach where the buildings meet the requirements of their occupants, and the planet, no more and no less. It is difficult however to achieve the appropriate qualities demanded in housing because in practice there is a narrow ground between meeting the requirements 'no more' and 'no less'. For example in the situation where 'sustainability' requires 'flexibility' (i.e. capable of providing for future generations) we are presented with something of a paradox. A house that exceeds requirements is no better than one that falls short of the requirements.

The rest of this paper explores some promising directions, both at a strategic level and the more immediate and detailed level of design intervention. We propose a breakdown of principles and practices for the design of housing that is more sustainable, affordable and serviceable.

STRATEGIC DIRECTIONS

Strategically, there are three main groups of issues to be addressed in order to provide affordable, sustainable and desirable housing: Global Issues, Local Issues, and Indoor/Personal Issues. These are summarised in Table 1.

Table 1. Issues To Be Addressed in Providing Affordable Housing

Global Issues	Local Issues	Indoor/Personal Issues
• Low embodied energy • Low or negligible use or production of toxic substances • Pollution-free manufacturing processes • Renewable energy sources • Greatly reduce use of resources • Degradable: use substances and materials that easily break down in nature • No materials or processes that produce toxic chemicals • No rainforest timbers or products • Renewable: change from use of finite resources to renewable resources • Natural: avoid interfering with natures ecocycle, i.e. earth's capacity to restore itself • Efficient: plan the use of materials, energy use, technology and transport to make the most benefit from the least expenditure of resources • No unnatural, persistent substances	• Maximum use of waste and recycled products • Minimise use of infrastructure (water, electricity) • Low operating cost (maximise use of the sun and wind, and insulation) • Desirable (not a boring box) Culturally and socially acceptable • Use of low value land, difficult sites • Water Economy i.e. No rainwater leaves the site. No sewerage leaves the site. Water supply from the roof • Simple to construct (non-technical low-skilled labour) • Transportable • Site friendly, lightly on land, least disturbance • Sortable: construct in a way that the constituents can be easily separated for recycling • Quality: select or invent products and systems that have a long life and are capable of repair or adaptation to new uses	• Safe indoor environment • Functionally adaptable, easy to alter or re-configure • Low moisture content • Well ventilated • Good natural lighting and energy efficient artificial lighting • Thermal comfort • Reduce non-gaseous indoor pollutants • Minimum use of materials which release VOC's • Simple to maintain and repair • Low first cost (target around $30k for 2 to 5 person house) • Double duty design principles • Generous tolerances

Think Global, Act Local

To address issues of housing at a global level, action is first to be taken at the local and personal level. This is a strategy that works because people affected are firstly satisfying their own needs and in the process finding that their needs, and the needs of their future generations, are connected. They take ownership of the solution in the realisation that sustainability is also good economics.

Neighbourhoods, regional groups and small nations (such as New Zealand) form the nucleus of "acting locally". Small groups and small nations can display a degree of flexibility not possessed by larger institutions and countries, generating ideas that catch the imagination of many. Small groups can make the first moves to dismantle apparently impossible problems. One outstanding example of this phenomenon is "The Natural Step" model (TNS) for dealing with problems of global sustainability. Started by Karl-Henrik Robèrt in Sweden in1989, TNS transformed Swedish manufacturing over a ten-year period from unsustainable to sustainable practices, without diminishing the profitability of the manufacturing sector.

New Zealand is a good place from which to develop solutions to problems of affordable and sustainable housing, at least for the first world countries, and possibly for some third world situations. We have the problems on our own doorstep (at least in kind, if not in degree), but we also have a country in which innovation and experimentation can flourish. A strategic step is the first step.

DESIGN DIRECTIONS: PRACTICES THAT WILL MAKE A DIFFERENCE

We have argued that three principles define the value of housing to its occupants and the planet: *affordability*, *sustainability*, and *serviceability*. The application of any *one* of these factors in housing could be termed *good* practice in that something useful is being achieved [Altman (1985), Cooper-Marcus (1986), Davidson (1994) Lawrence (1987), Waitakere Council (1998), Wellington City Council (2000)].

Good practice towards *SUSTAINABLE* housing:

- Use RENEWABLE resources: change from use of finite and scarce resources to renewable and plentiful resources
- Select DURABLE materials: select or invent products and systems that have a long life and are capable of repair or adaptation to new uses
- Construct in SORTABLE parts: construct with products and in ways that the constituents can be easily separated for recycling
- RE-USE others' waste: utilise products and materials already in a useful state but discarded by others because they are redundant to their use. Reuse, recycle and (sometimes) burn to release the energy, eg for heating
- Use DEGRADABLE materials: use substances and materials that easily break down in nature when returned to the earth
- Use NATURAL processes and materials: avoid interfering with nature's ecological cycle, i.e. earth's capacity to restore itself
- Be EFFICIENT: plan the use of materials, energy use, technology and transport to make the most benefit from the least expenditure of resources; avoid or cut back on the total use of resources
- Build only what is NECESSARY: only build it if it is truly necessary and is a fair and responsible use of the earth's resources.

Good practice towards *AFFORDABLE* housing

- Use LAND intensively: make maximum use of land by building upwards, and designing for medium to high density of population. Find sites that are relatively low cost; eg. sloping sites, left over spaces; spaces that can perform double duty, eg car parking or retail and housing over.
- Reduce LABOUR costs: strategies include occupants' self-help to construct or repair their own accommodation, simplifying construction techniques to eliminate the need for some trades and place less reliance on expensive labour; using mass production, repetition
- Reduce MATERIALS cost: reduce the size of houses; reduce the amount of material in houses; reduce or eliminate waste in construction; use lower cost materials; use recycled materials
- Reduce reliance on SERVICES: Avoid or limit use of infrastructure services such as water, power, drainage, and waste disposal
- Reduce reliance on TRANSPORT: save on total living costs by locating housing near places of work, schools and shops, to minimise expenditure on transport
- Reduce or eliminate FEES for services: strategies include the use of standardised practises to avoid the need for expert advice; use agencies that give advice for no fee, or reduced fee
- Reduce OCCUPANCY COSTS: Reduce the cost per person housed (without causing overcrowding). For example, maximise the use of built volume, or add a room that could be leased.

Good practice towards SERVICEABLE housing

- Provide SUFFICIENT space and facilities: provide space and facilities for a reasonable population in the household and space; include space for storage of belongings (may require a shed outdoors)

- Provide an appropriate LAYOUT: organise the space and facilities to provide for the required and reasonable range of activities
- Provide appropriate EQUIPMENT: provide (or make provision for the addition of) fixtures, equipment, and machines etc. that support basic household activities
- Design ADAPTABLE spaces: design and select space, layout and equipment that are adaptable to different needs within a household and between different households. This may involve phased construction of the building related to functional needs and budget
- Provide HEALTHY housing: constructed of non-toxic materials; ventilation to remove moisture, indoor pollutants, odours, etc.; sufficient warmth for reasonable comfort, particularly for young children and elderly people; free of damp and mould; easy to clean; physical and visual access to the outside for outlook, air, sunlight; adequate facilities for cleaning and washing/drying of house interior and clothes; sanitation facilities to allow people to
- Make housing that is SECURE AND SAFE: capable of being secured against unwanted entry by others; in a reasonably safe neighbourhood; constructed of materials that do not readily support the spread of flame; a place for children to play safely
- Provide TENURE: secure tenancy, either by ownership or equivalent security of tenure – unless occupants are in serious breach of agreements over money and behaviour
- Provide what is considered DESIRABLE: satisfy cultural needs; make an exterior that is generally regarded as 'looking good'; have a desirable character overall, accord with local norms for housing (without being characterless, or totally conformist), i.e.. houses that look house-like; avoid stereotypical 'cheap' or 'state' housing; avoid construction of whole tracts of identical housing; fit into the neighbourhood, allow occupants to express their cultural identity; allow for culturally specific behaviours (eg. ceremonies, major life events, rituals).

Best Practice

What characterises the *best* practice in the design, construction and use of housing is the combined application of all three principles and the combined application of the various factors outlined above. 'Best practice' housing is affordable and sustainable without compromising the factors that make the housing serviceable and desirable for its occupants. Innovation is possible in each area of requirement – for example, affordability might be enhanced with the invention of new construction systems; sustainability with the use of new products that use plentiful materials and substances; serviceability with the development of plans that better meet occupant needs. Innovation is an essential part of affordable and sustainable housing design and construction. The most innovative developments will be by people who find ways to bring all three requirements into play in each part of a house, and with the house as a whole.

A scoring sheet (see Table 2) has been devised to enable assessment of best practice design. It is based on a model for scoring the serviceability of office facilities (Davis et. al. 1993).

Table 2. Scoring Sheet For Sustainability, Affordability And Serviceability of Housing

REQUIREMENT	FACTORS		RATING LEVEL 1	2	3	4	5	IMPORTANCE V_{ery}; $I_{mportant}$; M_{inor}
SUSTAINABLE Definition: practices that leave a planet capable of providing for future generations, while meeting the needs of present generations.	Renewable	Renewable or plentiful resources used instead of finite and scarce resources from earth's crust						
	Durable	Materials and systems have a long service life and are capable of being repaired, reused, recycled, or adapted						
	Sortable	Components and constructions can easily be separated for recycling or reusing, or disposal/burying						
	Reused	Waste products are reused (or adapted, recycled, repaired) in place of virgin products and materials						
	Degradable	Substances and materials used will easily break down in nature once they are discarded or buried						
	Natural	Processes and materials do not interfere with nature's ecological cycle, i.e. earth's capacity to restore itself						
	Efficient	Makes the most from the least use of resources, in terms of materials, energy, land and infrastructure						
	Necessary	Construction is truly necessary and represents a fair and responsible use of the earth's resources						
AFFORDABLE Definition: within capacity to pay. In New Zealand, it is generally accepted that people on low incomes should not pay more than 25% to 30% of their net income on housing.	Land	Ratio of land cost to occupant is greatly reduced, eg by using low cost land, increased density of use, and use of left-over space						
	Labour	Labour costs are greatly reduced, eg by self-help systems, simplification, avoidance of trades						
	Materials	Material costs are greatly reduced, eg by reduction in quantity used, lower cost products, reduced waste						
	Services	Reduced reliance on infrastructure services, eg water, power, drainage						
	Transport	Reduced reliance on transport costs (as part of living costs) eg close to schools, shops, work						
	Fees	Reduced or eliminated costs of fees for services, eg compliance, design, insurance, legal						
	Occupancy	Reduced cost per person (without overcrowding), eg by maximising use of built volume, enabling added income						
SERVICEABLE Definition: capable of meeting occupants' and owners' requirements now, and in the future.	Space	Sufficient space for all basic activities and rituals carried out by individuals and groups with legitimate access to the house						
	Layout	Organisation of space, including basic furniture and fixtures that support occupants' functional and cultural needs						
	Equipment	Fixtures, fittings, machines, systems and storage facilities that support occupants' functional and cultural needs						
	Adaptable	Space, layout and equipment that is adaptable to different needs within a household, and between different households						
	Healthy	Warm; dry; easy to clean, non-toxic; facilities for washing and drying clothes; ventilation; access to the outside; sunshine						
	Safe	Capable of being secured; compliance for fire, falls, risk of burns etc.; view of outside play area from inside						
	Tenured	Secure tenure, equivalent to (or actual) ownership – unless in serious breach of agreements over money and tenancy						
	Desirable	Culturally appropriate, allowing occupants to express their identity; good appearance; fits into neighbourhood						

The procedure for using this instrument is as follows:

1. Decide the importance of each factor (V=very important; I=important; M=minor importance or not applicable). This is best done in a participatory manner, utilising information from various interest groups, and possibly adopting value management techniques
2. Rate the level of performance (or expected performance if rating a proposed design) on a scale 1 to 5, where 5 is the highest level. (Note that Table 2 is to be used together with a description of features that are found at each of the five levels of performance. Because of limitations in space available in this paper, this information is absent from the table. Interested parties should contact the authors for further information.)
3. Prepare a graphic profile of the overall performance of the house or house design being assessed
4. Identify the strengths and weaknesses of the house or house design by comparing the rating levels for the "important" and "most important" aspects.

CONCLUSION

The problems associated with affordable and sustainable housing are identified. The factors governing building performance in relation to affordable housing are examined. Three principles define the value of housing to its occupants and the planet: *affordability*, *sustainability*, and *serviceability*. The application of any *one or two* of these factors in housing is *good* practice, but *best* practice in the design, construction and use of housing is the combined application of all three principles. 'Best practice' housing is affordable and sustainable without compromising the factors that make the housing serviceable and desirable for its occupants. Innovation is possible in each area of requirement. Affordability can be enhanced with the invention of new construction systems; sustainability with the use of products that use plentiful materials and substances; and serviceability with the development of plans that better meet occupant needs. The most innovative developments will be by people who find ways to bring all three requirements into play in each part of a house, and with the house as a whole. It is possible with good design and appropriate use of innovative materials and the innovative use of traditional materials to provide affordable and sustainable housing.

REFERENCES

Altman, I. and Werner, C. (1985) *Home Environments: Human Behavior and Environment, vol. 8,* Plenum Press

Davidson, A. (1994) *A Home Of One's Own.* Almquist & Wiksell, Stockholm

Davis, G. et. al. (1993) *Methods for Setting Occupant Requirements and Rating Buildings*. The International Centre for Facilities, Ottawa, Canada.

Fill, B. (1984) *Seddon's State houses: the Workers' Dwellings Act 1905.*The New Zealand Historic Places Trust, Wellington, New Zealand

Hamdi, N. (1991) *Housing Without Houses.* Van Nostrand Reinhold

Kilbert, C. (1994) *Proceedings of the First International Conference on Sustainable Construction.* Tampa Florida.

Lawrence, R. (1987) *Housing, Dwellings And Homes: Design Theory, Research And Practice.* John Wiley & Sons

Marcus, C. and Sarkissian, W. (1986) *Housing As If People Mattered.* University of California Press The Natural Step Environment Foundation Aotearoa New Zealand (1999) www.naturalstep.org.nz

Waldergrave, C. (1994) Unpublished research report, Wellington, New Zealand

Waitakere Council (1998) *Sustainable Home Guidelines.* Waitakere Council, New Zealand

Wellington City Council (2000) *Framework For The Provision Of Housing*. WCC, New Zealand