Title: Integrating people, the built and natural environment: The use of ecological design in a low cost setting in Cape Town

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SECTION 1: LITERATURE REVIEW

Introduction

Ecological design provides an opportunity for human beings and their activities, needs and impacts to become integrated with the natural ecosystem they depend on. The lack of this integration can be seen as a state of un-sustainability (Van der Ryn & Cowan, 1996). In this paper the applicability of ecological design as a viable option towards the improvement of household and neighbourhood sustainability is examined within the case of the city of Cape Town. The fragmentation of Cape Town and the need to integrate the people of the city with each other and their natural environment frames a discussion that centres on ecological design options as contributing factors to sustainability in terms of lowering impacts on the natural environment, and improving the quality of life for low-income households and neighbourhoods. The first section of the paper concludes with a few lists of practical options for households and neighbourhoods. The second section tests the argument laid out in the first part by discussing one household and the options that pertain to its owner and the neighbourhood in terms of ecological design.

Ecological quality, ecological design and sustainable development

Sustainable development is indeed a field that reaches from ancient times where people were in touch with their natural surroundings and the cycles and flows of their impact and dependency (Van der Post & Taylor, 1984 cited in Hill & Powen, 1997), to the challenges of modern times where resource thresholds such as the depleting oil resources are now being hit (Wakeford, 2007). It is also a much contested term with a range of interpretations and applications (Hattingh, 2001).

From the wide selection of discourses available that intersect in the notion of sustainability, several are relevant to the discussion of ecological design as a strategy to integrate human settlement into natural ecosystems. Equality between human beings is a key aspect of the social dynamic of sustainability, but the question of equity between human and non-human role-players in an ecological system also arises. The anthropocentric approach places the quality of life of

humanity as the main factor that should be sustained while the eco-centric approach places the whole of nature as worthy of being maintained and sustained, with humanity only a part of this greater whole (Hattingh, 2001:9; Achterberg, 1994:136 cited in Hattingh, 2001).

In South Africa poverty is a key challenge and therefore an anthropocentric angle often dominates, where the quality of life of people is a priority for policy and developmental agendas. Issues of social justice are important and therefore sometimes ignore the natural ecosystems on which they are dependent (Swilling, 2006:23).The discussion below views ecological design through the lens of a combination of two value sets as an approach to sustainable development in a South African city, Cape Town. These two value sets are firstly, quality of life and equality between people and secondly, the importance of the natural ecosystem. To emphasize the importance of the environment I draw on the view that sustainable development is a dynamic interaction between policy, the natural environment, social systems and the economies that function within human social systems (RSA, 2006). In this view it is important to note that economy, social systems and policy are all ultimately dependent on a natural ecology. The creation of policies and the political environment guides and defines, theoretically at least, the integration and interaction of social systems, economy and the natural environment. Figure 1 (below) is the diagram that is often used.

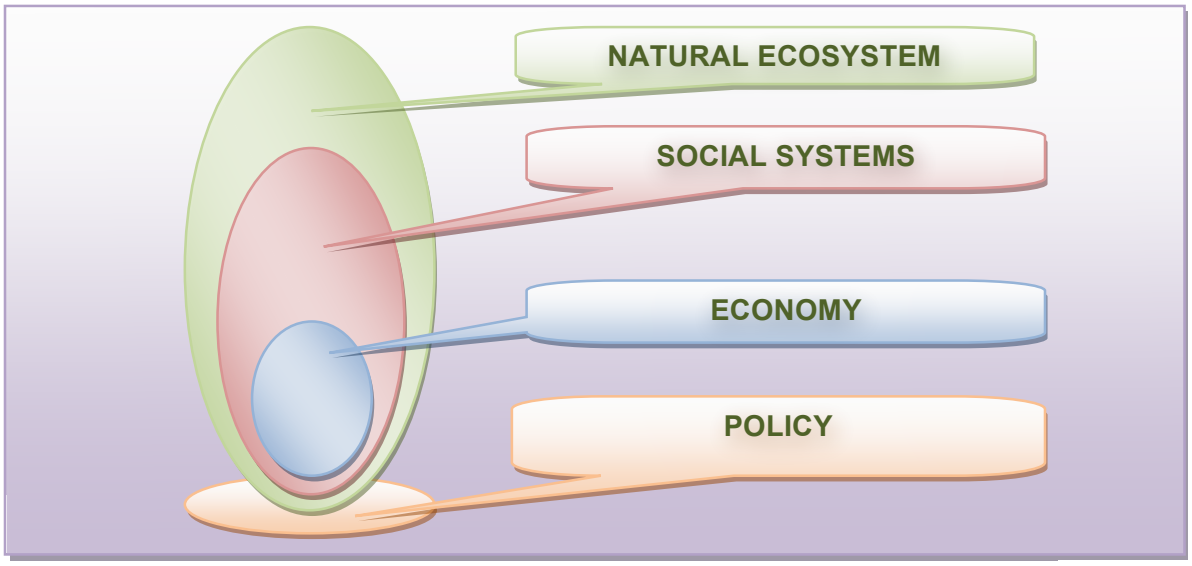

Figure 1: Embedded model of spheres of sustainable development (RSA, 2006)

The approach I use in terms of discussing equality is the environmental space approach, which proposes the ideal that each person on this planet has a 'fair share' of the resources the planet offers. All the available resources are divided by the population that depends on them and this delivers a quantified measure of resource use per person. This data has been translated into amount of land-space required, and has been popularly defined as the 'ecological footprint' of any activity from a micro scale like a household to the macro scale of the ecological footprint of a country (Swilling, 2006:33; Gasson, 2002; McLaren, 2003:22-23). Wackernagel and Rees (1996:51, cited in Gasson, 2002), ecological footprinting is defined as follows:

> The Ecological Footprint starts from the assumption that every category of energy and material consumption and waste discharge requires the productive or absorptive capacity of a finite area of land or water. If we sum the land requirements for all categories of consumption and waste discharge by a defined population, the total area represents the Ecological Footprint of that population on the Earth whether or not this area coincides with the population's home region. In short, the Ecological Footprint measures land area required per person (or population), rather than population per unit area."

The current world average per person amounts to 1.8 ha (Swilling, 2006:12). My discussion of ecological design and quality is placed within a sustainable development discourse that aims to express the challenges and contexts of an emerging democracy such as South Africa, where the growing gap between the living standards of the poor and the rich is a major concern. The subject of the case study below lives in a neighbourhood in Cape Town. Cape Town provides a clear example of the high level of inequality between the rich and the poor in terms of environmental use and impact, where the rich neighbourhoods effectively rely on poor communities to absorb their waste, for example. In rich areas each person generates 1.3 kilos of waste per day and in low-income areas the amount is 0.35 kilos per person (Swilling, 2006:36). In terms of environmental space the ideal of 'one planet living' (McLaren, 2003; Durney & Desai, 2004) has clear implications for businesses and homes to reduce, re-use and recycle. Table 1 represents some strategies suggested by Gasson on different levels of scale to increase the ecological sustainability of Cape Town.

Table 1: Some planning, engineering, design and environmental actions for promoting ecologically sustainable cities (Gasson, 2002)

	Scales and elements						
	Dwelling unit	*Block*	*Local area*	*Town / City*	*Industry*	*Crosscutting networks*	
						Transport	*Green*
Metabolic inputs							
Water saving	Water saving fittings and sanitation forms. Rain water gathering. Sullage re-use. Smaller gardens. Graduated tariffs.	Water saving fittings and sanitation forms. Rain water gathering. Sullage re-use. Graduated tariffs.	Water saving fittings and sanitation forms. Rain water gathering. Sullage re-use. Graduated tariffs. Reduced open space standards.	Green facilities sited in low lying wet areas. Reduced open space standards.	Water saving technologies. Inter-plant flows.		Green systems sited in low-lying wet areas. Indigenous plants.
Energy saving	Natural lighting. Solar collectors. Insulation. High capacitative building materials.	Natural lighting. Solar collectors. Insulation. High capacitative building materials.	Local solar and wind collection.	Mixed energy systems.	Natural lighting. Energy cascades. Co-generation and inter-plant flows.	Pedestrian ways / cycle ways / public transport.	
Materials saving	Attached dwellings.	Attached dwellings.		Compact city form.			
Metabolic							

outputs							
Solid wastes recycle	Waste sorting. Composting.	Waste sorting. Composting.	Local waste collection centre / recycling plant.	Central waste collection centre / recycling plant.	Inter- and intra-industry re-use and recycling.	Collection costs reduced by short distances in compact city form	Compost used in urban agriculture and green spaces.
Liquid wastes recycle	Sullage reuse on garden / in toilet.	Sullage reuse on garden / in toilet.	Local waste water treatment.	Centralized waste water treatment. Sewage sludge into fertilizer. Fish farms.	Integrated waste water treatment works. Fish farms.		Effluent and composted sludge to agriculture and green spaces.
Gaseous wastes and heat re - use					Filters, scrubbers. Combined heat and power: CHP	Foot, cycle and public transport to reduce vehicular emissions.	Urban greening – CO2 absorption.

A relevant question might be: Who in these categories provided in the table above, will enact and drive the suggested change, and why would they do that? Add the local perspective of neighbourhoods in Cape Town and view the above list of suggested strategies in the disaggregated footprint of neighbourhoods. The lifestyles of the poor in Cape Town have much less of an environmental impact than the richer suburbs of the same city (Swilling, 2006). For example, areas in Khayelitsha that include so-called 'below the breadline' households defined by '*shack settlements, desperation and insecurity*' have an ecological footprint, in terms of planets required, of 1 planet. An upper middle class neighbourhood, such as Camps Bay, that is defined by '*established, mature, conservative professionals and gated communities*' would have an

ecological footprint requiring 5.8 planets (Swilling, 2006). The question about who will drive the change can then be asked per neighbourhood, per strategy.

- Why would a business manager in Epping engage his operation in an integrated waste-water treatment works?
- Why would a home-owner in Camps Bay sort his waste and compost?
- Why would a ward councillor in Khayelitsha promote attached dwellings and good insulation to his constituents?

Within sustainable development a key point of entry is the opportunity to design the space where people and their environment interact in a way that can contribute to sustainability. If one places the different categories of households next to each other with the above questions it is apparent that the effects of some of the measures towards sustainability are much more immediate to those living in low-income settings. The measures taken by both the poor *and* the rich first have an impact on the quality of life of the poor. In fact, it can be seen that the lack of integration between the two worlds of people and their natural environment, which is equated to un-sustainability (Van der Ryn & Cowan, 1996:17), has a short-term impact on the quality of life of those that carry the rest, in other words, the poor neighbourhoods of Cape Town (Swilling, 2006:36). This is the point where ecological design becomes relevant.

The discussion below centres on a dwelling in a neighbourhood in Cape Town. In order to engage with this discussion, we have to approach the notion of ecological quality from the standpoint of sustainable development that I have generated to this point. Three important elements need to be borne in mind at this stage:

- *Strategies regarding the built environment* - These span various levels of intervention, from city to household level (Gasson, 2002);
- *Equality and social justice* – The social principles of sustainable construction and development;
- *Natural environment* – An integration of people into their natural environment.

This framework of three discourses engages with the discussion that follows towards ecological design as an integration opportunity for sustained ecological quality.

Constructing the built environment

Construction and its role in ecological impact are significant in the global scope – a tenth of the global economy is dedicated to constructing and maintaining homes and offices. This entails roughly 40% of the materials flow entering the world economy (Hill & Powen, 1997:225). In South Africa, data in terms of environmental impact is not formally captured, although certain studies have been conducted independently. The building construction sector in South Africa is, however, significant when compared with the civil construction industry (Table 2).

Table 2: Building Industries Foundation South Africa comparison between civil and building construction

	Civil construction	**Building construction**
Contribution to SA GDP 1999	2.4 %	3.3%
Formal employment in 1999	67 000 employees	222 000 employees

(BIFSA 2000: 24 cited in Irurah & Boshoff, 2003)

In terms of sustainability, social systems are embedded in the natural environment, and ecological design falls in the space where integration between people, the natural environment and the built environment happens (Van der Ryn & Cowan, 1996).The tasks of social sustainability are inherently linked to designing appropriate built environments, and achieving social justice in this endeavour has been identified as a difficult aim (Hill & Powen, 1997:226). In developing countries, the basic needs of the urban poor are a significant concern for the relevant economies and governments (Irurah & Boshoff, 2003). In Cape Town this is echoed in

the attempts to mitigate the social fragmentation that was left as a legacy after the apartheid regime's demise (Swilling, 2006).

Cape Town is, like other cities in South Africa, a city that is segregated and sprawled (Gelderblom & Kok, 1994:101-105, cited in Irurah & Boshoff, 2003:250). If one focuses on closing the social justice gap in Cape Town, and places construction as an entry point for intelligent ecological design, low-cost housing is a major opportunity to improve the lives of the poor within a sector that has a relatively low impact on the environment.

Considering low-cost housing

The low-cost housing sub-sector in building construction plays a relatively minor role in the energy use impact on the environment in South Africa. It is estimated that low-cost housing contributes less than a quarter of the 20% consumption of electricity that residential usage comprises in South Africa. However, this sector deserves some consideration in terms of the national sustainability agenda, since a great many people and households are affected through the sector, especially considering the backlogs of services and housing (Irurah & Boshoff, 2003:253).

Housing delivery has been a major programme in the South Africa government since 1994. The most subsidies-supported projects deliver housing *en masse*, with a typical basic specification of a 'matchbox'-type house with a minimum stand size of 250 square meters and a minimum house size of 30 square meters, laid out in a square grid with no regard for practicality, access or quality of life (Irurah & Boshoff, 2003:254). In Cape Town the homes are often called *I-Vezinyawo* in Xhosa. This translates as 'Your feet stick out when you lie inside' (Personal conversation*, 2007*). In terms of a backlog on housing, in 2006 there were 260 000 houses needed for Cape Town, that was disaggregated as 110 000 claims from shack settlements, 50 000 from backyard dwellers, 25 000 from recipients in serviced sites, 60 000 recipients in overcrowded areas and 15 000 families that would be able to build houses if they had access to credit (Swilling, 2006) .

As stated above, the impact of low-income communities in Cape Town contributes relatively little to the ecological footprint of the city, when compared with high-income neighbourhoods. It

might seem nonsensical to consider applying eco-design principles to these communities. However, this would only be true if one excluded a social justice perspective, and focused only on the environmental impact of a city. From a quality of life point of view, practical measures that incorporate ecological design could have an immediate impact on the quality of life of a person living in a 'below the breadline' community (Irurah & Boshoff, 2003:253). Ecological design in this case directly serves an anthropocentric agenda, as an embedded agenda in an ecological agenda.

Practical steps towards incorporating ecological design in a low-income community

Ecological design can intervene on several scales (Gasson, 2002). This paper focuses on the two smallest scales, namely household and neighbourhood. Below are some recommendations which have been drawn from the literature in order to guide the discussion that will follow, where a specific case study is discussed.

<u>The household level</u>

A home owner that is interested in improving the ecological design and quality of his house has a range of options at hand that, depending on the stage of construction of the home are either no-cost, low-cost or high-cost. These include the following:

A series of options suggested by Gasson (2002) for the dwelling unit scale:

- Water saving fittings and sanitation forms
- Rain water gathering
- Sullage re-use
- Smaller gardens
- Natural lighting
- Solar collectors
- Insulation
- High-capacitative building materials
- Attached dwellings
- Local solar and wind collection.

Passive solar design can contribute to the thermal efficiency of a house without adding extra solar technology, but just by using the normal construction process.

A series of options suggested by Klunne (2002) for the household scale:

- Focus on the orientation of the house, usually facing geographic north for maximum solar benefit.
- Use building materials with a high thermal mass, like earth bricks with a high thermal mass, that store heat.
- The size and position of glazing, is recommended to be twenty per cent of floor space area and north facing for best thermal efficiency. Double glazing is also thermally efficient but not much used in South Africa.
- There should be roof overhangs on the north face of the house, to shade the windows during summer.
- A ceiling that traps air is important to make a low-cost house thermally efficient.
- Insulating a wall by adding panels or building a double cavity wall.
- Flooring should be made of materials with a high thermal mass.
- Sharing walls saves costs on the shell of the house.

<u>The neighbourhood level</u>

Two sets of relevant recommendations are provided for sound ecological design for the neighbourhood level, which works on a larger scale. In keeping with our focus on people, the built environment and the natural environment, a set of 'social principles of sustainable construction' are firstly presented and then a 'sustainability manifesto' is discussed that relates to measures that impact on the neighbourhood and city level.

Hill and Powen (1997:227) discuss principles of sustainable construction. These are categorized into three 'pillars of sustainable construction', namely social sustainability, economic sustainability, technical sustainability and biophysical sustainability. They echo similar principles of urban sustainability, namely a consideration of environmental impact, economic growth, socio-cultural responsiveness and institutional capacity (Irurah & Boshoff et al., 2002, cited in Irurah & Boshoff, 2003) Continuing the focus on eco-design as a principle that bridges

the human environment with the built environment, I draw on these discussions for the principles of sustainable development that concern the social aspect involved in ecological design.

Integrating quality of life with environmental and ecological quality: Social principles of sustainable construction (Hill & Powen, 1997);

- Improve the quality of human life, including poverty alleviation.
- Make provision for social self-determination and cultural diversity in developmental planning.
- Protect and promote human health through a healthy and safe working environment.
- Implement skills training and capacity enhancement of disadvantaged people.
- Seek fair or equitable distribution of the social costs of construction.
- Seek equitable distribution of the social benefits of construction.
- Seek intergenerational equity.

The Sustainability Manifesto

The list below is drawn from a set of suggestions by Swilling (2006:47) regarding Cape Town that would be viable within a predetermined policy and action agenda that views the city as a collection of potentially sustainable neighbourhoods.

- Transition to renewable energy alternatives and energy efficiency
- Zero waste via re-use of all waste outputs as productive inputs
- Sustainable transport, with a major focus on public transport
- Sustainable construction materials and building methods
- Local and sustainable food
- Sustainable water use and re-use of treated sewerage
- Enhancing biodiversity and the preservation of natural habitats
- Valuing authentic cultural diversity, and community and citizen participation
- Equity and fair trade at all levels
- Health, well-being and soulfulness.

The options available at a household and neighbourhood level, presented by the above lists, are integrated with the three aspects of the built environment, the quality of life of people in that environment and the natural ecosystem to discuss a case study from Cape Town, to consider the future that low-cost housing delivery and ecological design could offer to a single household.

SECTION 2: CASE STUDY AND APPLICATION

Nombulelo and her house

Nombulelo[1] is a 25-year-old woman who lives in a shack in the township called Khayelitsha on the outskirts of Cape Town. She is unmarried and has no children. Her job is to work as a health educator amongst the young people of her community. She is employed by a well-established non-governmental organization that is also based in Khayelitsha. She travels by mini-bus taxi to her office every morning and evening, for R3.00 either way. It takes her roughly 15 minutes to get from home to work. The taxi drops her at a point that is about a five-minute walk to her house.

She shares the shack with her brother, who is 17 years old. He has dropped out of school, and she fears he is beginning to get involved in illegal activities. She points to her television and states that her brother took her DVD player, even before she had paid off the amount owing on it. She qualifies for credit as she has a permanent job. She has a little dog that sleeps in her yard and her home is always filled with children from the neighbourhood when she is at home. She calls them her friends. Her neighbour across the road is a useful handyman that can fix anything, from her electricity meter to her toilet, for a few Rand. This is when he is not drunk or fighting with his girlfriend. Every weekend the noise of arguments can be heard from across the road.

The house and the neighbourhood

Nombulelo lives in a wooden building she calls a shack. It roughly forms the shape of a rectangle of 5.2 by 4.4 meters (approx 22.9 square meters). The piece of land on which the shack stands belongs to her, as much as the house does. This is, however, not official yet, as I will discuss below. Figure 2 represents her yard and house.

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[1] Not her real name.

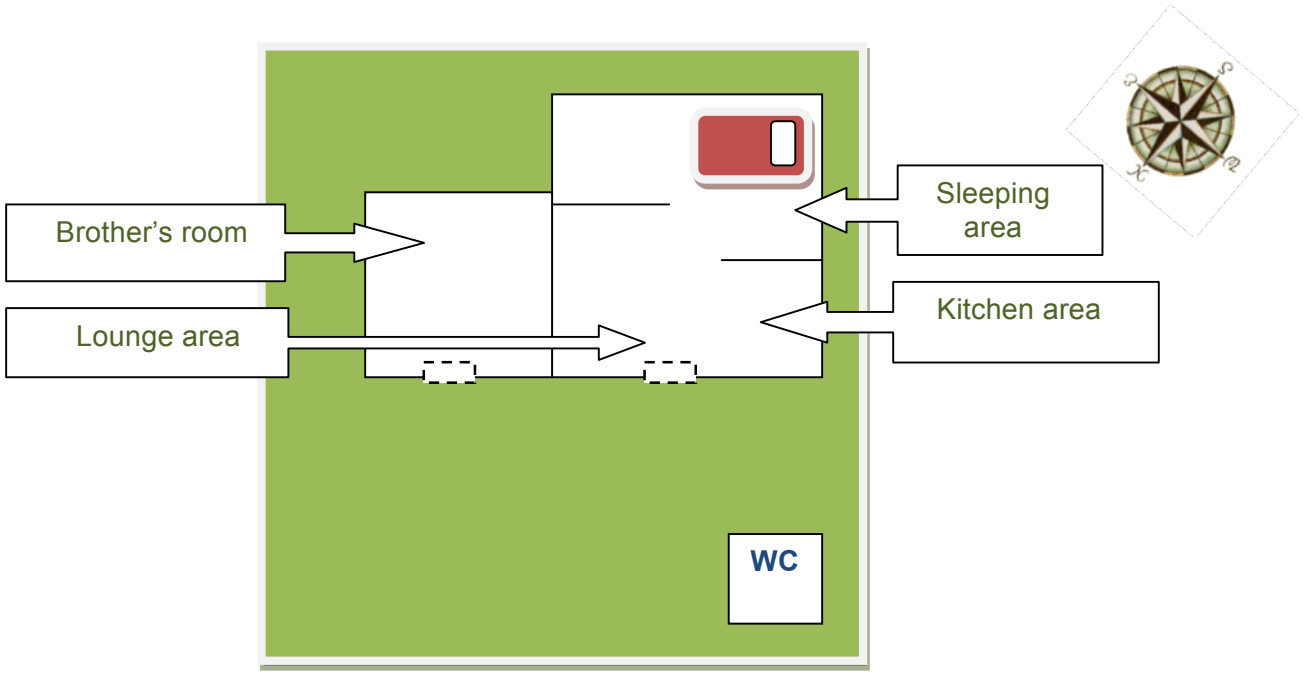

Figure 2: Nombulelo's house

The house consists of two separate rooms, which she and her brother occupy. Her brother has his own outside door and her house does not have access from his room. This is important to Nombulelo, as she does not trust him and she believes he stole her DVD player. Her DVD player was very important to her as she gets bored sitting in her house with nothing to do, and she enjoys listening to music.

Table 3 provides the elements of her house and living area.

Table 3 Measurements and amounts that comprise Nombulelo's shack

Element	**Amount**	**Total cost**	**Source**
RECENTLY ADDED OR REPLACED ELEMENTS			
Zinc roof plates	18	R 1 350	New plates can be bought locally at R75 each. Most are old ones from the

			previous house.
Ceiling boards	28	R140	The boards are readily available locally and quite cheap at R12 each.
Cement floor	2 bags of cement	R80 R 150 labour	Locally sourced, with help from the neighbour
Wood panels for internal divisions	Approx 50 planks	R300 material R 150 labour	The main road in the area has informal stands of second-hand building material.
Linoleum floor panels	About 100	R 100	Vendor who sells second-hand materials
One set of burglar bars	1 frame	R 150	A friend manufactures these to size locally.
ORIGINAL BUILDING MATERIAL			
Wooden panels		R2 500 estimated	The house was built from the same material that was used in the family's previous house.
Window frames			This material was dismantled and transported to the new site.
Door			
Wooden posts			
TOTAL COST OF		**R3 570-00**	

22.9 SQUARE METER HOUSE

She lives in a serviced neighbourhood, with a tar road and consistent water and electricity supply. Her water is supplied through a tap that is attached to the toilet building. The toilet is housed within a separate concrete structure that is situated right next to the road, in the front of her yard. The neighbourhood she lives in is a serviced neighbourhood. This means she has access to regular municipal services at municipal rates. This is starkly different from the conditions of the shack-dwellers who live in informal settlements such as Enkanini in Khayelitsha.

A shack amongst brick houses

It is significant to note that Nombulelo lives in the only shack left on her street. As we entered the road she lives on, she said:

"This is my street, I grew up here; it is my place."

Her shack stands out as the only structure on the road that is not built of concrete, cement or bricks. The other houses are all built on yards that look exactly like hers, but they are built of more durable concrete, and some of them have direct electricity or water into the house. This street is in a neighbourhood known as Makhaza in Khayelitsha. It is situated at the far end of the township from the city. The informal settlement that separates Makhaza from a sewage plant is called Enkanini. The smell of the sewage plant is overpowering if the strong wind does not prevail, and emphasizes the meaning of the word *enkanini*. It means to stubbornly hold on. Although the unique history of Khayelitsha and the role it plays in the fragmented design of Cape Town lies outside the scope of this paper, it is necessary to examine some facts about Khayelitsha briefly in order to better understand Nombulelo's situation. Table 4 provides statistics of dynamics that from Khayelitsha that impact on her life.

Table 4: Basic statistics about Khayelitsha relevant to Nombulelo

Important statistics about Khayelitsha	
Rape cases reported at clinics	**142 in September 2007** **57 in March 2008**
Population estimate end 2007	**357 893 people**
Unemployment rate in the province	**18.4 %**
HIV infection ratio Quarter One 2008	**27% of those tested**
(Source: City of Cape Town Department of Health, informal interview, July 2008)	

The population is mostly Xhosa-speaking and many regard their real home as the Eastern Cape, which is where the Xhosa-speaking people predominantly live. Consequently, the population of Khayelitsha regularly travel between the Eastern Cape and Cape Town. Funerals and weddings happen 'at home' as does the popular manhood ritual of circumcision. Some view Khayelitsha as an 'over-serviced' township, as there are literally hundreds of community-based organizations and non-governmental organizations that collaborate or compete with research institutions, universities, government departments or criminals for the lessons and resources that flow in various ways through the area. Residents of other townships like Mfuleni or Gugulethu often bemoan their lack of attention because "everyone works in Khayelitsha".

An important nodal point in the township is the Stocks and Stocks building. It aims to act as a centralized centre of services offered by the city of Cape Town. Two departments that are housed here are the Department of Health and the Department of Housing. The residents of Khayelitsha often utilize these departments. As we shall see later, the officials placed in these positions are

key gatekeepers to resources and utilize their position in official and non-official (and sometimes illegal) ways.

In this neighbourhood, 'environmental impact' means something different from what it means to an official of the Department of Environmental Affairs and Developmental Planning, the department responsible for approving environmental impact assessments. In the departmental sense, 'environmental impact' refers to the impact a project or development might make on the natural environment. In Makhaza, people are exposed to the impacts the environment makes on them. It refers to the relentless impact of the environment on people who are at the mercy of low-quality housing in a poorly planned frame of infrastructure. A few of the elements Nombulelo mentioned when probed, were the wind, the smell of the sewage treatment plant, the relentless danger of crime and assault, another unremitting battle with sand, and the annual flooding brought on by Cape Town rain.

Improving the ecological quality of Nombulelo's house

In the context of the environment having an impact on the people that live in it, once again the immediacy to the poor of any improvements is clear. As mentioned above, ecological design offers the opportunity to integrate people into the natural environment. In the first section a basic framework was created to discuss ecological design in terms of the built environment, the impact of development on nature, and the people that live in the built environment. The household level of intervention and the neighbourhood level of intervention are summarized below with comments about relevance and viability for Nombulelo. This also serves to highlight the details about her living conditions, and provide a description of a household that contributes to the below-average ecological footprint of areas such as these. Nombulelo should be living in a brick house like her neighbours. An obvious and clear step would be to gain access and ownership of a brick-built government-subsidized house. However, there is a powerful barrier to entry in this case, and this clearly falls in a context of social justice. This paper shall conclude with a discussion about this barrier.

Ecological quality on the household level

In terms of decreasing the impact on the environment by her household, some interventions are discussed below in tables 5 and 6, with the options Gasson (2002) and Klunne (2002) provided.

Table 5: A series of options suggested by Gasson (2002) for the dwelling unit scale:

Water-saving fittings and sanitation forms	Nombulelo's house has no direct water piping; she uses a tap in her garden. This tap is attached to her toilet shed. Limiting access to passers-by with a lock or a fence is an option to reduce this usage. She commented, however, that she is not aware of a water bill she has to pay.
Rain-water gathering	
Sullage re-use	Her toilet is a standard municipal fixture in a concrete shed on her lawn. Sullage re-use will have to be a council-led intervention.
Smaller gardens	Her garden is barely twice the size of her house. When asked about a food garden, she related that she had one once and her entire harvest was stolen. A fence that would succeed in keeping people out would be more expensive than her house.
Natural lighting	When she is at home her door is open, and both her windows are small for a reason, namely to keep unwanted visitors out. The only artificial light she uses is a CFL light bulb that she swaps between two sockets on the ends of two wires that protrude from her electricity box. She uses a pre-paid box and spends R120 a month on electricity.
Solar collectors	If she were to install a solar geyser, that would provide her with cheap hot water. However, at the time of my interviews with her she had no running hot water.

Insulation	She agreed that she desperately needs insulation and strengthening on her walls that currently consist of single panel wood, with gaps that let wind and water through. She has laid a cement floor that retains some of the daytime heat.
High capacitative building materials	
Attached dwellings	She attached a small room for her brother to live in at her own cost, in order to give him a home from which he can attend school.
Local solar and wind collection	These technologies are prohibitive in cost for her.

Table 6: A series of options suggested by Klunne (2002) for the household scale:

Focusing on the orientation of the house, usually facing geographic north for maximum solar benefit	Currently her house focuses north-west, and is aligned to her yard dimensions. She has laid a cement floor and this would make it impossible to move the house to a different area.
Using building materials with a high thermal mass, like earth bricks with a high thermal mass, storing heat	Bricks will be a major upgrade on the existing wood panels even before earth bricks are used.
The size of glazing is a recommended 20% of floor space and the position north facing for best thermal efficiency. Double glazing is also	Her windows right now are small for security reasons. Her main open space on the front of the house is the door. The windows are both approx 75 cm across by 50 cm high. In a new brick house double glazing would be an option.

thermally efficient but not very prevalent in South Africa	
Roof overhangs on the north face of the house, to shade the windows during summer	Her house roof has no overhang. This is relatively easy and cheap measure that she could undertake.
A ceiling that traps air is important to make a low-cost house thermally efficient	The ceiling that currently lies between the zinc plates and the room was a recent addition and she reports a massive improvement in the thermal effect in her house.
Insulating a wall by adding panels or building a double cavity wall	Until she has access to a brick house her walls can be clad with another layer of wood that covers a layer of plastic wool insulation material.
Flooring should be made also of materials with a high thermal mass	She has laid a cement floor that retains some of the daytime heat.
Sharing walls saves costs on the shell of the house	Her house has four walls. One of the four walls her house consists of (25%) is shared.

<u>On the neighbourhood level</u>

Table 7 below discusses options that are available to engage with on a neighbourhood level.

Integrating quality of life with environmental and ecological quality: Social principles of sustainable construction from Hill and Powen (1997).

Improve the quality of human life, including	This is very relevant to Nombulelo as she lives in a low-income neighbourhood. Her monthly income is R3 500 and

poverty alleviation	this is just enough for her to support her and her brother, but not to improve her housing.
Make provision for social self-determination and cultural diversity in developmental planning	This is an intervention that would require local government services to participate in partnership with civil organs and community organizations.
Protect and promote human health through a healthy and safe working environment	Nombulelo works and lives in an unsafe environment. She remains indoors after dark and knows she is at significant risk of mugging and assault - even of rape - if she has to venture outside after dark. She says that the situation has worsened. The worst time of the year for her is winter, when she has to return home at dusk and walk the stretch from the mini-bus drop-off point to her home.
Implement skills training and capacity enhancement of disadvantaged people	Nombulelo was a beneficiary of this. She had attended a health education program at school which led her to becoming a facilitator and gaining employment as an educator herself.
Seek fair or equitable distribution of the social costs of construction	Nombulelo and her mother were solely responsible for the acquisition and construction of the house. Her father 'disappeared' in her early childhood. When her mother passed away in 1999 she took full responsibility of the house, and was shunned by her family.
Seek equitable distribution of the social benefits of construction	Her brother is not a tenant but a dependant. She carries the costs and responsibilities of supporting both of them.

Seek intergenerational equity	She is an agent of this as she hopes to have a brick house for her future children.

The above options are placed locally in a neighbourhood level. Table 8 continues with options that are available to Nombulelo of processes that cut across household, neighbourhood and city levels, and comments that discuss the options in terms of practicality and viability for her.

Table 8: The sustainability manifesto (Swilling, 2006)

Transition to renewable energy alternatives and energy efficiency.	Compared to houses in other neighbourhoods, Nombulelo's house is very energy-efficient.
Zero waste via re-use of all waste outputs as productive inputs.	She produces minimal waste (a shopping bag full per week), mainly from food and grocery wrappings.
Sustainable transport, with a major focus on public transport.	She depends wholly on public transport.
Sustainable construction materials and building methods.	Her complete house has been built out of recycled material that was used for housing before and will be used for housing again. The main bulk is bio-degradable wood.
Local and sustainable food.	She does not have the ability to create her own food garden but she can potentially join a collective that collaborates on growing vegetables. She currently buys her vegetables from local vendors.

Sustainable water use and re-use of treated sewerage.	She uses minimal water, but is dependent on the water service provided by the Council. This intervention would be possible if led by local government.
Enhancing biodiversity and the preservation of natural habitats. **Equity and fair trade at all levels.**	These interventions are also beyond the scale that Nombulelo interacts on.
Valuing authentic cultural diversity, community and citizen participation. **Health, well-being and soulfulness.**	Nombulelo reports that there is a strong feeling of social capital and community coherence in her neighbourhood. She knows all her neighbours. The children of the neighbourhood often visit her. She exercises regularly at the neighbourhood gym and is incredibly fit. She is part of a small collective that lobbies for access to housing.

The final point in the sustainability manifesto raises the strategy of community and citizen participation. Nombulelo's main step towards accessing a better quality house depends at the time of writing this paper on her ability to utilize her own neighbourhood's lobby group.

Cape Town had a backlog of 260 000 houses to be awarded in 2006. Twenty-five thousand of these were of the category that applies to Nombulelo: serviced sites without a house (Swilling, 2006). In order to prove the right to receive a house subsidy one needs a title deed. Nombulelo's mother did not provide her with a title deed before she passed away in 1999.

Nombulelo went to the appropriate desk at the Stocks and Stocks building in Khayelitsha. The official found a record of her mother's title deed and agreed that she had a right to it. Then he proposed that she provide him with either a sexual favour or a financial bribe. She refused to

provide either and approached another official, who presented the same offer and warned her that if she attempted to report them she would lose all possibility of gaining a brick house.

That left her with the recourse of going to the neighbourhood collective which advocates for housing access. However, the decisions this group depends on are still made by the same local government officials. In this case the main resource that could aid a step to ecological quality and improved quality of life depended on a public service level of standards. At the time of writing there was no sign that the attitudes or standpoint in the governmental office were about to change.

Conclusion

Ecological design can play a role in improving the integration of people into the natural environment. This paper has attempted to discuss options available to people living in low cost housing, and the dynamics that impact their ability to engage in ecological design solutions, by discussing these solutions at a household and neighbourhood level. There are however often significant barriers to implementing ecological design methods, for example the challenges Nombulelo experienced in the basic step to gain a title deed. The individual case represented here was eventually resolved through a caring neighbour hearing about Nombulelo's predicament and communicating with friends who work in the city's department of housing. They then reported the people involved and provided her with the much needed title deed. Her friend however did not respond to an official complaint from her. Her solution depended on an informal association they shared by virtue of living in the same street. The example serves to demonstrate the need to base the integration between people and their environment on a sound human rights framework, combining social and environmental justice. A practical and comprehensive approach to achieving pervasive ecological design implementation would be one that is sensitive towards complexities such as these that involve the people who aim to integrate with the processes of nature.

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