Vision

A nation housed in sustainable human settlements

Mission

To facilitate an environment that provides sustainable human settlements

The Human Settlements Review will be a regular publication of the Department of Human Settlements. The intention is to develop it into a peer reviewed series. Each edition will be clustered around a particular theme that contains a balanced view from academic research, case studies and experiences of programme implementers. Articles will be sourced from research organizations, academic institutions, civil society organizations and public service practitioners. Inquiries about submitting an article for publication can be directed to Research@dhs.gov.za.

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## POLICY PERSPECTIVE

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Foreword

*Human Settlements Review* aims to contribute to a critical debate on appropriate responses to the challenge of providing adequate shelter for the poor, the impact of rapid urbanisation, the development of a single residential property market, sustainable planning and many other issues related to human settlements. More importantly it aims to provide a mechanism for the Department of Human Settlements to harvest and disseminate studies on various aspects in pursuance of developing sustainable human settlements.

This inaugural edition is devoted to innovation and alternative building technologies. It looks at how innovation and alternative building technologies should best be utilised in the provision of shelter while taking into consideration issues of environmental and economic sustainability. Papers contributed by scholars and practitioners explore the role of innovation and alternative building technologies in the development of sustainable human settlements. Issues examined include understanding the sustainable development paradigm, sustainable architecture and culture. The policy development and implementation discourse is introduced through substantive theory and case studies.

While the publication is not peer reviewed it is the intention of the Department of Human Settlements to develop it as a platform for new and established researchers to share new knowledge, review policy and deliberate on all matters related to human settlements. There is no doubt that in the next few years it will mature into a widely recognised and highly respected publication.
The prospect of development in any situation is fundamentally linked to that of social justice. In a country such as South Africa this must necessarily be linked to service delivery. Given the legacy of apartheid and its spatial agenda, delivery in the built environment remains an abiding priority. Recent policy evolution has shifted this imperative from a quantitative to a qualitative concern. The challenge to built environment professionals, and designers in particular, is to interpret this policy through the creation of new approaches to both design and delivery. By engaging the breadth and depth of new policy, one should reconfigure the arrangements that inform spatial production to provoke new spatial conditions that links quantitative and qualitative dimensions to radically transform the lives of the marginalised.

Participatory Practice is an instrument that is often deployed in engaging with communities. Its interpretation is however frequently a reductive one that seeks to gain concensus from user groups in relation to their needs and wants. Failure in this realm is more frequent than is generally supposed and maybe ascribed to the failure of process to genuinely interface with communities. On the one hand facilitators abrogate professional responsibility to the detriment of higher order concerns, and on the other designers lack the capacity to interpret competing community needs and/or to translate them through the application of speculative design imagination.

The potential of design is to engage Participatory Practice as an open representation in responding to society’s challenge. When responsibly applied, design can mediate between policy/planning, community needs, spatial transformation, local economic and sustainable development. One productive domain for sponsoring such a design dialogue is the realm of technological innovation. Mediating between modernity and tradition this approach permits the development of situated approaches to tectonic problems that entail tremendous possibility to capacitate local communities. This principled approach to design making is not necessarily sector of project based, but is capable of interpretive replication across multiple sectors and sites giving added meaning to participatory practice.

In his seminal publication, ‘The Coloniser and the Colonised’ Albert Memmi [1965] proposes the loss of original language as an explanation to the seeming chaos that accompanies...
the post colony. His insight has particular relevance in the realm of architecture and spatial practice. Colonisation conditions a cultural genocide that effectively eradicates most indigenous practices, rendering communities ‘speechless’ and unable to act. This disruption of tradition and the established approaches to the conditions that inform everyday lives of communities is most obvious in the spoken and written word. It is, however, somehow less obvious in the constructed world of human settlement where modernity seems to inevitably take command. The RDP house, as a solution to shelter in South Africa, is exemplary of this condition. Not only does its autonomy fly in the face of the collective spatial structure that is emblematic of ubuntu, but perhaps more so, it is in the massification of the means of its production that we dehumanise dwelling.

The contemporary task of architecture in a developing environment such as Africa demands an alternative approach to the design of the built environment. The norm of ‘top-down’ utilitarian and economic approaches that are prevalent in developed countries tend to sit uncomfortably within African contexts. Local practices and communities have been largely marginalised from modern modes of material production and consumption. In his publication ‘Modernity at Large’ the post colonial theorist Arjan Appadurai [1996] identifies this condition and establishes a coherent argument for the ‘production of localities’. Opposing the scaler and spatial dimensions of material culture, he proposes the elevation of complex co-axial interrelations between the imperative of the socius, technological interactions and the relativity that constitutes any context. At one level this may seem to imply a fundamentally different attitude to the structuring of human existence, however, when otherwise examined it could be interpreted as a plea for a return to origins, to a condition where inclusive human relations prefigured the making of ‘architectural form’.

Since the emergence of South Africa’s democratic independence in the early 1990’s, there have been many policy attempts to redress the legacies of colonialism and apartheid. Needless to say we have not succeeded in either quantity nor in quality of delivery in the built environment. Whilst we enjoy a rich policy domain we lag in delivery on the ground. Socio-economic empowerment underlay’s government’s ideology of transformation yet the predominant modes of architectural production are still dominated by market principles. These protect formal practices and establish barriers to inclusivity, marginalising the participation of the poor. The role of design in prefiguring inclusivity can maximise opportunity for more horizontal relations that promote direct involvement of the poor and marginalised. Design through participatory practice in its broadest meaning can revolutionise housing, education and health programs affording direct socio-economic opportunity for communities.

Initially the project had established a utilitarian approach to implementation. Directly translating MoE norms, a 50m² classroom unit built from concrete blocks with corrugated sheet iron was proposed. Its construction and appearance drew on the common utilitarian solutions that were prevalent in the region at the time. Lacking in any design consideration,
this approach produced classrooms that were devoid of any environmental quality and the environmental warmth necessary for human practices to thrive. In addition the construction techniques were not only minimal in standard, but moreso, often inferior and lacking the necessary resilience to withstand the pressures of intensified use associated with public buildings. In addition to these considerations, the severity of the Lesotho’s mountainous rural terrain imposes severe restrictions on the availability of materials, on the ability to move about with ease, on the availability of skilled labour and on the conditions under which one is forced to build, to identify but a few. The capacity for local contributions, in the form of self-help participation, as required by both the lender-donor, World Bank - International Development Agency [WB/IDA] and the Government of Lesotho [GoL] proved a mismatch. The reliance on a clear division between government contribution; new buildings, and community participation; maintenance proved unsustainable. The uncritical imposition and replication of predetermined standard models seldom achieves the desired and necessary success. The use of model solutions demands, at a minimum, contextual adaptation, or preferably transformation through local interpretation in order to derive approaches capable of absorbing those conditions and relations that pre-exist.

**The Participation of Space**

The production of space has its counterpart in a space of production. The effects of space lay in its usefulness to affect social relations and human events. Design innovation that positively influences upon modes of production can have much impact on this potential. Whereas ‘modern’ delivery results in buildings that often seem to have descended from the sky, ‘traditional’ means rely on a more piecemeal and nuanced approached to intervention, one that is supportive of continuity, as opposed to change or overwriting with ‘newness’. These two positions represent extremes and often compete irrationally playing out against each other in the same context. The complexity and contradictions that arises is often irreconcilable and leads to one or the other predominating, at the expense of the other. The result is that of weak formalism, in the prioritisation and overt reliance of architectural form over human experience. The practice of everyday life and the ordinary events whose iteration define the rituals of daily existence often become subsumed within the expediency of form making, and of cost efficiency and delivery.
Transformation in colonial contexts, such as South Africa, sits on an interface between divided conditions. Where design considerations recognise local exigencies, as both material and cultural practices, it is possible to achieve, through design means, what Arjan Appadurai has defined as the Production of Locality. When viewed through this lens the architectural project becomes situated within the condition of its specific locale. Its resolution requires the assimilation of multiple forces in order to produce a necessary valency and accommodate dissimilar things and the complexity and contradiction they evoke.

Unfortunately the progress demanded by Western modernity is often only measured quantitatively and remains a predominant gauge of delivery in global discourse on development. The potential of engaging dual phenomenon of social and physical is seldom insisted upon. Rather in contexts of transformation socio-economic empowerment should be the foundation stone of physical implementation.

In Lesotho under the TSRP program it was probably the severe constraint of rural conditions that encouraged deep integrated design innovation. The schools in the program are located throughout the kingdom, however, the majority are located in the interior of a mountainous kingdom sited within exceptionally poverty stricken villages. Roads, access to materials, water, skilled labour and etc. all pose severe constraint to a regular and efficient building process. In addition there is often limited land area on which to build, and that which is available slopes steeply and

fig. i | illustration of Peoples’ Facility in Qoaling outside Maseru, Lesotho; demonstrating early experimentation with concrete block and brickwork, and the subsequent utilisation of the TSRP framed structural system.
has either rock or soil or clay for founding on. There is seldom electricity or water reticulation and the weather is severe, particularly in winter months. Skilled and semi-skilled labour is not locally available. Construction materials need to be brought into rural areas where roads are practically non-existent.

In confronting extremes it becomes necessary to view conditions from multiple directions simultaneously. Henri Focillon [ ] poses a question of ‘How to become modern without loosing touch with sources’? How then do we incorporate different ways of seeing the world, and therefore of making new worlds? In Lesotho the challenge was to enfold local practice into the production of the new education facilities. When considered as a developmental tool, this posits issues regarding the leveraging of design thinking to elevate basic skills above or alongside those of so-called skilled workers. Essentially minimum investment and effort was expended in establishing an enabling framework for maximising the use of village skill and local materials. Given the unique human and geographic context of the Lesotho this question raised essential issues around questions of architectural language and the concomitant spatio-technical practices that are necessary for their realisation.

fig. ii | illustration of the TSRP system of construction through a number of different sites, demonstrating its freedom for adaptation in specific situations.
The system devised relies on a pad foundation system. Cast on beds of aggregated these are joined by a stepping ring beam at natural ground level. This approach addresses the clay and brick founding conditions, saves on excavation and underground walling, whilst establishing a somewhat over structured base on which to build the enclosure. T-shape quoining columns emerge and rise to door height where a second ring beam is connected to reinforced corner columns created from concrete filled blockwork. The material for infill between columns is locally sourced; stone in rural mountainous areas, brick in the lowlands where local brickfields are at hand and blockwork where local enterprises exist. The employment of local artisans ensures economic.

The grid of 1,630m is derived from a combination of the block column plus a standard school pivot type window, as well as the maximum spacing possible for a labour intensive site manufactured roof trusses. Corrugated iron roof sheeting is interrupted by clear paxit fibre glass sheeting at on the south the ridge to enable ‘free’ overhead even daylight during the school sessions. The underside is line with sisalation silver foil providing insulation and a ceiling finish, enabling the lowering of the wall heights. Where stone infil has been utilised an individual identity is created by the craftsperson, whilst the rear panel requires plaster and painting and provides a small but defined site for learning and skilling of new workers. In schools where the community is organised and motivated an extra ‘shell’ classroom is added providing for an outdoor shelter for dining, teaching, gathering, etc. Ultimately it affords the opportunity for an additional classroom, requiring only the infil of the space between the quoined columns; work which is directly related to capacity within the community and therefore immanently realisable.

Where sites are cramped and land is scarce, for instance in older urban schools, the allocated classrooms have been placed on the upper level. Similar to the case with the rural ‘shell’ classroom, the lower floor is prepared for later enclosure thereby affording densification of urban areas and the retention of exceptionally valuable outdoor playing and recreation space. It is easier to ‘build down’ than to build upward in extending a building, and the additional investment required to facilitate this type of extension is well spent. It leverages economic, spatial and technical capacity contributing to an integrated basis for sustainable development. This approach brings a new dimension to community participation as a living continuous process that is driven directly by internal needs and capacity of the community affected.

The 1,630m quoined columnar grid building system also lends itself to different forms of combination. Different building types that respond to the growing needs of these basic schools become possible. Science Laboratories and Domestic Science Workrooms can be achieved through small modifications and the incorporation of appropriate equipment and servicing. Special functions such as Offices, Staffrooms, Libraries, Kitchens and Ablutions lend themselves to more advanced interpretations of the construction system. These as smaller, individual buildings provide a basis for more complex training programs.
Emblematic of all the tectonic relations afforded by the system, a worker with advanced skill may gain critical training that prepares them for future deployment as construction foreman, or indeed in certain cases for commencing their own small entry level construction firm.

Collectively these individual building components can be deployed over a site, allowing for best orientation, for ease of interconnection, for phased growth and for productive collective spatial configurations. This temporal dimension to development is consistent with traditional rural practice, and contrasts strongly against the master planned ‘mega’ structure approach promoted by contemporary utilitarian approach which demand maximum delivery in the minimum time.

This 1,630m grid and column therefore forms the DNA of the project; it is not a reductive controlling cartesian grid, but rather an enabling one that provides maximum freedom for absorbing and accommodating the many dimensions of the complex building process. Despite the utilisation of a systems approach to design and building with the use of iterative components and plans, the outcome of each school is differentiated by mediation of the model across all the scales of implementation, from site making through configuration of selected units and the infil material chosen down to the hand of the individual craftsperson who effects the actual work.

One of the preconditions in pursuing this line of design is time/space for research. It necessarily involves significant delay in the delivery of goods and services; raising another conflict in the process. The project was therefore reinterpreted as Design Build Research [DBR]. Essentially the program became a laboratory for investigation and experimentation that produced concrete results capable of measurement and thereby contributing knowledge in a positive feedback cycle.

The initial buildings focussed in nuanced responses to the existing classroom designs. Critical knowledge was acquired in this process that lead to an eventual reconfiguration of the modes of production. However, the knowledge was gained in-situ, by doing. In other words, ‘thinking and making’ are reconciled within a single space of production. This approximates both early vernacular responses to shelter and settlement making, as well as to contemporary responses that are prevalent in the townships and informal sector. Here necessity and the limitation of financial, spatial and material resources has prompted genuine innovation.
The role of the detail in architectural production has been profoundly explicated by Marco Frascari. In his seminal essay, The Tell-the-Tale Detail, Frascari [1984] locates tectonic sensibility as the basis for both constructing and construing meaning in architecture. “The art of detailing is really the joining of materials, elements, components, and building parts in a functional and aesthetic manner.” In the realm of spatial production this argument maybe extended to both spatial and experiential tectonic. In other words we might consider all human actions as having a tectonic implication; whether it be the connection of humans with their god[s] through mediation of light, or the combining of materials through techniques of joining, or the empowerment of impoverished communities through modes of material production that are inclusive of their capacity to construct. Under conditions of austerity and in developing contexts, such as those of Africa, the imperative for architectural imagination to speculate beyond the conventions of the formal becomes a necessity. Attending to the tectonic of architectural detail has liberated the iterative from its mundane representation. Design skill deployed imaginatively expands that freedom to render a unique valency to standardisation. In the case of TSRP in Lesotho this has enabled the production of space to engage society in multiple ways; in economic development of poor communities, in the incorporation of local materials, traditional skills and space making and in the potential for harnessing passive energy, to identify a few.

fig. iii | illustration of the building system identifying columnar framework with quoined openings for less skilled labourers to infil; evidence of identity making through different rock/brick face relative to sourcing, cutting and subsequent laying.
Conclusion

Whilst the Lesotho example suggests that severe conditions are a prerequisite for tectonic invention, the project is in fact not about technology, nor education for that matter. It is about design, about design as a critical response to a set of pre-existent conditions that have power to impact upon a decision making process and affect its outcome in the interests of more than simply the production of space. Design interpretation of any situation in order to maximise the latent potential that is inherent in the complex set of circumstances enable the configuration of space. By bringing intellectual insight to given conditions, imagination and speculation find a resonance with contingency, enfolding them productively into an interpretative design process that is predicated on unforeseen outcomes.

The Lesotho project will find direct correlation in many [southern] African situations. It may not be directly applicable, but local interpretation of its principled approach to socio-economic empowerment could contribute a force in directing built environment development in our own contexts. This becomes particularly relevant in the phase of the rapid urbanisation of our cities and the growing informality that has come to characterise ‘African Urbanism’. The approach of Design Build Research posits a productive framework for engaging this work and suggests new instruments of delivery that engage critical human agency in focussing design creativity to social conditions.
The prospect of envisioning the informal sector as a laboratory for engaging questions of community building, as opposed to that of a problem of slum clearance, we may discover new and poetic modes of spatial production that deliver socio-economic as well as physical shelter benefits.

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Endnotes


ii. Generally the emphasis is on both the social and physical, sometimes the political, but seldom, if ever, on the economic needs required for sustaining community development.

iii. Memmi, Albert; The Colonizer and the Colonised;

iv. That is a non-western / non-modern one

v. Reconstruction and Development Program [RDP]; Growth Employment and Redistribution [GEAR]; [ASGIAS], Extended Public Work Programs [EPWP]

vi. The notion of competing rationalities and the difficulty of conciliation is a key tenet formulated in Watson’s PhD inquiry which critique’s planning processes in the City of Cape Town; Watson, Vanessa [200X] Change and continuity in the planning of Cape Town

viii. These are the very qualities that Robert Venturi ascribes the roman baroque whose complexity approximates our contemporary condition, and demands similar effort in attempting to resolve its questions.

ix. The problem of continuity and change is intimately linked to the breakdown of tradition and the speed of delivery that modernization and economic progress demands. Focillon’s prompt is toward an inclusivity that enables the co-existence of difference necessary for democratic practice and the maintenance of civil society, particularly in an age of radical/accelerated change.

x. Frascari, Marco [1984]; The Tell-The-Tale Detail; Via 7: The Building of Architecture, pp23-47; University of Pennsylvania/Rizzoli, NYC.
1. Introduction

The growth of human settlements in Africa has been a characteristic in the last century. Africa is the continent with the highest urban growth rate. This has serious implications for the urban environment, the social circumstances and the ecology. Providing housing and infrastructure are two priorities governments have to tackle. However, merely constructing new houses and the associated infrastructure is inadequate. Housing is much more. The UNCHS (1997) defined housing in a comprehensive context as “physical shelter plus related services and infrastructure, including the inputs (land, finance, etc.) required to produce and maintain it”. The United Nations (1978) provide a definition of rural housing, which can also be applied to urban housing, to illustrate the multitude of components involved:

“... as the dwelling units plus utility services such as roads, water supply, sewage disposal, electricity and fuel. Furthermore, it includes markets, health centers, social and cultural areas for education, religion, recreation, community participation and management. Facilities for agricultural and agro-industrial activities and services also form part of the system”.

In urban areas the latter will include non-agricultural industries, bureaucracies, and higher educational institutions. If the challenges of housing are to be addressed, a multitude of factors have to be incorporated in the process, as indicated in the definition above.

The reliance on conventional approaches has not contributed to problem solving in the case of housing. Many attempts have been made to alleviate some of the constraints, e.g. community based projects or involving small contractors in the construction processes. In most cases conventional materials and construction methods formed the basis of the activities. The affordability of many households declines continuously, due to the constant increases in prices for conventional materials and services, and the slower growth rates in incomes. This has lead to various attempts to find a solution through mass production, economies of scale, and subsidies, to lower the costs. Other initiatives looked at non-conventional approaches in order to overcome constraints, among them were alternative technologies. Some examples will illustrate the design and work done by the Habitat Research and Development Centre.

2. Alternative technologies

So-called modern construction materials are regarded as more durable than traditional
materials, such as clay, wood, or thatching. In most cases the utilization requires skilled personnel, and requires money to purchase materials and to pay artisans for work done. This contrasts with what was achieved over centuries by many indigenous societies, who relied on locally available materials and their own skills. This vernacular knowledge is nowadays often ridiculed and described as backward, although they could be described as eco-materials.

Non-conventional or alternative technologies have been advocated especially in the 1960s and 1970s. Wang (1991:10) differentiates between three terms, which are often lumped together. The first is intermediate technology, an approach to development in which full industrial technology is eventually possible. The second term, appropriate technology was discussed above. Proponents criticised many industrial technologies, which are not appropriate for poor communities. The third term alternative technology, is a radical criticism of the excesses of the industrial society. By promoting alternative technology, its proponents seek to reform society by making use of technology, which is environmentally sustainable, affordable, and allows equity in the access to resources. The alternative to industrial technology should have aspects accommodating the needs of the rich and also the poor. The rich need a technology to allow them to achieve their desired living conditions without unnecessary depletion of natural resources, whereas the poor require technology suitable for their survival needs (Wang 1991:11). These technologies should be cheap, simple and effective. Among the alternative technologies are for example biogas plants, which make use of waste products, are environment friendly, and could be used for fertiliser production and to produce gas for cooking purposes in rural areas, thereby minimising the need for firewood.

Intermediate technology is concerned with small-scale industries starting with existing techniques and using knowledge of advanced techniques to transform or improve them (Rondinelli & Ruddle 1978:105-106). In poor communities technological innovations must be inexpensive and of minimal risk. Thus to be relevant, the demand for products must be within the purchasing power of the consumers. Another form of intermediate technology is village technology aimed at small farmers. It is advocated that innovations in this respect should begin at the current level of village competence, for example using traditional carpenters or blacksmiths. Materials used should be locally available at low costs. “Village technology should seek principally to reduce bottlenecks and constraints in production systems” (Rondinelli & Ruddle 1978:104). Intermediate technology must be made available to those interested and requiring it. Knowledge can be transmitted through training and information channels from one place to another. A central authority gathering, researching and providing relevant information, can be a useful point to start with the dissemination process.

The term ‘appropriate technology’ is defined by Napier, et al. (1987:1) as “technology that is appropriate to the needs of a particular society at its present level of development, since different cultural and geographic groups require different technologies.
‘Technological self-determination’ should harmonise with cultural identity and complement the needs of the community in a satisfying and creative process”. It also stresses that every society has a technological tradition and new technologies should not come into conflict with traditions. This however is not always possible, especially in cases where the communities demand those technologies used by the ‘modern’ sections of the society.

With references to Alternative Technology (AT), the question is, alternative to what? BusinessDictionary.com (2010) defines the term as manufacturing or production methods that are less polluting and more resource efficient than the traditional methods, whereas Dictionary.com (2010) describes it as a technology, which conserves or renews natural resources and is considered environmentally friendly. These definitions refer to alternatives to the expensive conventional technologies and their negative effects of the natural environment.

Jamison et al. note that during the 1970s AT activists advocated technologies that would facilitate the radical transformation of industrial society to facilitate a transition to a more ecologically harmonious, socially convivial, and economically steady-state society (Smith 2005:106). Examples included renewable energy; organic food production; autonomous eco-housing and communities; co-operatively operated workshops; small-scale infrastructures for water (Smith 2005:107). Corresponding to this position, a key figure in the AT movement, Fritz Schumacher, intended to change the poor transfer of capitally-intense technologies from the industrialised world to the developing and this resulted advocating ‘appropriate’ technologies (Smith 2005:110).

A comparison with conventional technologies is depicted in Figure 1 (Smith 2005:111):

![Figure 1 – AT solutions versus conventional technologies](image-url)
Morris (2009:1) points out that Schumacher used the term “appropriate technology” to refer to “technologies that fit local conditions, are inexpensive, small-scale, simple to use, made from local materials, do not deplete natural resources, and help create fulfilling jobs and workplaces, especially for poor and rural people”, and these were intended to promote self-reliance. Schumacher’s book Small Is Beautiful highlights some of the important themes (Morris 2009:2):

• The importance of human scale,
• The idea of natural capital; treating nature as capital and not as income,
• Including concern for workers and environmental integrity in business decisions,
• The “economy of permanence”, based on sustainable use of natural resources, and
• Decentralism and a belief in community self-reliance.

Although AT and the related concepts declined in the 1980s and 1990s, the principles reemerged at the beginning of the 20th century. Environmental crises, energy crises, and climate change are among the triggers, which aided what the early AT advocates intended in industrial countries such as reduction of polluting industries, renewable energy, and ecological protection. However, the “alternative energy challenge was being interpreted through the incumbent, industrial frame, into which AT ideas did not fit comfortably” (Smith 2005:112). Wind and solar energy technologies are very expensive and require a considerable initial investment. A plant manager in a German solar panel factory stated (pers. Communication June 2010) that the establishment of a new factory requires huge amounts from Government, i.e. subsidies. This is one reason why no production facility operates in Southern Africa. Laszlo (2010) summarises arguments for a further evolution of technology:

“The evolutionary challenge for technology in the third millennium is one of designing the vehicles for sustainable human and societal development in partnership with earth. The challenge calls for the conscious creation of evolutionary systems-not through the ‘hard technologies’ that shape and mold the physical infrastructure of our planet, but through ‘soft technologies’ that augment creative and constructive processes of human interaction. Through them, humanity has the opportunity to create the conditions for the emergence of a true learning society at both regional and global levels. The meaning of key terms such as evolution, technology, and development must be explored if we are to create a shared understanding of the contemporary survival challenges faced by humanity”.

The soft technologies inter alia refer to attitudes, ethics, and other psychological factors, where the hard technologies include alternative technologies. The combination of these two factors can be found in what is termed Eco-materials and green building. Ecomaterials is defined by EcoSouth as those construction materials that are ecologically and economically viable (ECOsur, 2010a). Due to the diminishing income from the sale of sugar to the former Soviet Union after 1989, Cuba began to develop its own building materials.
Universities were involved in developing, for example, an alternative binder product CP40 (see ECOsur, 2010b). Village technologies were developed in Cuba to enable inhabitants to produce building components such as bricks, window and doorframes, roof tiles, and sewer pipes, all made from concrete. The transfer of certain technologies has, for example, resulted in the manufacturing of micro-concrete roof tiles are in Namibia.

The building of shelter, according to Wines (2000:9), consumes one-sixth of the world’s fresh water supply, one-quarter of its wood harvest, and two-fifth of its fossil fuels and manufacturing materials. Sustainable architecture or green architecture, attempts to advance three purposes: 1. to advance the purely selfish motive of survival by a cooperation with nature, 2. to build shelter in concert with ecological principles as part of this objective, and 3. “to address the deeper philosophical conflicts surrounding the issue of whether we really deserve the luxury of this existence, given our appalling track record of environmental abuse” (Wines 2000:20). The challenge is to reach the point where green architecture is indistinguishable from good architecture (Jones 1998:9).

Brenda and Robert Vale pioneered energy-efficient architecture in the 1970s and wrote Green Architecture. They were “not so much concerned with what a building looked like as with what it did to the environment” (Madge 1993:160). They also discussed the viability of Western patterns of consumerism and the need to ‘green’ city planning.

A green building serves the needs of the people who inhabit it, which means it supports and nurtures their health, satisfaction, productivity, and spirit. It requires the careful application of the acknowledged strategies of sustainable architecture: non-toxic construction, the use of durable, natural, resource efficient materials, reliance on the sun for day lighting, thermal and electric power, and recycling of wastes into nutrients (ARC Design Group, 2000).

Green building or architecture considers solar passive or earth sheltered design, solar hot water heating and cooling systems, photovoltaic systems, and energy efficient appliances.

Kibert and Schultmann (No date:1) argue that the “green building movement espouses that the built environment should be created using ‘ecological’ principles, yet there is little evidence that there is any real understanding of ecology or ecological principles on the part of the various actors in the building process”. The authors stress that a deeper understanding of ecology and ecological concepts is needed to create a truly effective green building movement. According to Bringezu (Kibert & Schultmann (No date:4); Wallbaum & Buerkin (2003:54)), the Wuppertal Institute in Germany suggests an alternative set of rules for the industrial systems to follow ecological principles, labeled the Golden Rules of Eco-Design:

1. Potential impacts on the environment should be considered on a life cycle basis or from cradle-to-grave,

2. The intensity of use of processes, products and services should be maximized,
4. Hazardous substances should be eliminated, and
5. Resource inputs should be shifted towards renewables.

The emergence of the term Construction Ecology refers to the development and maintenance of a built environment, which contains 1. a materials system that functions in a closed loop that is integrated with eco-industrial and natural systems; 2. dependence on renewable energy sources, and 3. the fostering of preservation of natural system functions. These objectives have also been applied to industries as part of Industrial ecology, where four cardinal rules can be hypothesized that should govern the flow of materials in the built environment along the lines of how ecological systems function (Kibert & Schultmann No date:5). These rules are referred to as the Cardinal Rules of the Construction Materials Cycle:

1. Buildings must be deconstructable,
2. Building products must be disassemblable,
3. Building product materials must be recyclable, and
4. The dissipation effects of materials recycling must be harmless.

In line with the above UN definition, considering a building only is not sufficient. Infrastructure is needed to provide energy, water and sanitation services. Several ideas were incorporated of which solar energy was a requirement in a land with an abundance of sunshine. As the most arid country south of the Sahara, water is an important consideration. Rainwater harvesting and dry sanitation were added to reduce water consumption. Community organizations requested conference facilities, which they could use, as part of the facilities. Dry sanitation was not considered as suitable for large numbers of people using the facilities in a short period of time. Therefore conventional flush toilet were used in the ablution blocks, but in order to avoid wasting the water, all were connected to a biogas plant, which in turn is connected to an artificially constructed wetland to treat the effluent.

3. The example of the HRDC

3.1 Functions and role of the HRDC

The operations of the HRDC had to consider a wide range of activities. The HRDC is an institution in which the public and private sector can participate, as well as NGOs active in housing and associated fields. This requires a transdisciplinary and transinstitutional knowledge generation approach to achieve the numerous objectives in the field of housing and its related issues.

a) Research:
The first priority is the gathering and analysis of information available inside and outside the country. For this skilled manpower (human resources) in the private, public and NGO sectors is required to facilitate the gathering, analysis and flow of information between professionals and users. Existing techniques, approaches or technologies have to be identified and tested. This process provides information on possible products and projects within the country, which could be implemented.
b) Development
Once enough information has been collected and evaluated, the development of materials, equipment, technologies, can commence to provide a basis for communities and small and medium scale entrepreneurs. This can be supported by adapting technologies and by networking with other institutions and partners.

c) Consultancy services
Once products have been researched and developed, consultancy services can be (and have been) provided by the HRDC, based on the experience gained and the available technology. This benefits individuals and communities, as the service is aimed at individual homebuilders (self-help); community facilities which can be built by communities (labour intensive projects); government projects, such as infrastructure provision or buildings. In general the HRDC offers the following services: consultancies relating to urban and rural development, housing, infrastructure, environmental issues, technology transfer, policy advice, and information services.

d) Marketing:
Two marketing strategies have to be considered once services and products are available: The first is product marketing, which aims at potential clients in the private and public sector, to make them aware what is available and what has been developed. The second is technology marketing, which targets entrepreneurs who can provide services and products to consumers.

The HRDC was also intended to be the site for a permanent exhibition of building products and technologies to encourage the private sector to use the Centre’s marketing opportunity and to have products and technologies tested in Namibia. This was a request made by smaller companies during the inception phase.

e) Skills Training:
Another area is the provision of training facilities at the HRDC and in co-operation with an existing training institution, to enable people to learn or upgrade skills in six to eight week courses. To support the informal sector, village based industries could be promoted by giving trainees the opportunity to manufacture their own tools and equipment and to repair them, even if they are living and working in a remote rural area by utilising locally available resources.

3.2 Embodied energy
The establishment of the HRDC was initially based on the fact that about 80% of building and construction materials were imported. It is a well-know fact that there are many resources in Namibia, which are not utilised. In 2002 the then Ministry of Regional and Local Government and Housing (MRLGH) supported the proposal to build a Centre, which will investigate and test alternative technologies, building materials and approaches. The latter included design and architecture with a focus on various types of energy inputs. This resulted in expanding the options to be considered, from available resources, e.g. clay and lime, to additional natural resources such as prosopis and local stone, to what is called waste. The latter included old tyres, building rubble, and metal drums.
The built environment has been more a part of the problem than the solution (Wines 2000:32). Architecture and environment are inextricably linked and their relationship is complex and multi-faceted (Jones 1998:15). The building of shelter, according to Wines (2000:9), consumes one-sixth of the world’s fresh water supply, one-quarter of its wood harvest, and two-fifth of its fossil fuels and manufacturing materials. Many resources on earth are regarded as finite, therefore, cannot be replenished. One of the most complex and problematic issues over the next century is how to construct a human habitat in harmony with nature (Wines, 2000:8). Even the most advanced designs are struggling with ways to integrate environmental technology, resource conservation, and aesthetic contents (Wines 2000:20).

Conventional building materials shown in table 1 consume enormous amounts of energy - non-renewable energy, except when recycled. Holtzhausen (no date:2) clarifies two types of embodied energy: 1. Initial embodied energy and 2. Recurring embodied energy. The first includes energy that is non-renewable and is consumed in the process from acquiring the raw materials to the construction of the building. Recurring embodied energy is non-renewable energy required for the maintenance, repair, restoration, refurbishment or replacement of materials, components or systems during a building’s life span. There are associated environmental implications of embodied energy. They comprise resource depletion, the production of greenhouse gases, maintenance of biodiversity, and environmental degradation.

One impact of building materials is related to embodied energy, which correlates with the amount of energy utilised to mine raw materials, transport them to a factory, manufacture a product, and transport the product to sellers and consumers. The Victoria University of Wellington (no date) shows some figures for selected materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>MJ/kg</th>
<th>MJ/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium, virgin</td>
<td>191</td>
<td>515,700</td>
</tr>
<tr>
<td>Aluminium, extruded, anodised</td>
<td>227</td>
<td>612,900</td>
</tr>
<tr>
<td>Aluminium, recycled</td>
<td>8.1</td>
<td>21,870</td>
</tr>
<tr>
<td>Cement</td>
<td>7.8</td>
<td>15,210</td>
</tr>
<tr>
<td>Soil-cement</td>
<td>0.42</td>
<td>819</td>
</tr>
<tr>
<td>Adobe block, straw stabilised</td>
<td>0.47</td>
<td>750</td>
</tr>
<tr>
<td>Insulation wool (recycled)</td>
<td>14.6</td>
<td>139</td>
</tr>
<tr>
<td>Paint, water based</td>
<td>88.5</td>
<td>115/I</td>
</tr>
<tr>
<td>PVC</td>
<td>70</td>
<td>93,620</td>
</tr>
<tr>
<td>Steel galvanised</td>
<td>34.8</td>
<td>273,180</td>
</tr>
<tr>
<td>Steel, recycled</td>
<td>10.1</td>
<td>37,210</td>
</tr>
<tr>
<td>Stone, local</td>
<td>0.79</td>
<td>890</td>
</tr>
<tr>
<td>Vinyl flooring</td>
<td>79.1</td>
<td>105,990</td>
</tr>
<tr>
<td>Zinc</td>
<td>51</td>
<td>364,140</td>
</tr>
</tbody>
</table>

*Table 1 - Embodied Energy Coefficients*
In addition to embodied energy, other types of energy were considered in the design, construction and use of the buildings, to address the conservation of each of these types of energy (Maritz, 2002):

- **Embodied energy:** consumed in the manufacture of building materials, components and systems.
- **Grey energy:** consumed in the distribution and transportation of building materials to the site.
- **Induced energy:** consumed during the construction of the building.
- **Operating energy** is used in running the building and its occupants’ equipment and appliances.
- **Added energy:** consumed in the building’s maintenance, alteration and final disposal.

4. **Lessons learned**

4.1 **Design and architecture**

The design took into consideration local aspects, such as rivers, small trees and bushes. The concept for this design revolved around three objectives (Maritz, 2002):

- To integrate architecture and landscape
- To relate to the scale of the local housing context, and
- To attempt a completely environmentally appropriate building as far as possible in the context of its Windhoek location and role in Namibia

With regard to the landscape, the buildings were designed to ensure that only a few plants had to be removed.

The office building was turned 25º east of north in order to incorporate passive responses to keep the buildings cool in summer and warm in winter. The north facing parts of externally fixed solar screens to the roof overhangs shade the offices. The positions of the sun during the various seasons are illustrated in Figure 2.

*Figure 2 – Sun positions during the year and on 21 June at 13h00*
Massive walls were intended to act as thermal buffers, preventing the building from heating up quickly in the summer and cooling down quickly in winter (Maritz, 2002). However, the external shading had a negative effect on inside temperatures in winter. As Figure 2 shows, the shading makes it impossible for thermal buffering to occur. Instead the walls remain cold. The orientation of the building worsens the situation, as it is turned towards the morning sun, which is a cold sun. The warm afternoon sun does not penetrate into the interior and therefore NO thermal buffering of the walls and floors occurs.

Passive solar design requires proper training and utilisation by the staff members, for example, curtains have to be withdrawn in winter to warm up the inside space. Contrary to the design principles of passive design, electrical coolers were installed in the offices. The public wing comprising the multi-purpose hall, library and exhibition hall, are cooled naturally by three windtowers, or badgir (see Section 5.1). They have proven to be very effective during summer. The rooms are cool, not cold, and have the added advantage that moist air, not cold and dry air, enters the halls. The wind towers have proven to be efficient enough, without using the installed backup system of electrical pump and sprayers. However, as no shutters or doors were installed to close the openings, the cooling effect is also maintained during winter.

4.2 Building materials

The construction of the HRDC integrated a wide range of building materials, ranging from industrial to natural. An overview of some of the most used materials will illustrate what has been incorporated:

Many industrial products can be recycled or reused. Examples of industrial materials are steel imported from South Africa, burned clay brick manufactured in Kombat and Mariental, or local ready mixed concrete. The HRDC obtained concrete test cubes from an engineering lab, which were used as paving for the entrance area. Steel is a material that can be reused for many purposes, such as gates and burglar proofing. Second hand door and window frames were extensively used.

Stabilised soil blocks were one of the most widely used wall materials in the construction
of buildings. The inventor of the machine (Hydraform) in Windhoek estimated that about 80% of all soils in Namibia are suitable for the usage as stabilised soil blocks. For the HRDC materials from a farm dam and the leftovers of road construction projects (fines) were used. For the first phase, the blocks used for the offices has a cement content of around 4-6%, whereas for the much higher walls at the public wing (library, conference room) about 6-8% were added. After the first blocks were manufactured on site during a fairly cold month of August, the tests after 28 days showed low compressive strengths, which was less than what was required. The curing period was extended and once the temperatures got higher, the compressive strength of the blocks was up to standard. Other wall materials include rammed earth walls for the exhibition hall, burned clay bricks, old tyres, sand bags, dry stone walls made from mica and building rubble from a demolished municipal flat building.

Clay has been utilised in various ways varying from burned bricks to adobe. Some foundations and walls were built with burned bricks from Namibian factories, which stated operations during the time when the HRDC construction started. Good quality clay does not require any additions in adobe construction. Reinforcement such as straw or grass can be added. For the construction of one of the ablution blocks, sand bags constituted the foundation and reinforced clay balls were formed by hand are then used to build the walls by twisting them to form a solid mass. Hydraform blocks also contain some clay.

Several walls and buildings were built entirely from old tyres, e.g. storerooms and a double garage. Several retaining walls were also constructed with tyres. The idea came from the USA, where buildings, constructed with tyres, are called Earthships. The concept was developed by Michael Reynolds near Taos, New Mexico, where communities of earthships have established themselves (GreenHomeBuilding.com, no date). The original design incorporates passive solar architecture, but also have built-in systems to take into account human needs (Ehrhardt 2000:26). They use the planets natural systems to provide all utilities - using the sun’s energy and rain to provide heat, power and water. They are buildings that heat and cool themselves, harvest their own water and use plants to treat their sewage (Low Carbon Trust, no date).

The German Technical Development Cooperation (GTZ) provided funding for building material research, in particular lime based materials, to assess geological resources, properties and the economic viability of products. Calcretes suitable for building purposes are widely distributed in the northern and eastern parts of Namibia (Epukiro), which were utilised from the end of the 19th century as dimension stones in several locations. These soft calcretes allow the artisanal shaping of building blocks with simple means, e.g. a panga. The extraction of these materials and the shaping of dimension stones are labour intensive and yield low recovery rates (GTZ, BGR, GSN & HRDC 2008:5-6). Once the research was completed, blocks were transported from the eastern part of Namibia to Windhoek.
A rondavel was built on the site of the HRDC, because the results from the research indicate that the “calcrete bricks and blocks are economically quite competitive compared to standard masonry materials on the market” (GTZ, et al. 2008:29).

The combination of the various building materials had one surprising effect - for all participants and visitors: at the end of the construction phases, money from the project funds was still available. There was no cost overrun, no request for additional funding. The reason - many materials were made available free of charge or at a very low cost.

5. Infrastructure

5.1 Water and sanitation

The roofs of most buildings are connected to water tanks to ensure rainwater harvesting. The rainwater of the public wing is collected for air conditioning purposes. Three wind towers or badgir were constructed, based on the age-old method originally created in Persia, nowadays Iran. According to Prof. Ghavami, this technology is up to 5,000 years old. At the top, a badger is usually open toward the direction of the favourable winds. In the case of the HRDC a basin was constructed at the bottom of the first floor of the tower, to hold the water. Wind blown into the tower during summer time is usually warm and dry. If this air makes contact with the water, evaporation takes place. The humid, cool and heavy air enters the adjacent rooms through an opening, resulting in comfortable inside temperatures. The opening should be closed during wintertime to avoid cold from entering the halls.

The first phase of the HRDC only utilised dry sanitation systems. Seven toilets were installed, consisting of two industrial units imported from South Africa and some experimental units, including a double-chamber composting toilet. The imported units are made from plastic materials, whereas the experimental units have pits built with cement bricks. It was found that these pits collected water, up to 14 centimetres per pit. This was the result of condensation. All pits and the imported units can be serviced from the outside. The experimental toilets had cast iron covers, where the condensation was observed. Therefore extractor fans were successfully installed to ensure a steady flow of air through the system to prevent condensation.

The final phase in construction consisted of two conference halls, which can accommodate up to 160 delegates, and four workshops. Due to the fact that dry sanitation systems are not suitable for a large numbers of users, e.g. during a tea break, it was decided to make use of flush toilets. All the toilets, and the showers at the workshops, are connected to a 10 cubic metre biogas plant. This has two purposes: 1. to produce biogas, and 2. to show that the remaining effluent (which contains a large volume of water) can be used, after treatment in an artificially constructed wetland, to produce food. This forms part of the promotion of EcoSan (ecological sanitation).

EcoSan offers an approach to combine several apparent disparate aspects, such as water, sanitation and food production. Several technological components can also be integrated to offer a paradigm shift away from the conventional sanitation approach,
i.e. waterborne sanitation. This is especially relevant in an arid country, because: 1. water is scarce and should not be wasted, 2. soils are usually poor and require fertiliser, 3. combining water and fertilizer can be useful in food production. Sunita Narain (2004:12) contends that in view of the water crisis of the world,

“we need policies and practices that augment, minimise and recycle the resource. It is on this yardstick, when we measure the modern sewage system, we will find it is ecologically mindless and inequitous. This is because:

• It is natural resource intensive: It uses materials, energy and generates waste. It has high environmental and health costs.
• It is highly capital intensive: It divides the urban population into rich and poor, that is, between people who can afford the expensive urban services and those who cannot”.

The various sanitation systems at the HRDC illustrate the fact that a large center can be independent from a municipal sewer network. Every aspect of sanitation can be handled on site. What is required is an attitude and confidence in what is regarded as waste is in fact a resource.

5.2 Energy

Due to the fact that Namibia has excellent solar radiation, solar technology was installed to generate electricity. For the Windhoek area a figure of 6.0 to 6.2 kWh/m2/day can be obtained. At present on a sunny day, the HRDC can run on 100% solar energy, if not too many activities take place. Excess energy is fed into the municipal grid and at night electricity from the grid is provided. This has the advantage that no batteries have to be used to store energy, as batteries are very environmentally unfriendly if not disposed properly and very expensive to replace. Shortly after completing the first phase, a local private school adapted the system for its school. Once feed-in tariffs are available in Windhoek the two institutions can generate electricity and a small income from selling electricity.

Solar energy is also used to obtain warm water for the kitchen by means of a solar water geyser. In addition the HRDC promotes solar cookers, which are manufactured in Namibia. A project is underway to utilise one of the workshops to produce box cookers locally as the suppliers do not meet the demand for these cookers.

Energy prices are increasing annually. In Namibia it is expected that parity will be reached shortly, i.e. the cost per unit from solar energy sources will be the same as for grid electricity. Thereafter grid electricity will become more expensive than solar energy. It therefore makes sense to invest in this technology.

Another versatile fuel is biogas. The plant at the HRDC is primarily used for educational purposes. This has generated interest by builders and several individuals, e.g. farmers. However, there are very few builders
in Namibia, capable of constructing a biogas plant. Such a plant requires quality work to ensure that the investment is worthwhile. To build capacity it is planned to cooperate with a network partner in Lesotho to provide the necessary training.

6. Education and training

6.1 Skills training in alternative materials and construction methods

The HRDC is constructed from a wide variety of materials, including non-conventional materials. Therefore the builders were not acquainted with many of the techniques. In-service training was as a consequence a key requirement. Initially frustrated with working with stabilised blocks, which do not require mortar, they struggled with the first few layers. Once they understood how to work with the blocks, one builder declared: I am building my house with these blocks. The construction process then proceeded to such an extent that it was ahead of schedule after a few weeks. The learning curve by the contractor was also evident. For the first construction phase stabilised soil blocks cost R3.50 per block, whereas in the final phase the costs dropped to less than 50%. The reason was that stabilised blocks were unknown to the main contractor, who therefore increased the price per block to cover the perceived risk. The same contractor also built the remaining facilities of the final phase, based on his earlier experiences.

During the final construction phase a group of trainees was included. They were trained in theoretical and practical aspects of construction, ranging from tyre construction to producing bags for insulating the ceilings. A private sector firm executed the training with experienced teachers. One of the halls was used as classroom and an outside area was constructed for practical exercises. Afterwards the trainees worked on the construction of various buildings.

Training and skills transfers are regarded as very important. Once the HRDC has established that a material, technique or technology is suitable, capacity building is required to have competent artisans, who can use these materials or methods. This is also part of marketing a product or technology. This has been successfully done by the Clay House Project, which constructed a clay house (compacted clay foundation and clay block walls) at the show house area of the HRDC.

6.2 Education and advocacy

The HRDC has one primary function: to educate. This is not limited to particular strata in society, but includes everyone from pre-primary school to university. Guided tours are one opportunity to show visitors the various materials, technologies and approaches. Some of these provided ideas, which were used in several tourism projects, such as construction of houses with bottles, sandbags, and tyres. The Shack Dwellers Federation of Namibia bought a block-making machine in July 2009, to manufacture stabilized blocks for its projects, after members were convinced that after five years at the HRDC the blocks were still in a very good condition.

One example may suffice to illustrate the process of promoting one of the items exhibited
at the HRDC. The Village Council of Aranos resettled 800 families to a new area in 2005. One problem was the provision of sanitation facilities. Representatives visited the HRDC several times to obtain information on the various systems. In 2006 Council requested a meeting in Aranos with the community to address the options available. The HRDC explained some options by means of lightweight plastic toilets and pictures. After explaining the options, community members stated that they could build one of the options – the Otji-toilet. The latter was designed and is constructed by the Clay House Project in Otjiwarongo. With the help of a project grant to promote these dry systems, where the local authority has to contribute 560 bricks and accommodation for one week to the training team, two units were build shortly after. In the following years the local authority employed these trained builders to construct additional toilets.

A project in northern Namibia intended to construct a building to house the offices of a community forestry programme. It was proposed to use clay as main building material. However, officials in Windhoek were critical. The clay house at the HRDC convinced them that the material was not inferior. The project was approved and the offices plus two Otji-toilets and a shop, to sell local handicraft, were constructed. With the support of the Clay House Project the office and toilets were constructed.

Education and advocacy includes cooperation with network partners in the private sector, local authorities, and organizations, such as the Shack Dwellers Federation of Namibia and the Clay House Project. Another activity is lecturing at educational institutions inside the country, but also on international level.

Education is of utmost importance if new concepts and their related technologies are advocated, for example, EcoSan. Avvannavar and Mani (2008:5) explain the reasons:

“Two sets of people can be classified based on the nature of association with nature in terms of handling human excreta. The first include the faecophilic, who consider human excreta as a part of a natural cycle and have evolved suitable mechanisms. The second include the faecophobic, who consider human excreta something to ‘stay away’ from and their sanitation approach reflects such a fear”.

Avvannavar and Mani point out that, a faecophilic believes that soil can take good care of human excreta by decomposition. If properly buried in hot-dry climates the faecal matter does not carry a bad odour, which is in line with modern findings that burial of excreta breaks the faecal-oral transmission and is nearly 100% safe mechanism of handling the need to construct latrines (Waterkeyn & Cairncross quoted by Avvannavar & Mani 2008:5). In predominantly agricultural countries, the practice to defecate in the fields returns human excreta to the soil. Winblad and Kalima (quoted by Avvannavar & Mani 2008:5) point out that, “Societies that have traditionally used excreta in agriculture (and even aquaculture) for thousands of years have been predominantly found to be high-density settlements in countries like India, China and South-East Asia”. Jenkins (2005:125)
underscores that this should provide a fairly convincing testimony about the usefulness of human “waste” as an agricultural resource.

The use of the term “waste” to describe recycled or recyclable materials “is an unpleasant semantic habit that must be abandoned” (Jenkins 2005:8). Winblad and Kilama (1978:22) propose that “waste” is a misleading term for excreta, kitchen refuse, crop and garden leavings. Therefore the term “waste” should in this case be replaced by “residue”. Unlike humans, Nature does not generate waste.

“We do not recycle waste. It’s a common semantic error to say that waste is, can be, or should be recycled. Resource materials are recycled, but waste is never recycled. That’s why it’s called ‘waste’. Waste is any material that is discarded and has no further use” (Jenkins 2005:7).

7. Policy formulation and consultancy work

As alternative technologies and approaches are at present not always well-known and understood, it is necessary to raise awareness and sensitise policy-makers on central and local levels. Therefore participating in the process of formulating policies is essential. Another possibility to disseminate and utilise experiences is in projects. A few examples may suffice.

In 2008 the Namibian cabinet requested a review of the 1993 water and sanitation policy. One central task was to suggest how the remaining bucket toilets in the country could be replaced. This resulted in a review of policy options available. The new policy incorporates principles in line with Integrated Water Resources Management (IWRM), dry sanitation and ecological sanitation as alternatives to the conventional waterborne systems. This was based on the experiences made by the HRDC with the various technologies and approaches. The policy also recommends that “community ownership and management of sanitation facilities should be adopted if the strategy of choice is a communally shared sanitation system, whether ecological, dry or water-borne sanitation” (Republic of Namibia 2008:11).

In order to implement the policy, government supported the formulation of a five-year national sanitation strategy in 2009, based on the policy’s indication that an operative strategy would guarantee safe and affordable sanitation, encouraging decentralised sanitation systems where appropriate. In addition the strategy should also promote recycling through safe and hygienic recovery and use of nutrients, organics, trace elements, water and energy or the safe disposal of all human and other wastes” (Republic of Namibia 2008:4). The implementation of the national sanitation strategy started in 2010 with a focus on reorganising the lead agency in the Ministry of Agriculture, Water and Forestry, and capacity building efforts. Educational activities have been incorporated, as communities, residents and decision-makers have to be educated on the various alternative sanitation options available. To support these endeavours, various publications are being prepared with the assistance of the HRDC.
With regard to consultancies and advice, several projects can be mentioned. The HRDC conducted stakeholders’ consultations to gauge current awareness, knowledge and practices with different rainwater harvesting mechanisms in Namibia. The ultimate aim will be a situation analysis report capturing the main barriers to the adoption of rainwater harvesting in Namibia with a special case study of the Khomas Region. The purpose of rainwater harvesting is to provide water to those who are not served by a communal system.

An investigation in the eastern parts of Namibia investigated the opportunities for the introduction of water recycling technology, rainwater harvesting technology and solar technologies in two communities in the Omaheke Region, with the aim to improve the supply of affordable water for irrigated food production systems.

A study tour to various locations was undertaken to learn about different sanitation options as part of the Service Delivery Promotion Project (SDPP). Members of this team meet to exchange experiences and discuss problems relating to cost reductions in the servicing of land and to provide low income areas in towns with sanitation. Therefore the team members undertook an Alternative Toilet System Study Tour to familiarise themselves with different sanitation systems, such as in Aranos (dry sanitation), Gibeon (vacuum system) and Mariental (urine diversion system).

8. Constraints and opportunities

8.1 Constraints

It has to be accepted that not everyone can get an all the alternatives. There are not enough resources available – suitable clay deposits are not found everywhere, old tyres are not available everywhere, second-hand items cannot be purchased everywhere, and knowledge is not accessible everywhere. Capacities in using alternatives for formal housing are lacking on all levels. Therefore training and skills transfer are needed in the promotion of non-conventional approaches. Affordability, skills, and quality of the final product or service has to be ensured.

With regard to natural resources, resource availability and harvesting rates have to be taken into consideration. It is impossible that everyone on Earth can have access to all the options described. With the still exploding global population growth rate, resources become less not more. A state of overpopulation cannot solve any problem. As Miller (1996:22) points out, “People overpopulation exists when there are more people than the available resources can support at a minimal level”.

E.O. Wilson stresses that if each person currently alive would attain the US level of consumption, it would require four more Earths (Wilson 2002:150). These additional issues should be addressed in order to broaden the basis for the promotion of alternatives, but a critical mass of progressive minds is lacking. Another question is whether so-called leaders or decision-makers understand technologies and natural processes.
They often have a one-dimensional view or too many other important priorities, which require their attention. During the 2008 Windhoek sanitation policy workshop, several gaps and challenges were identified, which can be applied to other areas too, such as it is easy to write the policy, but it is difficult to implement the policy effectively, as it

- requires political will,
- requires coordination,
- requires understanding of principles,
- requires institutions to assume duties or responsibilities.

Alternatives need to be incorporated in formal education, ranging from vocational training to tertiary institutions. The Ugandan Minister Mutagamba (2004:9) acknowledges that, politicians have to carry out advocacy work, however “we also need to be trained for that, we need information that will help us sensitise the masses out there”. Education and acceptance of alternatives go hand in hand. During field work, in connection with the implementation of the national sanitation strategy, school teachers requested more literature on alternative sanitation, as the available school books did not provide the necessary details.

8.2 Opportunities

The two major phases of construction has one aspect in common: at the end of each phase there was still money available, despite that fact that the HRDC is a government funded project and experienced bureaucratic delays. The reason is simple: the team involved constantly looked for resources, which could be used. When the municipality demolished a flat building, contacts were made to enquire about the fate of the materials, e.g. building rubble, window and doorframes. The latter two were to be kept in store for a community project, whereas the rubble was to be dumped at a landfill site, as it was regarded as useless waste. Cooperating with the municipal department and the contractor the rubble was transported to the HRDC site, where it was reused in gabions and cement bricks were reused in walls. Similarly when a service station was built close to the site the natural stone (mica) left from the excavations for the petrol tanks were brought to the HRDC site – all free of charge.

When the construction of the HRDC started, the municipality issued a directive that all old tyres had to be transported to the main landfill site, where a fee of R7.50 per tyre was charged. This resulted in many tyres were disposed in the veld around Windhoek. When the HRDC offered to take the tyres free of charge, hundreds were delivered to the site. They were incorporated in the construction of retaining walls, and buildings such as walls for storerooms and the double garage. Farmers in the southern parts of Namibia provided sheep wool, Grade 3, which was regarded as useless due its poor quality, but it was utilised in the construction as an insulating material between the roof sheets and the ceiling.

The question could be asked: what is the value of alternatives? Alternatives provide choices, they can support efforts of employment creation, they can utilise locally available materials. Most governments are interested in creating
employment opportunities. Government has, for example, provided funding to train young school leavers in various skills. A group was trained as masons in 2010 at the HRDC. A private contractor provided them with the chance to gain practical experiences at one of his building sites what they have learned as interns. This cooperation of public and private institutions shows that there is an untapped potential of advancing local opportunities.

9. Conclusion

Most of the HRDC design is in accordance with concepts such as alternative technology and Green Architecture, by utilising locally available materials, recycling materials, environmental benefits are derived, and taking environmental aspects into consideration in the design and during the construction process.

The work done by the HRDC has found its way into projects, policies, and education. In addition, requests are made by individuals or organisations, who plan to build an own house, an office, to provide information on materials and builders. Cooperation with NGOs has resulted in additional projects on site, for example, recycling paper and gardening (urban agriculture). Another success is the fact that more and more organisations are using the HRDC as a conference or workshop venue, because it provides a different working atmosphere. The HRDC has been presented on TV, in newspapers and magazines on national and international level.

The HRDC demonstrates that many alternative technologies and approaches are feasible and effective. Due to the many problems found in the field of housing, it is necessary to offer choices and to understand these alternatives. The inclusion of choices in projects, policies and educational activities illustrates that these products or approaches are not inferior. Why is the HRDC doing this? Albert Einstein provides the answer:

“The significant problems we face cannot be solved at the same level of thinking we were at when we created them”.

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Sustainable Development Criteria for Built Environment Projects in South Africa (CSIR)

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1 Introduction

South Africa faces a range of social, economic and environmental challenges. HIV/AIDS has resulted in life expectancy dropping from 52 years in 1997 to 43 years in 2007 (Harrison 2009). Unemployment is estimated to be 23.5% and about 6.7 million people in South Africa are functionally illiterate (Presidency 2009, DoE 2009). Climate change is likely to make this situation worse and will lead to increasing water stress, reduced food security and loss of species and ecosystems (DEAT 2009).

Sustainable development, which aims to achieve social and economic improvement while reducing, or avoiding, negative environmental impacts can be used to address these challenges. However sustainable development is difficult to achieve. It requires a holistic and integrated approach and the development sector and in particular, the construction industry, tends to operate in a highly fragmented way. The application of sustainable development is also not well understood and has not been adequately translated into practical actions that can be implemented.

This paper is based on work undertaken for the Gauteng Department of Agriculture and Rural Development (GDARD) developing a set of sustainable development criteria for built environment projects requiring environmental impact assessments. (Gibberd 2010). Some aspects therefore refer specifically to Gauteng-based policy, although the general principals of the work are applicable to other areas of South Africa. The paper provides a definition of sustainable development and shows how this can be translated into objectives and criteria which can be used to guide the development of more sustainable built environment projects.

2 The environmental context

Increasing carbon emissions from human activities and a reduction in the ability of the natural environment to absorb carbon dioxide is leading to an accumulation of greenhouse gases in the upper atmosphere. These gases trap more heat in the upper atmosphere leading to global warming. As a result, temperatures are predicted to increase by 2 - 6°C OC by the end of the century (IPCC, 2007). Estimates carried out for the City of Joburg indicate that temperatures in the next 50 years may increase between 2 and 3.5°C (Hewitson, Engelbrecht, Tadross, Jack, 2005).

Within Africa, South Africa produces the highest CO$_2$ emissions and has one of the highest CO$_2$ emissions per GDP in the world.
In 2002, carbon emissions per capita in South Africa were 8.4 tonnes/capita - higher than Western European averages of 7.9 tonnes/capita (SEA 2006).

Global warming is likely to impact Africa particularly negatively. The National Climate Change Response Policy developed by the Department of Environment and Tourism outlines the following impacts (DEAT 2009a):

- Agricultural production and food security in many African countries are likely to be severely compromised by climate change and variability. Projected yields in some countries may be reduced by as much as 50% in some countries by 2020 and as much as 100% by 2100. Small scale farmers will be most severely affected.
- Existing water stresses will be aggravated. About 25% of Africa’s population (about 200 million people) currently experience high water stress. This is projected to increase to between 75-250 million by 2020 and 350-600 million by 2050.
- Changes in ecosystems are already being detected and the proportion of arid and semi-arid lands in Africa is likely to increase by 5-8% by 2080. It is projected that between 25 and 40% of mammal species in national parks in sub-Saharan Africa will become endangered.
- Projected sea-level rises will have implications for human health and the physical vulnerability of coastal cities. The cost of adaptation to sea level rise could amount to 5-10% of gross domestic product.
- Human health will be negatively affected by climate change and vulnerability and incidences of Malaria, Dengue fever, Meningitis and Cholera may increase.

3 The contribution of the built environment

Construction and the built environment make a substantial contribution to global warming and play a significant role in most economies. Environmental, social and economic impacts attributed to the built environment at a global scale are outlined below.

- Consumes 40% of energy use,
- Consumes 17% of fresh water use,
- Consumes 25% of wood harvested,
- Consumes 40% of material use
- Employs 10% of the world’s workforce
- Construction is the largest employer of micro-firms (less than 10 people)
- Buildings are typically located on the most productive land (Estimated to be 250 million hectares world wide, mostly on primary agricultural land)

In South Africa the built environment is directly responsible, through electricity consumption, for over 23% of South Africa’s carbon emissions (see table below). Vehicle-based infrastructure and transport planning has resulted in transport contributing to 16% of South Africa’s CO₂ emissions and an additional 18mt CO₂ per year, or about 4% of South Africa’s CO₂ emissions, come from the manufacture of building materials (CIDB 2009).
Defining sustainability

Recent work by the World Wildlife Fund contributes substantially to defining sustainable development by providing quantified minimum criteria for sustainability. In the 2006 Living Planet Report, sustainability is defined as achieving an Ecological Footprint (EF) of less than 1.8 global hectares per person and an Human Development Index (HDI) value of above 0.8 (WWF 2006). This is shown by the shaded rectangle in the graph below.

<table>
<thead>
<tr>
<th>Sector</th>
<th>CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>10%</td>
</tr>
<tr>
<td>Residential</td>
<td>13%</td>
</tr>
<tr>
<td>Transport</td>
<td>16%</td>
</tr>
<tr>
<td>Industry</td>
<td>40%</td>
</tr>
<tr>
<td>Mining</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 1: South African carbon emissions per sector

Figure 1. Human Development and Ecological Footprint (WWF 2006)
Ecological Footprint

An Ecological Footprint is an estimate of the amount of biologically productive land and sea required to provide the resources a human population consumes and absorb the corresponding waste. These estimates are based on consumption of resources and production of waste and emissions in the following areas:

- Food, measured in type and amount of food consumed
- Shelter, measured in size, utilization and energy consumption
- Mobility, measured in type of transport used and distances traveled
- Goods, measured in type and quantity consumed
- Services, measured in type and quantity consumed

The area of biologically productive land and sea for each of these areas is calculated in global hectares (gha) and then added together to provide an overall ecological footprint. This measure is particularly useful as it enables the impact of infrastructure and lifestyles to be measured in relation to the earth’s carrying capacity of 1.8 global hectares (gha) per person.

The Human Development Index

The Human Development Index was developed as an alternative to economic progress indicators and aimed to provide a broader measure that defined human development as a process of enlarging people’s choices and enhancing human capabilities (United Nations Development Programme 2007). The measure is based on:

- A long healthy life, measured by life expectancy at birth
- Knowledge, measured by the adult literacy rate and combined primary, secondary, and tertiary gross enrolment ratio
- A decent standard of living, as measure by the GDP per capita in purchasing power parity (PPP) in terms of US dollars

South African EF and HDI figures

The figures below show that South Africa has an ecological footprint of 2.1, above the maximum required of 1.8 gha and a human development index measure of 0.66, below the minimum of 0.8 required for sustainability.

<table>
<thead>
<tr>
<th>Measure</th>
<th>South Africa</th>
<th>Sustainability Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Footprint (gha)</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Human Development Index</td>
<td>0.658</td>
<td>0.8</td>
</tr>
</tbody>
</table>

For South Africa to move towards sustainability there must therefore be an improvement in both the Ecological Footprint and Human Development Index performance.
5 The legislative and policy context

South Africa has legislation and policy that aims to protect the environment and support sustainable development. Examples include the South African Constitution and the National Environmental Management Act (NEMA) which are discussed briefly below.

South African Constitution

The South African Constitution contains a Bill of Rights that enshrines the rights of all people in South African and affirms the democratic values of human dignity, equality and freedom. The Bill has sections covering equality, human dignity, privacy, freedom of religion belief and opinion, environment, property, housing, healthcare, food, water and social security, children, education, language and culture. Through a section on equality, the Bill requires that all people have full and equal enjoyment of these rights and freedoms:

Everyone is equal before the law and has the right to equal protection and benefit of the law.

Equality includes the full and equal enjoyment of all rights and freedoms. To promote the achievement of equality, legislative and other measures designed to protect or advance persons, or categories of persons, disadvantaged by unfair discrimination may be taken.

Environmental rights in the Bill of Rights include the right to an environment that supports health and well being. It also requires legislation to be developed to ensure that the environment is protected and that development that does occur is both sustainable, and justifiable:

24. Environment

Everyone has the right

a. to an environment that is not harmful to their health or well-being; and

b. to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that

i. prevent pollution and ecological degradation;

ii. promote conservation; and

iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development

Sustainable development and the protection of the environment is therefore a constitutional obligation, and government and society must ensure that this is fulfilled through ‘reasonable legislative and other measures’.

Section 24 also refers to a requirement to ‘secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development’. Within the context of the Bill of Rights, justifiable economic and social development can be interpreted to define development that promotes the achievement of other rights in the Constitution such as the equality, housing, healthcare, food, water and education. Within this paper this interpretation is used to suggest that development that helps to fulfill

2Human Development Report 2006, United Nations Development Programme
3Section 9 of the South African Constitution
The National Environmental and Management Act

The National Environment and Management Act include a set of principles that specifically address sustainable development and environmental management (DEAT 1998):

(2) **Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.**

(3) **Development must be socially, environmentally and economically sustainable.**

(4) (a) Sustainable development requires the consideration of all relevant factors including the following:

(i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;

(ii) that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;

(iii) that the disturbance of landscapes and sites that constitute the nation’s cultural heritage is avoided, or where it cannot be altogether avoided, is minimised and remedied;

(iv) that waste is avoided, or where it cannot be altogether avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;

(v) that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;

(vi) that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;

(vii) that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and

(viii) that negative impacts on the environment and on people’s environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.

This Act makes it very clear that there is a requirement for projects to be ‘socially, environmentally and economically sustainable’. However it does not provide much further detail on what this entails. This makes it both difficult to interpret, and to enforce.

The sustainable development criteria listed later in this paper are an attempt to describe this requirement in the form of a set of criteria that can be used by both government and the private sector to guide the integration of

*Section 24 of the South African Constitution*
sustainable development into built environment projects.

### 6 Carbon emission mitigation strategies

South Africa is a signatory to both the United Nations Framework Convention on Climate Change (UNFCC) and the Kyoto Protocol. In order to address UNFCC commitments the Long Term Mitigation Scenarios (LTMS) process was initiated in 2006 and completed in 2008. This formulated strategies to ensure that South Africa would reduce carbon emissions. Many of the mitigation strategies identified have implications for the built environment and a number of these are outlined below (DEAT 2009b):

- Limits on less efficient vehicles
- Passenger modal shift
- Solar water heater subsidy
- Commercial efficiency
- Residential efficiency
- Renewables with learning
- Waste management
- Land use: afforestation
- Escalating CO$_2$ tax

Following the LTMS process, key policy approaches were agreed on by the South African cabinet. These strengthen current energy efficiency and demand-side management initiatives such as environmental fiscal reform and carbon taxation. These will penalize energy inefficient technology and provide for additional tax allowances of up to 15% for energy efficient equipment.

![Figure 2. Strategic options to get from ‘Growth without Constraints’ to ‘Required by Science’ (DEAT 2007).](image-url)
The LTMS showed that although significant emission reductions can be gained through technology-based actions, these are not sufficient for the scale of change required to achieve the ‘Required by Science’ trajectory shown in the graph above.

Adaptations in social behavior were therefore also explored and the LTMS proposes a number of people and building orientated measures that achieve low-cost, large scale mitigation impacts (DEAT 2009c). These include:

- Social adaptation and changes in human habitation, urban planning and the built environmental
- Changes in the distance between work, home and other life functions
- Modal shifts to public transport and moves away from individual car owners towards the operation of shared vehicles
- Changes in food production and consumption and the localization of these activities.

The LTMS is valuable because it provides direction for the future development of the built environment. By presenting the scale of the problem, it communicates the necessity for immediate change and the requirement for a paradigm shift in the way we design and manage the built environment. It also demonstrates that technological interventions are not sufficient.

### 7 Built environment sustainable development objectives and criteria

The environmental context, legislation and scenario modelling indicate that it is essential that the built environment support sustainable development. Supporting sustainable development in the built environment will require measures that can be easily understood, and implemented.

This section of the paper proposes a set of sustainable development objectives for the built environment. These objectives aim to ensure that the built environment supports sustainable development as defined earlier in the paper. Linked to each of these objectives are criteria which list key measures which, if implemented, will support the achievement of the overarching sustainable development objective.

### 8 Land Use and Integrated Development

**Objective:** Development should be integrated with existing and planned infrastructure and land uses to ensure efficient systems and balanced use of land.

**Criteria**

- **Spatial Development Frameworks:** Proposed development can demonstrate it is aligned with Spatial Development Frameworks.
- **Environmental Management** Frameworks: Proposed development can demonstrate that it is aligned with
relevant Environmental Management Frameworks.

- **City Development Strategies:** Proposed development demonstrates it aligns with relevant city development strategies.

- **Urban development boundary:** Proposed development can demonstrate that it is within the urban development boundary.

- **Existing and planned infrastructure:** Proposed development can demonstrate it will be integrated into and use existing or planned infrastructure such as roads, storm water and sewage systems and water and energy supplies. Studies have been carried out to demonstrate there is adequate capacity in these systems and proof that the Local Authority accepts these findings.

- **Public transport networks:** Proposed development demonstrates access to the site can be easily achieved through existing or proposed public transport systems (see also TR, Transport and Routes).

- **Complementary social and economic land uses:** Development demonstrates that it will complement local land uses.

- **Building density:** Development demonstrates that it will exceed the minimum building density requirements of relevant local policy and planning schemes.

- **Open space:** The nature and type of open space provision in the development is aligned with local planning, policy and bylaws. Development includes the following minimum open space provision.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Open space provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>20% of site area</td>
</tr>
<tr>
<td>Other Residential</td>
<td>20% of site area</td>
</tr>
<tr>
<td>Business</td>
<td>20% of site area</td>
</tr>
<tr>
<td>Industrial</td>
<td>20% of site area</td>
</tr>
</tbody>
</table>

Where open space provision is specified by local municipalities these can be aligned with in preference to the above requirements.

9 **Biodiversity**

**Objective:** Development should be located where damage to natural environments and ecosystems is minimised. It should ensure that existing natural environments are preserved and take opportunities to strengthen this.

**Criteria**

- **Sensitive areas:** Proposed development demonstrates that it does not include any areas that could be defined as sensitive. If the development does include areas that may be defined as sensitive, the project demonstrates full compliance with all requirements of the
GDACE Requirements for Biodiversity Assessments (GDACE 2008).

- **Development on ridges:** Proposed development demonstrates that no development will occur on ridges. If the proposed development does occur on a ridge, the development will indicate classification of affected ridge and demonstrate that conditions in Departmental Policy Development Guidelines for Ridges will be achieved (GDACE 2001).

- **Greenfield sites:** Proposed development can demonstrate that the site that will be used is not a greenfield site and does not provide valuable ecosystem services. The site proposed has been previously been built on or is already extensively disturbed. Where part of a proposed site is in a green field condition the proposed development retains and protects this within the proposed development.

- **Site clearing:** Design and contract documentation indicating the following considerations:
  - **Site clearing:** Large-scale clearing of the site is avoided and the area disturbed by development is minimized.
  - **Mature trees and natural features:** Mature trees and natural features such as large rocks or outcrops are retained (see also MC Materials and Construction for protection measures). Exceptions to this are trees which are invasive species and trees which are incompatible with the relevant town planning scheme.

- **Existing vegetation:** Where existing indigenous vegetation is to be cleared and is of an appropriate quality, plants should be rescued and replanted, or propagated and replaced.

- **Locally indigenous planting:** Planting scheme including locally indigenous plants proposed for the development. This demonstrates how local biodiversity and the creation of habitats will be supported.

### 10 Agriculture and Landscaping

**Objective:** Development should not lead to a loss of agricultural land. Appropriate agriculture and landscaping should be integrated in developments to improve the provision of local fresh food and ecosystem services.

- **Retention of agricultural land:**
  Development should avoid sites with high agricultural potential and ensure that this land is retained for farming. The proposed development does not encroach on land identified by The Gauteng Agricultural Potential Atlas (GAPA) as land with high agricultural potential. Exceptions to this include land within the Urban Edge that has high development potential such as land located in a development node. Development nodes are defined in local Spatial Development Frameworks (SDFs).
- **Environmental impacts of agriculture**: Management plan that ensures that negative environmental impacts of agriculture are minimized. This may include plans to manage and monitor agricultural inputs, such as fertilizer, herbicides and pesticides, in order to minimize negative environmental impacts. The use of organic and labour intensive farming methods.

- **Degraded or contaminated sites**: The proposed development is located on a degraded or contaminated site. Proposed remediation and improvement processes are outlined.

- **Planting**: The proposed development demonstrates how planting will be effectively integrated into the site. Planting will be determined by local circumstances, however the following guideline provision is proposed.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Planting provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>Minimum of 1 indigenous or fruit tree per unit</td>
</tr>
<tr>
<td>Other Residential</td>
<td>Minimum of 1 indigenous or fruit tree per unit</td>
</tr>
<tr>
<td>Business</td>
<td>Minimum of 1 indigenous or fruit tree per 200m² of gross floor area</td>
</tr>
<tr>
<td>Industrial</td>
<td>Minimum of 1 indigenous or fruit tree per 300m² of gross floor area</td>
</tr>
</tbody>
</table>

Other planting instead of trees also meet this criteria if they are deemed to be equivalent alternatives. Equivalent alternatives to the provision to 1 tree are: 5 m² (area) of indigenous grasses, shrubs, or other plants or 5m² of food gardens.

- **Green roofs**: Proposed development demonstrates that the vegetation lost through development, or a substantial portion of this (over 40%) will be replaced in the form of green roofs.

- **Hard external surfaces**: Large areas (over 500m²) of impermeable external hard surfaces are avoided. This does not apply to strips of hard external surfaces (less than 15m in width) such as those used for roads and paths.

- **Environmental impacts of landscaping**: Management plan that ensures that negative environmental impacts of landscape maintenance are minimized. This may include plans to use landscaping that has minimal irrigation requirements, and to manage and monitor landscape inputs such as fertilizer, herbicides and pesticides in order to minimize negative environmental impacts. It may also include the use of organic and labour intensive methods.

### 11 Water, Sewage and Storm Water Runoff

**Objective**: Development should minimise the consumption of municipal potable water and the disposal of sewage into municipal systems. Increased storm water runoff and water pollution should also be avoided.

**Criteria**

- **Water efficient fittings**: Efficient water fittings should be used in new
development to avoid wasting potable water.

- Shower heads have a maximum flow rate of 10L/minute
- Wash-handbasins taps have a maximum flow rate of 6L/minute
- Toilets are not water based or are dual flush and do not exceed 3L (1/2 flush) and 6L (full flush)
- Waterless urinals are used or these have a maximum flush of 2L/flush.

- **Rainwater harvesting**: Development demonstrates how it will use rainwater harvesting to reduce mains potable water consumption and include the following minimum provision. Where possible this capacity should be increased.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Minimum rainwater harvesting capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>40L/m² of gross floor area</td>
</tr>
<tr>
<td>Other Residential</td>
<td>40L/m² of gross floor area</td>
</tr>
<tr>
<td>Business</td>
<td>20L/m² of gross floor area</td>
</tr>
<tr>
<td>Industrial</td>
<td>10L/m² of gross floor area</td>
</tr>
</tbody>
</table>

The above capacity can be provided individually (per building) or collectively in larger storage facilities such as large underground tanks.

- **Grey water**: Eighty per cent of wash hand basins and showers are linked to grey water systems.
- **Sewage**: Water efficient fittings (see above) are installed to reduce production of sewage. Where there is adequate space the proposed development uses ecological local sewage treatment plants that ensure that sewage can be treated locally and provides useful outputs such as fertilizer. Plan to show how treated effluent will not cause negative environmental impacts. This criterion can be deemed ‘not applicable’ if confirmation from the local authority has been provided stating that it will not accept onsite ecological sewage treatment plants.
- **Storm water runoff management**: Sustainable urban drainage systems (SUDS) including swales, filter strips, retention ponds, infiltration trenches, green roofs and permeable paving are used to avoid polluting storm water runoff and control storm water runoff from site. Calculations and or modeling to show how SUDS will function to reduce peak flows, ensure onsite retention and avoid water pollution. This should include data such as climatic information, infiltration potential of surfaces, capacity of rainwater harvesting systems as well quantitative performance of SUDS components such as attenuation ponds and swales. requirements are specified. Exotic plants with high water requirements are avoided.
- **Low water requirement planting**: Locally indigenous plants with low
water requirements are specified. Exotic plants with high water requirements are avoided.

- **Irrigation water**: Efficient irrigation system linked to controls which ensure irrigation does not occur when it is not needed and irrigation occurs when evaporation losses are lowest. As far as possible, water for irrigation is sourced from grey water or rainwater harvesting systems. This criterion does not apply to agricultural irrigation.

### 12 Materials and Construction

**Objective**: Development should minimise the negative environmental impacts of construction and the consumption of resources. Positive social and economic impacts of construction and resource use should be maximised.

**Criteria**

- **Sourcing of building materials**: Procurement policy requiring twenty per cent of materials (such as bricks, sand and cement) by weight used in construction to be sourced within 400km from site.

- **Sourcing of components and equipment**: Procurement policy requiring twenty per cent of equipment and components (such as electrical, mechanical and wet services materials and equipment and components such as doors and windows) by value to be sourced from within 400km of site.

- **Local jobs**: Procurement policy that requires eighty per cent of construction workers to be sourced within 50km of site.

- **Labour intensive construction**: Design and construction strategies support the use of labour intensive approaches. Targets in terms of person years of construction work created per million rand construction spent should be provided showing how these compare favourably with best practice benchmarks. Best practice benchmarks can be obtained from organisations such as the Development Bank of South Africa and the Department of Public Works (Expanded Public Works Programme). Compliance with the Construction Industry Development Board (CIDB)'s labour intensive construction guides including ‘Labour-based methods and technologies for employment intensive construction works’ and ‘Implementing labour intensive road works’ (CIDB 2005, CIDB 2007).

- **SMME support**: Procurement policy supports the use of small and medium enterprises based within 50km of site. Compliance with the CIDB’s guide for small and medium enterprises and contracting ‘3 R’s basic guide for SMMEs’ (CIDB 2003).

- **HIV / AIDs**: Construction planning and contract documentation for the development comply with the ‘Specification for HIV/AIDs awareness’ (CIDB 2003a).
Material selection: Design specifications and contract documents reflect the following material selection considerations.

- Embodied energy: Preference is given to materials that have consumed the least amount of energy in their sourcing, manufacturing and transportation.

- Reused materials: Reused materials such as materials from the demolition of buildings, including crushed aggregate is used in new construction.

- Recycled content: Preference is given to materials that have recycled content over those that do not.

- Renewable sources: Checks and accreditation is in place to ensure that materials specified, such as timber, are from renewable sources. For instance, timber with Forest Stewardship Council (FSC) certification comes from forests where trees are replanted.

- Grown materials: Where possible, renewable grown materials such as timber, thatch, wool and cork are used in construction.

- Insulation: Insulation that contains refrigerants or uses refrigerants in its manufacturing process is avoided.

- PVC: The use of PVC based materials and components is avoided or minimised.

- Construction waste: A requirement for at least thirty per cent of all construction waste to be recycled or reused is included in contractual documentation.

- Soil retention: Construction and contract documentation indicating the following considerations:
  - Movement of earth: Large-scale cut and fill operation and movement of earth is avoided.
  - Soil erosion: Soil erosion and sediment control plan for construction works which indicate measures such as mulching, seeding, vegetative filter strips, gabions and retention ponds to prevent soil erosion.
  - Retention of topsoil: Where top soil is removed this is reused on site and not transported elsewhere.

- Protection of vegetation and natural features: Construction and contract documentation provide for protection measures such as buffers, fencing and signage around trees, vegetation and natural features being retained on site.
13 Energy, Mechanical and Electrical Systems

Objective: Development should minimise the use of non-renewable energy and maximise use of renewable energy sources.

Criteria

• **Urban heat island**: Roof and external hard surfaces have absorptance value of less than 0.5. For further information see ‘SANS 204, Energy Efficiency in Buildings’ standard (SABS 2009).

• **Urban heat island**: Large areas of car parking or hard external surfaces (over 500m²) should be avoided. If these cannot be avoided, a minimum of 20% of the area should be shaded, preferably by trees.

• **Site layout**: Site layouts and modeling demonstrate that buildings have good access to fresh air, views and daylight. A minimum of 4m of clear external space (vegetation and open fencing can be located in this area but not solid walls or other buildings) immediately in front of windows in useable spaces should be provided. This does not apply to rooms not occupied on a continuous basis such as storerooms and toilets.

• **Orientation**: The long section of buildings should be orientated to +/- 15 degrees North and the extent of the façade facing north should be maximized while the length of façade facing east and west should be minimised.

• **Built form**: Building plan depths should not exceed 15m, unless buildings have substantial atria or their particular function ie a cinema, requires this.

• **Glazing**: Solar shading and glazing designed to comply with ‘SANS 204 Energy Efficiency in Buildings’ standard (SABS 2009).

• **Thermal insulation**: Insulation values of all elements of the building envelope (roof, wall and floors) meet ‘SANS 204 Energy Efficiency in Buildings’ standard (SABS 2009).

• **Natural ventilation**: Opening area in building envelope (such as opening windows) equivalent to a minimum of 5% of useable area.

• **Daylight**: Daylight modeling showing that eighty per cent of useable area within buildings has a 2% or higher daylight factor. A deemed to satisfy condition for this can be achieved where eight per cent of the useable area can be shown to be within 2h of an external window, where h is the height of the head of the external window.

• **Passive environmental control**: Proposed buildings demonstrate use of passive environmental control strategies to reduce energy consumption.

• **Water heating**: Water heating is achieved through solar water heaters or other energy efficient means of heating water provided.

• **Electrical lighting**: Internal electrical lighting power densities in the development comply with ‘SANS 204, Energy Efficiency..."
in Buildings’ standard

• **Electrical lighting:** Lighting controls such as motion sensors, timers and daylight switching are used to ensure lighting is only on when needed.

• **Swimming and ornamental pools:** Avoidance of swimming or ornamental pools, unless these have no energy demands or these are met from renewable energy sources.

• **Energy consumption and peak demand:** Proposed development confirms that it will comply with ‘SANS 204 Standard on Energy Efficiency in Buildings’ standard and achieve energy consumption and peak demand targets.

• **Renewable energy:** New development demonstrates that 10% of its energy requirements will be met from onsite renewable sources. Where possible this capacity should be increased.

14 Waste and Pollution

Objective: New developments should minimise the amount of waste diverted to landfill. Pollution should also be avoided.

Criteria

• **Recycling provision:** Provision for waste recycling made in the new development including recycling space of sufficient size and appropriately located for ease of use by occupants and recyclers.

• **Organic waste:** Where possible, development proposals demonstrate how organic waste produced on site, is recycled on site.

• **Recycling plans:** Recycling plan which sets out waste minimization, reuse and recycling targets and describes strategies and systems that will be used to achieve these including local recycling partners.

• **External lighting:** Low level lighting and light fittings with hoods are used to avoid light pollution. In addition controls such as timers and movement sensors are used to ensure lighting is only on when needed.

15 Local Economic Development

Objective: Development should support diverse productive local economies that create work and sustainable enterprises.

Criteria

• **Small enterprise development:** The proposed development demonstrates that it will support existing or new small or micro enterprises.

• **Job creation:** The proposed development demonstrates that it will support a labour intensive approach and shows how employment created will be in line with local best practice.

16 Transport and Routes

Objective: Development should reduce the reliance on cars and ensure that energy efficient, environmentally friendly forms of transport are encouraged.
Criteria

- **Public transport:** Development demonstrates that people who work or live in the development are located within 1,200 m of scheduled public transport (bus or train). Where public transport is not available, a green transport plan is developed which demonstrates how car usage will be avoided and energy efficient transportation used. This could include agreements with local minibus or bus operators and provide details on how other criteria in this section would be achieved.

- **Walking:** Provision of dedicated accessible pedestrian paths on the site linking buildings to each other and to public transport nodes on public highways.

- **Cycling and walking routes:** Cycle routes along dedicated cycle paths and clearly demarcated cycle lanes are provided for at least the equivalent length of vehicular roads provided within the estate. Cyclist and pedestrians are given priority at all crossing points and junctions and measures such as signage and traffic calming features are incorporated into roads to ensure that drivers acknowledge this. Compliance with ‘Cycle Friendly Environment Guidelines’ (Gauge 2009).

- **Cycling facilities:** Work environments: Secure cycling parking is provided for at least 3% of the building occupants. Residential environments: At least one secure parking point per unit is provided.

- **Local facilities:** Access to following local facilities is provided.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Local facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>Access to the following facilities within 750m can be demonstrated: bank (or bank ATM), crèches, food retail and leisure and recreation facilities</td>
</tr>
<tr>
<td>Other Residential</td>
<td>Access to the following facilities within 400m can be demonstrated: bank (or bank ATM), crèches, food retail or café/restaurants</td>
</tr>
<tr>
<td>Business</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
</tr>
</tbody>
</table>

- **Working facilities:** Access to following local facilities is provided.
17  Health and Well Being

Objective: Development should support the health and well being of people on site and in neighbouring communities.

Criteria

• Daylight: Eighty per cent of all useable space within buildings should achieve a 2.0% daylight factor. This can be demonstrated through daylight modelling. Alternatively, an acceptable deemed to satisfy condition is to demonstrate that eighty per cent of the useable area is within 2.5H of an external window, where H is the height of the head of the window.

• Ventilation: All buildings in the estate have ventilation openings (such as an opening window) of at least 5% of the associated useable floor.

• Views: Eighty per cent of all useable area within buildings is within 6m of an external window and has a direct line of sight to this. An unobstructed space of 4m is provided externally in front of windows (vegetation and open fencing can be included but not solid walls and other buildings) to ensure that the view of the external space is adequate.

• Indoor air quality: The specification of materials for buildings in the development should avoid these materials and finishes.

• VOCs: Some carpets, adhesives and paints have volatile organic compounds (VOCs) which are off-gassed, negatively affecting air quality. Products with no or low VOCs are specified.

• Formaldehyde: Formaldehyde similarly can be off-gassed from composite boards and timber products, negatively affecting indoor air quality. Products with no or low formaldehyde are specified.

• Exercise and recreation facilities: Access to following local facilities is provided.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Working facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>Access to a business centre / facility with video / tele-conferencing / internet,</td>
</tr>
<tr>
<td></td>
<td>meeting rooms and printing facilities within 1,200m of every residential unit.</td>
</tr>
<tr>
<td>Other Residential</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>Access to broadband/video/teleconferencing within 400m of any office work</td>
</tr>
<tr>
<td></td>
<td>environment accommodating more than 5 people.</td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
</tr>
</tbody>
</table>
18 Education and Ongoing Learning

**Objective:** Development should support education and ongoing learning of people on site and in neighbouring communities.

<table>
<thead>
<tr>
<th>Type of development</th>
<th>Exercise and recreation facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy housing</td>
<td>Access to the following facilities within 1000m from residential environment can be demonstrated: park / gym / walking or running trails.</td>
</tr>
<tr>
<td>Other Residential</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>Access to the following facilities within 400m from work environments can be demonstrated: park / gym / walking or running trails.</td>
</tr>
<tr>
<td>Industrial</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**Criteria**

- Facilities for education and ongoing learning: Access to following local facilities is provided.

- **Primary schools:** Primary school facilities are located within 1,500m of all family dwellings along a safe walking route.

- **Secondary schools:** Secondary school facilities are located within 2,250m of all family dwellings along a safe walking route.

- **Site operation worker training:** Proposed development demonstrates that human resource policy will include a requirement for site operation workers to access accredited education for a minimum equivalent of 5% of working hours.

- **Construction worker training:** Construction contract document indicates a requirement for construction workers to access accredited education for a minimum equivalent of 5% of working hours.

19 Housing

**Objective:** Development should support Inclusionary Housing and ensure that people who work on site do not have to travel long distances to access affordable housing.
Criteria

- **Affordable housing:** The development demonstrates everyone working on the site that needs affordable housing is able to access this within 10km of the site.
- **Inclusionary housing:** Inclusionary housing is integrated in the development in line with the Inclusionary Housing Policy and local compulsory prescriptions.

20 Social Cohesion and Inclusion

**Objective:** Development should support social cohesion and benefit the full diversity of the population.

Criteria

- **Sporting and recreation facilities:** Affordable access to sporting and recreation facilities in the development is provided for local communities as well as for people within the development.
- **Health and education facilities:** Affordable access to health and education facilities in the development is provided for local communities as well as for people within the development.
- **Children and youth facilities:** Affordable access to children and youth facilities in development is provided for local communities as well as for people within the development.
- **Natural, cultural and historical landscapes:** Access is provided to the local community as well as for people within the development to natural, cultural and historical landscapes located within the development.
- **Inclusive and accessible facilities:** The new development demonstrates that facilities will be inclusive and able to accommodate the full diversity of the population.
- **Information about the development:** Inclusive participatory processes are planned that respond to local communities and take into account issues such as language, income, education and disability.

21 Management and Monitoring

**Objective:** Sustainable development targets that reflect the South African context should be set for the development. Management and monitoring should be carried out to ensure that these are achieved.

Criteria

- **Development conditions:** Developer should make the Record of Decision (ROD) and other development conditions readily available to the local community through a website or other means. Information and reporting on compliance should also be made available through the same means.
- **Environmental Management Plan (EMP):** Environmental Management Plan for the development
covering both construction and operational phases. Environmental Management Plan includes sustainable development criteria from this guide and show how these will be achieved.

- **Environmental Control Officer (ECO):** An Environmental Control Office is appointed for the development. The ECO reports on the achievement of ROD development requirements, the EMP and sustainable development targets to management (and possibly to relevant stakeholders such as the future homeowners, the local community and local and provincial authorities). Reports are developed on a monthly basis during construction phases and on a two monthly basis during operation of the development.

- **Operational performance:** Building user guides are developed for occupants of buildings to ensure that systems designed to support sustainability are maintained and operated optimally.

- **Operational performance:** Facilities management manuals and monitoring requirements to ensure that systems designed to support sustainability are maintained and operated optimally. As minimum, energy, water and waste performance against targets should be reported on.

- **Independent certification:** Commitment by developer that independent environmental rating or certification such as a ‘Greenstar’ rating or ‘Fair Trade in Tourism’ certification will be achieved.

---

22 **Using the sustainable development criteria for built environment projects**

The sustainable development criteria for built environment projects can be used in a range of different ways. Their key use however is as a framework that can be used by developers to design projects and then to show how these projects have addressed sustainable development.

As part of an iterative development process the criteria can be used to evaluate different options and strategies in order to rapidly identify the most sustainable solutions. Once a project has been have been developed, data tables and documentation, as outlined below, can be used to demonstrate how sustainable development has been addressed. This documentation helps to ensure that there can be effective evaluation of proposals and constructive interaction on key issues with key stakeholders before implementation occurs.
<table>
<thead>
<tr>
<th>Land use categories*</th>
<th>Existing site</th>
<th>Proposed development</th>
<th>Difference (units)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy and affordable housing (m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other residential (m²)</td>
<td></td>
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<tr>
<td>Business (m²)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Industrial (m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education, community or institutional purposes (m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resorts (m²)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Mining (m²)</td>
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<tr>
<td>Transport (m²)</td>
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</tr>
<tr>
<td>Service infrastructure (m²)</td>
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<td></td>
</tr>
<tr>
<td>Open space (m²)</td>
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</tr>
<tr>
<td>Private open space (m²)</td>
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<tr>
<td>Agriculture (m²)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total site area (m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land use indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of the site used for residential purposes (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of the site used for education, community or institutional purposes (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of the site that is open space (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of site used for agriculture (%)</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Table 1. Data table for Land Use and Integrated Development.*

<table>
<thead>
<tr>
<th>LU</th>
<th>Land Use and Integrated Development</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LU</td>
<td>Data table</td>
<td>Completed data table, discussion of positive and negative differences (%)</td>
</tr>
<tr>
<td>LU1</td>
<td>Spatial Development Frameworks</td>
<td>Extract of SDF, statement of compliance</td>
</tr>
<tr>
<td>LU2</td>
<td>Environmental Management Framework</td>
<td>Extract of EMF, statement of compliance</td>
</tr>
<tr>
<td>LU3</td>
<td>City Development Strategies</td>
<td>Extract of Strategy, statement of compliance</td>
</tr>
<tr>
<td>LU4</td>
<td>Urban Development Boundary</td>
<td>Extract of SDF with Urban Development Boundary, indication of site location relative to boundary</td>
</tr>
</tbody>
</table>
Conclusion

The social, economic and environmental context of South African suggests that implementing sustainable development is increasingly important. However, opportunities within built environment projects to adopt a sustainable development approach often appear to be missed. This may be the result of planning and design approaches that do not take sustainability into account. It may also be easier to follow conventional routes rather than take on processes that appear to be both complex (by addressing a range of different objectives simultaneously) and contentious (by addressing social, economic and environmental issues).

This paper aims to demonstrate that a relatively simple framework can be developed to help ensure that sustainable development is integrated into built environment projects. It argues that a holistic and integrated approach, in which social, economic and environmental objectives are addressed simultaneously, encourages the development of innovative and effective solutions that support sustainable development within a South African context.

References

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Hewitson, B, Engelbrecht, F, Tadross, M. and Jack, C., 2005, General conclusions on development of plausible climate change scenarios for southern Africa, in:


A framework for assessing building technologies for marginalised communities

Joe Odhiambo and Benson Wekesa

Agrément South Africa

Abstract

The majority of the urban poor population in most developing countries find shelter in informal settlements, which are characterised by inadequate dwelling units. There is a need for building technologies that are responsive to such communities and their environment to empower them to make their own contribution to the process of improving their housing conditions.

Literature shows that during the past few decades there has been tremendous development and evolution of alternative building technologies considered responsive to the urban poor. However, there are no appropriate frameworks or methodologies that can be used to assess the response of these technologies in a holistic manner. Most studies tend to address this theme from a single point of view and without taking other issues into account. Examples are when people focus on the technical aspects of technology, such as production and manufacturing processes, or when they deal with social, economic and environmental issues separately.

This paper proposes a conceptual framework that can help to define and evaluate the response of building technologies to the urban poor and their environment in a holistic manner and in a regional context. It is based on the concept of sustainable development. Building technologies can be analysed, evaluated and finally compared to select the optimal variant according to a set of criteria. The outcome can enhance the understanding of the potentials of the technologies which, in turn, can demonstrate how to empower the urban poor to make their own contribution to the process of improving their housing conditions.

1 Introduction

The majority of the poor urban population (marginalised communities) in most developing countries find shelter in informal settlements. In general, the settlements are characterised by inadequate dwelling units and lack of basic infrastructure such as potable water, electricity, access roads, sanitation facilities and the majority of the inhabitants are poor (UN-Habitat, 2003: chapter 5; Srinivas, 1994: 1-2). In Africa, from Cairo to Cape Town, millions of poor urban dwellers reside in such settlements. It is estimated that 166 million people or 73% of sub-Saharan Africa’s urban population reside in informal settlements (UN-Habitat, 2004: 2; De Vries, 2003: 13). In South Africa up to 9.1 million people currently reside in informal settlements (StatsSA, 2001).
The conditions in most settlements are hazardous to health and tend to exacerbate the already severe socio-economic conditions of the urban poor as well as environmental pollution and the degradation of the local ecosystems (Gulis et al., 2004: 1-9; Richards et al., 2006: 375-388).

In general, the proliferation of informal settlements is due to poverty brought about as a result of market and public policy failure for a significant segment of the urban population (Wegelin, 2004: 8). For example, the majority of the urban population in sub-Saharan Africa, including in South Africa, rely on the informal economy for subsistence – hawkers, small traders, and artisans and technicians in home industries (Burton 2002: 25). The informal economy does not have the necessary base to sustain the ever growing urban population in these developing countries.

Internationally, it is widely acknowledged that adequate shelter is a basic human right rather than a basic need. Since the adoption of the Universal Declaration of Human Rights in 1948, the right to adequate shelter has repeatedly been reaffirmed. The International Covenant of Economic, Social and Cultural Rights (1966), the Vancouver Declaration of Human Settlements (1976), the Habitat II Declaration (1996) and the Millennium Development Goals (http://www.unmilleniumproject.org) all reaffirm the right to adequate shelter. In South Africa, the right to housing is enshrined in the country’s Constitution, with adequate shelter being central to everyone’s quality of life, including health, economic, social and cultural aspects. It is also a critical component in the social and economic stability of nations. However, adequate shelter varies from individual to community and even to country depending on the socio-economic, cultural and political factors. Article 60 of the Habitat Agenda (1996), for example, defines “adequate shelter” as:

“...more than a roof over one’s head, it also means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and durability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water supply, sanitation and waste-management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities; all of which should be available at an affordable cost...”

Furthermore, the Habitat Agenda states that “adequacy should be determined together with the people concerned, bearing in mind the prospect for gradual development”. The above definition highlights the functions and requirements of adequate shelter. These are very subjective in that people’s needs and requirements are different. In addition, adequate shelter is not just the provision of dwelling units, but a whole process that integrates the socio-economic, cultural and environmental factors of the target community.

The problem of inadequate shelter associated with the urban poor population in developing countries has been approached from different points of view, some of which include:

• provision of a housing subsidy (Huchzermeyer, 2003: 591-612)

• clearing informal settlements and relocating residents into public houses (Werna and Keivani, 2001: 84-87; Okpala, 1992: 9-32; Ogunshakin and Olayiwola, 1992: 41-53)

• promotion of housing production and delivery modes that target a reduction in the unit cost of houses (UN-Habitat, 2005: 1-2).

The outcomes of these interventions have had varying degrees of success in different countries. However, informal settlement upgrading seems to be the most successful approach. It involves the integration of the physical, social, economic, organisational and environmental improvements undertaken cooperatively and locally among citizens, community group businesses and local authorities (Wegelin, 2004: 6). This is because it seeks to empower the communities to make their own contribution to the process of improving their living conditions and hence their quality of life.

The presence of informal settlements in developing countries has generated many views from various stakeholders, including scholars. Leading authors on urban planning, such as Abrams (1964), see informal settlements as an invasion by the poor of cities areas for the purpose of seeking shelter. However, Turner (1969) who is considered an authority on informal settlements due to his pioneering work on the favelas of Lima, portrays such settlements as extremely successful solutions to the housing problem of the urban poor population in developing countries. Payne (1977) agrees with Turner and concludes that informal settlements are inevitable in the overall urban growth in developing countries. Steyn (2003), who believes that social and economic systems in Africa require a fundamentally different type of urbanism compared to western systems, reinforces Turner’s view. Steyn proposes that apart from the uncomfortable building configurations, informal settlements are responsive to the socio-economic conditions of the urban poor. This paper conceptualises informal settlements as a transitional phenomenon associated with urbanisation in developing countries which allows the very poor to access urban opportunities and hence it should be supported. Furthermore, informal settlements represent an active, grassroots attempt by the desperate poor to take care of their housing needs without professional and institutional support. There is a need to support the efforts of the poor to continue making their own contribution to the process of bringing about betterment in their living conditions and improving the quality of their lives.

This paper advocates the need for building technologies (materials and construction methods) that are responsive to the urban poor and their environment. These technologies can provide good quality dwelling units while simultaneously addressing the socio-economic needs of the urban poor and minimising negative impacts on the environment.
As stated earlier, a good quality, durable dwelling unit is central to everyone's quality of life. The socio-economic conditions of the urban poor are desperate, for example, with unemployment being very high. However, the choice of building technology can help address such issues. There exists a definite relationship between, for example, employment opportunities and the production and selection of building materials and assembly of both the structural and non-structural elements and components that make up the physical fabric and form of a building (Watermeyer, 1999: 1).

The protection of the environment has become an important criterion worldwide to sustain the species Homo sapiens (Du Plessis, 2002: 6). The built environment is considered to have significant impacts on the environment, including disturbing the eco-balance, land degradation, air pollution, and energy consumption (Kibert, 2007: 595). Energy consumption is also a major cause of climate change due to the release of carbon dioxide into the atmosphere during the combustion of fossil fuels. Such an approach will without doubt empower the urban poor communities to make their own contribution to the process of improving their living conditions.

It is important though, at both national and local policy levels, to be clear about the notion that the bulk of housing for the urban poor will always be built by the poor themselves. No government in developing countries, especially in sub-Saharan Africa, can finance the eradication of its housing backlog. While the population in these countries is still growing, the majority of people continue to rely on the informal economy for subsistence and the rate of urbanisation and rural urban migration remains high, thus the demand for housing in urban centres will always be there.

2 Building construction technologies

Literature surveys show that during the past few decades there has been tremendous development and evolution of alternative building technology options. Some of these are considered responsive to the urban poor and their environment. Typical examples include modified earth building technologies such as techniques of soil stabilisation, water resistant mud plaster, techniques of preventing contact of earth-based construction by rain, and stabilised soil-cement blocks (UN-Habitat, 1985; CSIR, 1987; Mathur, 1993 and Bolton and Burrough, 2001). Many authors, for example Fathy (1973), consider such technologies as responsive to the urban poor and their environment as these technologies rely on labour-intensive methods and allow communities direct participation and control and are affordable. These are the same views held by Steyn (2003: 21). The technologies are also based on low and local use of renewable energy and materials, which are simple and work in harmony with the environment and are thus inherently sustainable, asserts the Development Workshop, Tehran (DWT) (1975: 1).

Other developments include reducing to a minimum the volume of expensive materials needed for masonry wall construction components, including various forms of cavity and perforated masonry. These are, for example, extruded burnt clay blocks, hollow
concrete blocks, random voids by aeration – gas concrete made with the help of aluminium powder, or no-fines concrete, as well as large masonry units, interlocking and self-aligning masonry units and prefabricated masonry, to make them more affordable while improving the technical performance such as thermal and energy efficiency and the rate of construction (Parry, 1984: 252).

Developments in construction techniques include self building and techniques aimed at reducing costs, for example, building flatter roofs, the use of roof cladding materials (metal and fibre-cement roof sheets) that can prevent water penetration when used at low slopes, and self-supporting ones such as W-shaped roofing sheets (Parry, 1984: 250-253). Alternative binding materials such as lime-pozzolana, which are cheap compared to the expensive and environmentally unfriendly Portland cement, have also been proposed. One can add improved techniques for the production of building materials and equipment on small scale and closer to construction sites. Typical examples include the widely used equipment for the manufacture of fibre-cement roofing sheets developed by Intermediate Technology Building Materials Laboratory, United Kingdom (UK) and “Cinva-ram” for earth-based products developed in Latin America (Parry, 1984: 250-253).

In addition, the use of plastics in building construction and the development of advanced composite materials are also good examples. Plastics are considered inexpensive and perform well as a building material. Plastics are used in, for example, door and window frames, as roofing sheets, and as water-proofing and insulating materials. Examples of advanced composite materials include reinforced fibre-cement products. These have been developed to complement conventional construction materials.

A considerable body of literature describes the methods for production and use of these building technologies in the provision of dwelling units. However, there are no frameworks or methodologies that can be used to assess the response of such technologies to the urban poor and their environment, given that people’s needs and requirements are different and subjective.

It is necessary to reconsider building technologies that can improve people’s life from a holistic point of view. This will enhance understanding the potential such technologies have and how to empower the urban poor to make their own contribution to the process of improving their housing conditions.

This paper proposes a conceptual framework that can help to define and evaluate building technologies that are responsive to the urban poor and their environment in a holistic manner and in the regional context (South Africa). It is based on the concept of sustainable development.

3 Methodology

In designing the framework, the methodology adopted was literature surveys and a desktop study. The framework defines responsive technologies in terms of technical, socio-economic and environmental criteria defined in the regional context. The technologies can
be analysed, evaluated and finally compared to select the optimal variant according to the given set of criteria. In reality, to develop such a framework, built environment professionals should be consulted throughout to capture and reflect the value systems of various stakeholders. However, many expert opinions are in the public domain and therefore literature was consulted in developing the framework and using stakeholders to validate it.

The concept of sustainable development was adopted in developing the framework. This was because development processes that seek to address social and economic needs and concerns, and to facilitate the economic empowerment of targeted communities while minimising negative impacts on the environment, have generally been referred to as sustainable development (Bowen and Hill, 1997: 223). Sustainable development has also increasingly become a central element of the urban planning process (Choguill, 1995: 583). Building materials are commonly selected based on functional, technical and financial requirements. However, with sustainability as the current key concept in the urban planning process, the environmental load of building materials has also become a more important criterion (Van der Lugt et al., 2005: 648; DuBose et al., 1995: 11).

The concept of sustainable development and how it relates to the built environment and building technology in general was outlined, and then applied in developing the framework. The framework utilises a set of criteria generated based on the socio-economic environment of the urban poor and expert opinions as reported in the literature. It presents a multi-criteria optimisation problem and the simple multi-attribute rating technique was recommended in solving the problem.

4 Sustainable development

4.1 Definition and interpretation

The most widely used definition of sustainable development in the literature is what was put forward by the United Nations-sponsored World Commission on Environment and Development (WCED) in 1987. It states it as the development that “meets the needs of the present without compromising the ability of future generations to meet their needs”. The phrase “meeting the needs of the present” refers to developmental aspects of sustainability, which include economical and societal (social, cultural and political) expectations. The phrase “without compromising the needs of the future” mostly refers to environmental degradation.

The key elements are thus to find a balance between the human needs of improved lifestyles and the feeling of well-being on the one hand, and preserving natural resources and ecosystems on which we and future generations depend. This introduced the notion of intergenerational equity, which translates into a need to adopt to changing circumstances. As stated by Sahely et al. (2005: 73), there is no way of knowing what future generations will want, and the ability to adapt to changing environmental or socio-economic conditions is key to sustainable development. Also implied in the definition is the need for a multidisciplinary and holistic approach in the development and decision-making processes.
The definition of sustainable development therefore envisages a development process that seeks to empower communities through self-determination. The concept can be applied to any sphere of development which has as its main objective improving the quality of life without compromising that of future generations.

4.2 Sustainability in the built environment

The concept of sustainable development has drawn interest from built environment professionals (Shen et al., 2008: 57), as the construction industry is considered to have a significant impact on the environment.

According to Van Wyk (2007: 4), construction activities consume 50% of all resources globally, 70% of all global timber products and 40% of energy. The consumption of these resources adversely affects the environment through over-exploitation of both renewable and non-renewable resources (materials and energy). Over-exploitation, for example, of building materials may result in stripping of top soil and destruction of the natural topography, resulting in problems such as soil erosion, landslides and loss of fertile soil for farming and detrimental effects on local hydrology (Kibert, 2007: 595).

Consumption of energy is a major contributor to climate change. This is due to the release of carbon dioxide (CO2) into the atmosphere during the production process, for example, the combustion of fossil fuels. In the construction industry, energy is used in the extraction, production and transportation of building materials, manufacture and operation of machinery, and operation and maintenance of buildings. The increase in global temperature has been linked directly to the production of greenhouse gases, including CO2, causing climatic change (Kibert, 2004: 494). Other adverse environmental impacts relating to the construction industry include loss of biodiversity, depletion of major fisheries, and toxification of soil, water and air due to the releases of toxic chemicals, some of which mimic natural hormones, which might cause havoc in both animal and human reproductive systems (Kibert, 2004: 494).

Sustainable construction was first defined by Kibert in 1994 as “the creation and responsible maintenance of a healthy built environment, based on resource efficient and ecological principles” (Kibert, 2007: 595). The inclusion of construction in sustainable development was proposed at the World Summit for Sustainable Development held in Johannesburg in September 2002. The Agenda 21 for sustainable construction in developing countries was launched as a discussion document during the summit (Du Plessis, 2005: 406). Although there are various definitions, for example, Kibert (1994); Huovila and Ritcher (1997); Lanting (1998); UNEP (2003) and Du Plessis (2005: 407), the aims and goals of sustainable construction remain the same. It is a way for the building industry to move towards achieving sustainable development, while taking into account environmental, socio-economic and cultural issues.

Although the concept of sustainable development in the built environment is relatively new, much has been written about the

4.3 Principle issues affecting sustainable construction

The summary of principle issues and the rationale affecting sustainability in the built environment are given in Table 1 (Shafii, 2006: 3). Bowen and Hill (1997: 227) divided these principles into four pillars of sustainability, that is, social, economic, biophysical and technical – with a set of over-arching, process-oriented principles, to be used as a checklist in practice.

Table 1: Issues and rationale affecting sustainable construction (source: Shafii, 2006: 3, Table 1)

<table>
<thead>
<tr>
<th>Issues</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental-friendly construction materials</td>
<td>The building construction industry consumes as much as 50% of all materials extracted from the earth’s crust</td>
</tr>
<tr>
<td>Energy efficiency in buildings</td>
<td>The operations of the construction industry and subsequent demolition of built facilities account for about 40% of all energy used and a similar percentage of greenhouse gas emissions</td>
</tr>
<tr>
<td>Construction and demolition waste management</td>
<td>Construction and demolition waste account for 50% of all waste generated prior to recovery</td>
</tr>
<tr>
<td>Health in buildings</td>
<td>The quality of the internal environment of buildings is an essential element to the health of its occupants</td>
</tr>
<tr>
<td>Sustainable architecture</td>
<td>Urge for implementing principles and measures in the design process leading to the overall performance of buildings</td>
</tr>
<tr>
<td>Social impacts arising from construction and the built environment</td>
<td>Sustainable construction can improve the living context and relationship between citizens and their environment and contribute effectively towards social cohesion and job creation, and the promotion of cultural and regional economic development.</td>
</tr>
</tbody>
</table>
A close inspection of these principle issues reveals that the building construction industry can be targeted to significantly reduce environmental loading on planet earth. In addition, the technology adopted can be used to address social and economic needs of the target community.

### 4.4 Methodologies for promoting sustainable construction

There are several methodologies that have been put forward to promote sustainability in the built environment. These can broadly be classified as educational, management systems, green design and buildings, green procurement, green technologies in production and construction methods, and waste management (Table 2). The use of technology emerges consistently as one of the vehicles to enhance sustainability in the built environment.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>It calls for curriculum and training programmes in the construction industry to include more knowledge and materials on sustainable construction practices such as cost saving methods from a reduction of construction waste. Funding needs to be provided for training and education for those who cannot afford the costs themselves, and setting up incentive and reward schemes (Ekanayake and Ofori, 2000: 5)</td>
</tr>
<tr>
<td>Environmental management systems (EMSs)</td>
<td>Various EMSs have been introduced to address the impacts of construction activities on the environment; generally they tend to promote measures such as establishing waste management plans, reducing and recycling construction and demolition wastes, providing in-house training on environmental management, and legal measures on environmental protection (Bowen and Hill, 1997: 235-236)</td>
</tr>
<tr>
<td>Green building</td>
<td>Kibert (2007) defines green buildings as health facilities designed and built in a resource-efficient manner, using ecologically based principles. Such buildings are meant to consume significantly less energy and materials, provide healthy living and working environments, and greatly improve the quality of the built environment. Several methods such as CASBEE in Japan, LEEDR in the USA, NABERS in Australia, BREEAM in the United Kingdom, and SBAT in South Africa have been developed to help assess the ‘greenness’ of buildings (Ding 2008: 453; Kibert, 2007: 598; Cole, 2005: 949-957; Gibberd, 2005)</td>
</tr>
</tbody>
</table>
4.5 Sustainable building construction technologies

Construction technology has been identified as one of the key methods for promoting sustainability in the construction industry by the application of green technologies in production and construction methods and waste management. This is because of the potential benefits across the economic, environmental and social spectrums. It is through technology that we extract natural resources, to modify them for human purposes, and to adapt our man-made living space.

DuBose et al. (1995: 5) defines green/sustainable technology as “the technology that promotes a societal move toward sustainability, a technology that fits well with the goals of sustainable development”. These are practical solutions for achieving economic development and human satisfaction in harmony with the environment. Such technologies serve to contribute, support or advance sustainable development by, for example, reducing risk, enhancing cost-effectiveness, improving process efficiency, and creating processes, products or services that are environmentally beneficial or benign while benefiting humans (DuBose et al., 1995: 5). Technologies adopted in the building construction can therefore be used to address social and economic needs and concerns and, depending on how they are structured, to facilitate the economic empowerment of marginalised sectors of society while minimising negative impacts on the environment.

To qualify as a sustainable technology, such solutions, in addition to meeting pre-existing requirements and constraints (e.g. technical viability), must have the following

<table>
<thead>
<tr>
<th>Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green design</td>
<td>This calls for the identification of suitable methods of construction at the design and tendering stages (Ekanayake and Ofori, 2000: 5)</td>
</tr>
<tr>
<td>Green procurement</td>
<td>Green procurement systems have been promoted to mitigate construction waste and to achieve better performance (Ekanayake and Ofori, 2000: 5; Rwelamila et al., 2000: 49)</td>
</tr>
<tr>
<td>Green roof technologies</td>
<td>Nelms et al. (2007: 239) introduced a methodology for assessing green roof technologies</td>
</tr>
<tr>
<td>Lean construction</td>
<td>Engineered-to-order methodologies are being explored to see what techniques can help reduce construction times, and achieve other performances that increase customer and stakeholder value while minimising waste. Prefabrication is one such technique - it reduces construction waste on site and other construction activities (Kistan and van Wyk, 2007: 10)</td>
</tr>
<tr>
<td>Waste management</td>
<td>Reducing construction waste has become a key issue in promoting sustainability in the construction industry. It aims at reducing the remains of the materials delivered on site after being used in construction work (Ekanayake and Ofori, 2000: 5; Poon, 2007: 1715; Tam et al., 2007: 1470)</td>
</tr>
</tbody>
</table>
characteristics (DuBose et al., 1995: 5):
• minimise the use of non-renewable energy and natural resources
• satisfy human needs and aspirations (economic, social, political) with sensitivity to the cultural context
• minimise negative impacts on the earth’s ecosystems.

Bowen and Hill (1997: 229) state that minimising consumption of both materials and energy is necessary because over-consumption inherently involves increasing the disorder and rendering them of lower utility for future use. Therefore, consuming as little material and energy as possible, or doing more with less, is a fundamental objective of sustainable technology.

Sustainable technology must also meet the needs of the population it is intended to serve. Such needs may include economic, social and political. In fulfilling these needs the technology must account for human preferences and cultural differences. In some cases these preferences may conflict with environmental objectives and a compromise will have to be reached. This does not mean that human preferences should be ignored; fulfilment of our desires means the difference between surviving and living.

Causing minimal negative environmental impact (as well as maximising positive inputs) is an important objective of sustainability since the environment consists of ecosystems of which the ongoing health is essential for human survival on earth (DuBose et al., 1995: 5; Du Plessis, 2002: 6). Sustainability of the human race requires that ecosystems be protected and preserved in a reasonable state of health through maintaining biodiversity, adequate habitat, and the ecosystem.

Further scrutiny of the definition and characteristics of sustainable technology reveals that it is not a new concept. It is similar to the theory of “appropriate technology” that evolved in the 1970s. “Appropriate technology” was defined then as the technology that is designed with special consideration to the environment, ethical, cultural, social and economic aspects of the community it is intended for (Eckaus, 1977: 10). It has only taken on increased importance as the negative impacts of human activities on a planetary scale became apparent.

4.6 Assessment of sustainability

One of the many questions that have surfaced as a result of the discourse on sustainable development is “how can we assess sustainability?”. As a result, several types of assessment methodologies of sustainability have been put forward that can be categorised in three groups on the basis of their methodological foundations (Adinyira et al., 2007: 3). These are environmental in general, life cycle assessment methods and sustainability indicator assessment methods.

4.6.1 Environmental in general

Environmental methods in general methodologies mainly focus on issues relating to preserving natural resources and ecosystems on which we and future generations depend such as wise resource consumption, curbing pollution and looking
at our impact on bio-diversity (Cole, 2000: 949-957). With this methodology environmental impacts tend to be identified, mostly using methods such as checklists, matrices and evaluations, logical frameworks, cost-benefit analysis and multi-criteria assessments (Adinyira et al., 2007: 3). On the basis of this methodology, many sustainability assessment techniques have been developed that focus on energy and material flow and address both resources use and wastes, arising across a wide range of development activities.

In general, environmental methodologies have significant limitations with respect to the range of sustainability issues they are capable of addressing. The methods are mostly limited to environmental issues of sustainability and to applications at the levels of policy planning, programme development and urban design. These fall short of technical, social and economic issues that this paper aims to address.

4.6.2 Life cycle assessment

Life cycle assessment (LCA) methodologies are aimed at incorporating the four key elements of sustainability including environmental, intergenerational equity concerns and the need for a multidisciplinary and holistic approach in the development and decision making processes (Adinyira et al., 2007: 4). LCA is based on a structured methodology that can be utilised, for example, to evaluate environmental implications of products, processes, projects, or services throughout their life cycles from raw materials extraction to end of life (Sahely et al., 2005: 74). Its origin is traced to Agenda 21’s call for the integration of the environmental aspects and other key elements of sustainable development, as envisaged in the definition put forward by WCED (Adinyira et al., 2007: 4).

Life Cycle Analysis (LCA) has four components, namely goal and scope definition, inventory analysis, impact analysis, and improvement analysis (Sahely et al., 2005: 74). Goal and scope definition requires defining the purpose and boundaries and establishing the functionality unit of the system to be considered. The inventory analysis is mainly an accounting of energy and raw materials usage and discharges to all media over the entire life cycle of the system (i.e. product, material, process, project, or service). In practice, the impact analysis component of LCA lists the results from inventory analysis in various environmental impacts categories, such as depletion of resources and global warming potential. Lastly, improvement analysis is a systematic evaluation of the needs and opportunities to reduce the environmental burden associated with the life cycle of the system. While LCA focuses mainly on environmental impacts, life-cycle costing (LCC) has emerged as an equivalent tool for examining the economic impacts of a system (Sahely et al., 2005: 75).

The main advantage of LCA is that it is a well-established, standardised methodology, where potential impacts are aggregated and quantified and it is system or project specific. However, LCA also has some major drawbacks, including the complex and time consuming nature of the analysis, large data requirements and boundary definition. Furthermore, LCA is mainly limited to environmental aspects
and does not explicitly consider the other key elements of the sustainability paradigm such as economic and social factors. Nevertheless, the LCA methodology has contributed significantly to the sustainability analysis by advocating expanded time and spatial boundaries in the analysis of systems.

### 4.6.3 Sustainability criteria/indicator assessment

Sustainability criteria/indicator assessment methodologies are used to monitor and measure the state of the environment by considering a number of variables or characteristics (Adinyira et al., 2007: 5; Sahely et al. 2005: 73). Many sustainability criteria/indicator assessment methodologies have been developed to attempt to simplify the holistic assessment of a sustainability paradigm. The methods use sustainability criteria/indicators as a way of understanding and quantifying the interaction between the four key elements, as envisaged in the definition of sustainable development.

From a methodological point of view, sustainability criteria/indicator assessment methodologies are useful integration tools to evaluate development from several dimensions and test sustainability (Adinyira et al., 2007: 5). However, the main problem is relating what the indicators measure to the actual sustainability. Indicators are unavoidably value-laden, and sometimes present difficulties in interpreting whether or not any progress towards sustainability is actually being made (Adinyira et al., 2007: 5). The other challenge, according to Guy and Kibert (1998: 1), is that there are no definite criteria/indicators applicable in the building construction industry. They propose developing such criteria/indicators through brainstorming, focus groups, expert opinion, and both quantifiable and perceptual measurements, including surveys that are region or project specific. On the other hand, Šaparauskas and Turskis (2006: 323) propose an indicator selection procedure using an algorithm to create appropriate indicators. The indicator is accepted on the basis of its availability, reliability and measurability. Such an approach is likely to exclude some of the vital criteria that might not be measurable.

Nevertheless, a combination of LCA and sustainability criteria/indicator methodologies seems to be more suited to a framework that can define and evaluate building technologies responsive to the urban poor and their environment. This is because technologies can then be viewed as a system and from a multi-criteria perspective that this study is attempting to address.

### 4.7 Principle challenges

The principle challenge is to propose a practical framework for defining and evaluating building technologies that are responsive to the urban poor and their environment in the regional context. As stated earlier, ‘responsive’ is taken to imply a building technology that provides a good quality dwelling unit and at the same time addresses the socio-economic needs of the urban poor while minimising the negative impacts on the environment. Thus, these are practical solutions to achieve economic development and human satisfaction in harmony with the environment.
Literature reveals that there is no universal framework that defines such technologies. However, the sustainability paradigm gives us the avenue through which such frameworks can be developed, although from a region, project or process-specific perspective.

It is difficult to have a universal framework because, as stated earlier, people’s needs and requirements are subjective and different. This is also because of the conflicting goals in the development and management of construction activities, for example, (i) financial versus technical factors, (ii) short-term versus long-term planning horizons, and (iii) network versus project factors. With the advent of the sustainability paradigm, we now have an avenue to balance various objectives and trade-offs. The key, however, is to utilise a systems approach in defining the goal and criteria methodologies for measuring sustainability (Sahely et al., 2005: 74).

Furthermore, the envisaged framework seeks to address building technologies from a multidimensional perspective, that is, technical, socio-economic and environmental components. However, each component has different characteristics and solutions than the others, and more often than not, with different units of measurement. Figure 1 illustrates the three dimensions and their interaction. The optimum technological solution is confined to the area where the three components overlap. It is easy to see that any solution complying simultaneously to the three components has to be contained within this area. However, even if this common area could be known or determined, it is necessary to remember that there can be thousands of different solutions, but only one of them will be the optimum solution.

When one considers that there is a set of building technologies that is responsive to the urban poor and their environment, how can these technologies be evaluated on the way they comply with these three dimensions? The answer is that one can compare the alternatives and a reach a compromise which allows for the selection of the best combination of technologies in a given scenario.

However, to reach a compromise, it is necessary to establish a set of acceptable criteria for the different components of sustainable technology. Such criteria should be determined with the target community in mind. Consequently, there will be a set of criteria regarding the socio-economic aspect, and others for the environmental and technical aspects of the technology alternatives. These criteria can then be used to gauge the contribution of each technology alternative in attaining the final goal. It is important to note that each criterion can impose a threshold.

Figure 1: Superimposing the three components of sustainability
or a pair of these, which must be met by the diverse technology alternatives, but usually with different cardinal values. There exists, most likely, a common ground for some of the alternatives, considering the interaction of trade-offs, and consequently the task is to find a method that could identify this common ground for all the technology alternatives.

5 The proposed conceptual framework

5.1 Systems approach

It was proposed to view housing delivery as a system (Figure 2). The goal is building technologies that can result in a good quality dwelling unit and at the same time address the socio-economic needs of the urban poor while minimising the negative impacts on the environment. The responsiveness of the technology can then be considered in terms of the quality of the dwelling (engineering objective), quality of life (socio-economic objective) and minimisation of negative impacts on the ecosystem (environmental objective).

A good quality dwelling unit will improve the quality of life of the household. The feedback mechanisms in the system have both environmental and socio-economic implications. For example, the use of sustainable technologies will lead to the minimisation of negative impacts on the environment, and improved quality of life. In turn, improved quality of life leads to diminishing environmental degradation.

![Figure 2: Conceptual framework](image-url)
5.2 The proposed criteria

Appropriate criteria should be determined, bearing in mind the needs of the targeted community. In this instance the target community is the urban poor in South Africa. In general, the environmental concern is universal. It is concerned with minimisation of the negative impacts on the environment and efficient utilisation of resources, especially materials and energy. Socio-economic concerns are, however, not universal and are different from region to region. However, in the case of South Africa and indeed the whole of sub-Saharan Africa, it can be stated conclusively that it is concerned with improvement of the quality of life. Therefore, the first step towards improving the quality of life is poverty alleviation. In this regard the proposed criteria are given in Tables 3 and 4.

Table 3: Building technology – Environmental criteria

<table>
<thead>
<tr>
<th>Environmental sustainability objective</th>
<th>Environmental criteria</th>
</tr>
</thead>
</table>
| Efficient utilisation of building materials | Restriction on overexploitation  
Extending the life of non-renewable materials by:  
• reduction in their use  
• re-use  
• recycling  
• switching to renewable substitutes  
Construction methods that allow adaptability (assembly techniques that allow non-destructive disassembling)  
Reduction in waste generation(Du Plessis, 2002) |
| Optimisation of energy consumption (reduction in both embodied and operating energy) | Production of building materials close to construction sites  
Careful planning and design in relation to ventilation and orientation  
Use of building materials and methods that enhance thermal performance of buildings  
Use of energy from renewable |
| Protection and maintenance of biodiversity | Minimisation of particulate and gaseous emissions  
• apply procedures to eliminate or manage noise, dust, vibration, chemical and particulate emissions  
• eliminate or carefully manage the use of building materials or finishes with volatile organic compounds  
Avoid sensitive ecosystems  
Protect on site vegetation and topsoil (Kibert, 2004: 495; Häkkinen, 2007: 249-250) |
<table>
<thead>
<tr>
<th>Socio-economic sustainability objective</th>
<th>Socio-economic criteria</th>
</tr>
</thead>
</table>
| Stimulate and support local economy; and community participation | Self-determination  
Use of building technologies that:  
• have evolved over time  
• are labour intensive  
• are small scale  
• use un-skilled or semi-skilled labour  
(Bowen and Hill, 1997: 227-229; Steyn, 2003: 21) |
| Equity | Mixed use  
Socially acceptable (Bowen and Hill, 1997: 229) |
| Skills and capacity development | Allows community participation and control  
Training  
(Bowen and Hill, 1997: 228) |
| Human health and safety | Avoid the use of building materials or finishes that are hazardous to health  
Healthy and safe working environment  
(Bowen and Hill, 1997: 228) |
| Financial affordability | Labour-intensive building technologies  
Abundant and locally available resources  
Less emphasis on technical standards  
Owner built/self help  
Indigenous systems  
Small scale  
Addressing market imperfections  
(Bowen and Hill, 1997: 229) |
| Employment creation | Small scale  
Labour-intensive methods  
Abundant and locally available resources  
Owner built/self help  
Supported by government policies  
(Bowen and Hill, 1997: 228) |
| Adaptability | Construction methods that:  
• allow incremental addition  
• allow future expansion  
• fixing details that allow non-destructive separation (Van Wyk, 2007: 4-5) |
The technical objectives are aimed at achieving a good quality and durable dwelling structure. Quality can be described in terms of housing attributes. Becker (2002: 926, Table 2), amongst others, provides a list of housing attributes. The national building regulations and design codes, for example, SANS 10400:1990 The Application of the National Building Regulation, usually provide for design and construction procedures to meet the performance requirements of these attributes. In general, though, it should be demonstrated on a factual and technical basis that can be substantiated and verified by means of tests, calculations performed in terms of appropriate design codes of practice, or from first principles that the construction system, materials, element or components satisfy the performance requirements (SAICE, 2000: 1-1) enlisted by the housing attributes.

In this study, the housing attributes were considered as the technical criteria. Not all the attributes were taken into account, only the ones given in Table 5 were considered as appropriate. This was because these aspects are considered to be influenced the most by the type of building technology employed and as being the minimum requirements (SAICE, 2000: 1-1).

Table 5: Building technology – Technical criteria

<table>
<thead>
<tr>
<th>Technical objective</th>
<th>Technical criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance (quality)</td>
<td>Durability, Thermal and condensation, Structural strength and stability, Behaviour during fire, Water penetration and rising damp, Structural serviceability</td>
</tr>
</tbody>
</table>
The proposed criteria were conceptualised as an objective hierarchy model as shown in Figure 3. As stated earlier, the challenge is to compare the alternative technologies and a compromise reached that allows for the selection of the optimum. The proposed methodology is given in the section that follows.

**Figure 3: Objective hierarchy model**
4.3 The proposed assessment method

The proposed framework presents a multi-criteria optimisation problem. There are many techniques for multi-criteria optimisation, such as simple multi-attribute rating techniques, the analytical hierarchy process, order preference by similarity to ideal solution (Engelbrecht, 2007: 113-177). The simple additive weighting (SAW), one of the simplest and probably the best known and most widely used technique, is recommended in this study. The model is used to aggregate the scores into one score based on the criteria weights. At first the scores are normalised (converted) by the formulas:

1. \[ x_{ij} = \frac{a_{ij}}{a_{\text{max}}^j} \]
2. \[ x_{ij} = \frac{a_{ij}}{a_{\text{max}}^j} \]

Where \( x_{ij} \) = the score for the criterion.

When the criteria are maximised, Formula 1 has to be used, and Formula 2 when the criteria are minimised. The scores are aggregated into one score using the formula:

3. \[ S = \frac{\sum_{i=1}^{n} w_i x_i}{n} \]

Where \( S \) is the total score, \( n \) is the number of criterion, \( w_i \) is the weight of each criterion, and \( x_i \) is the normalised score of the criterion.

In the event that the criteria are not measurable, it is proposed to approach several stakeholders, including academics and industry players to rate the technology. However, it is important to note that such score rating is subjective and based on the perceptions of the respondents. Yet, statistically the information can be used to draw objective conclusions. Alternatively, it is proposed that such criteria be defined in terms that can be quantified and systems developed to capture data which can then be presented and analysed accordingly.

It is also necessary to compute the weighting of the three pillars of sustainability (socio-economic, technical and environmental). Such computation can be based on a field survey where the targeted community participates to establish the most pressing issues, which can then be weighted using social science techniques. The score rating for each criterion and category (technical, socio-economic and environmental) can be averaged, normalised and aggregated into one score. The grand total score rating can then be calculated as the sum of the three total scores.

6 Conclusions and recommendations

The concept of sustainable development is now well defined and it can be applied to any sphere of development and decision making, including the built environment. The proposed framework defines building technologies responsive to the urban poor in terms of technical, socio-economic and environmental sustainability objectives in the regional context. Building construction technologies can be analysed, evaluated and finally compared in order to select the optimal variant according to the given set of criteria. The outcome of such an evaluation can enhance the understanding of the potentials of the technologies,
which in turn can demonstrate how to empower the urban poor to make their own contribution to the process of improving their housing conditions. Such outcomes can also be useful for policy formulation and decision making. However, it should be noted that the framework is not universal, especially with regard to the criteria, it is regional specific.

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55-69.


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Innovation and Alternative Building Technology within a Sustainable Development Paradigm

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ABSTRACT

People are at the centre of sustainable development. Basing on this anthropocentric viewpoint this paper posits that alternative building technologies can play an active role in solving today’s shelter problems and indeed in creating habitats for sustainable living. The routinely assumed powerlessness of the poor is problematised to make the case that, with alternative building technologies, everyone can get to be part of the solution. For alternative technologies to be effective in such a role, it is argued, innovation at all building lifecycle must be catalysed. The goal should be creation of a self-organising framework for reconfiguration of processes and products at different scales to develop and utilise alternative technologies in ever fresh ways of building sustainable habitats. International and local South African statistics and examples are used to support the arguments.

INTRODUCTION

Sustainable Development is, above all, about fulfilling human needs for present and future generations (World Commission on Environment and Development, 1987). Shelter features along with nutrition and healthcare as an indispensable essential for fulfilling the health, safety, welfare, socialisation and self-actualisation needs of humans (Dunin-Woyseth, 1993). In South Africa, it widely acknowledged that the shelter and housing needs for the largest sections of the population remain unfulfilled – with the shelter deficiency growing. Taking the case of Cape Town, 400 000 families are without adequate shelter. With a high annual rate of increase of 20 000 households per annum, this number is growing steadily (City of Cape Town, 2009). This is in a context where 40 percent of the city’s population are considered to be living below the poverty (ibid) with the majority of them staying in the unsanitary conditions of informal settlements.

Generally, post-1990s government in South Africa has taken a lenient approach to informal settlements, demolition being the rare exception rather the rule. Additionally, the government has proactively been engaged in provision of housing to the poor most significantly under the Redistribution and Development Programme (RDP) and subsequently the Breaking New Ground (BNG) strategy. The main approach by government to the housing problem is centred on delivery of a finished building for the formerly disadvantaged to move into, and with the beneficiaries sometimes getting a bonus in form of a job and training during the construction process.
And there are also instances of Black Economic Empowerment (BEE) whereby black-owned local firms are contracted to execute the construction. But the housing problem remains and evidence suggests the problem is growing. Thus, this intervention approach of constructing contractor built housing, with standard materials has failed quantitatively. Moreover, evidence also suggests qualitative problems with many of the houses constructed under such arrangements. These problems include poor indoor environmental quality, substandard construction, and monotonous blandness. It is in this context that service delivery riots continue as people remain passively expectant of government delivered housing and related services. This failure should come as no surprise because it was realised as long as the 1970s that such top-down house-provision-focussed approaches are problematic. And lamentations by authorities about their increasing hopeless in providing housing only goes to underscore the prescience of the 1970s argument against this mode of housing delivery. Governments using the public housing approach have almost always failed in quantitative terms to construct sufficient housing to fulfil demand. It was also the experience back then that it is difficult (if not impossible) for public housing schemes to provide solutions that meet the diversity in needs and preferences among lower income groups in terms of trade-offs between size, quality, use, location and cost. Many projects were far away from employment centres where the poor could find jobs. And the plan layouts were not suited to living patterns, for instance to the cooking habits of the people, carrying out of petty trade and subletting. They were also based on Western designs and so proved poorly suited to specific climates and micro-climates. Repair and maintenance were a continual problem. For instance, buildings deteriorate very fast in rainfall and high humidity locations and yet governments proved perpetually ineffective at implementing maintenance programmes (see Turner, 1976).

This paper takes the stance that the current predominant approach to government intervention in housing has structural flaws that need innovative re-examination. By taking the well-being of the human being as a focal and starting point, this paper weaves a framework from a building lifecycle perspective to highlight the immense latent energies that are locked down by the current top-down government approach. The paper makes the case the the government-facilitated self-help approach aimed at reconceptualisation of process and product at different levels in the housing production chain can activate resources, energies and synergies for a far more effective mode of habitat development. The scope of the paper is limited to the individual building and to the outdoor spaces defined between it and other buildings/elements. Technologies discussed are mainly those in regard to building materials and other inputs into the construction of the building envelop but the principles are clearly applicable to other aspects of building. The value of this paper is in proposing a framework under which people can be empowered by government to improve their habitats under a sustainable development paradigm. The paper’s arguments are explicitly or implicitly underpinned by empathy for conditions in informal settlements as well as the wider contextual consideration that South Africa experiences.
experiences a high unemployment rate of more than 20 percent (Statistics South Africa, 2009)

The paper starts by a brief discussion of the concept of innovation, alternative technologies and sustainable development. It then presents the building as a lifecycle system.

INNOVATION

Innovation is essentially about beneficial (to humans) novelty. It is a generic concept that is applicable to all spheres of human activity. Innovation is not absolute, but can be context dependant. For example, an old product/idea in a context where it was previously unknown or use of a known material in a way not yet tried before could all qualify to be innovations.

Fig. 1 above presents the different types of innovation. Process innovation is on the production side and encompasses equipment (i.e. capital and investment goods) increased productivity of labour, production cost reduction all aimed at increasing profit. Importantly, process innovation also includes organisational innovation (e.g. better management, organisation of labour), education of work-force etc. Under the sustainability paradigm the above framework this paper expands the above framework to also include other environmental and socio-economic sustainability considerations (not necessarily chosen by the producer but enforced by government through legislation or demand of such products by the consumers (such as those pertaining to pollution control).

Fig 1: Categories of Innovation (Adapted from Diyamett, 2004)

Product innovation is about introduction of new goods and services that customers are not aware of. Product innovation can also be about improvement in the quality of a product (see Diyamett, 2004).
There are different degrees of innovation. Budworth (1996) identifies the following: incremental innovation, radical innovation and fundamental innovation. In incremental innovation, beneficial changes to production process or final product are small but persistent. Rosenberg (1982) argues that such changes, though small, can cumulatively have a significant beneficial effect. Rosenberg (ibid) adds that incremental innovation comes through learning on the job, that is, learning by doing. The next degree, radical innovation, is a much more substantial change that does not however establish a new industry. The highest degree is fundamental innovation, which is a result of strong scientific research that creates a completely new industry based on previously unknown production systems. Fundamental innovation requires the most investment and therefore carries the highest risk amongst the three (Diyamett, 2004).

Of the three types of innovation, this paper proposes that incremental innovation is the model that would provide maximum benefit in the addressing the human shelter needs in South Africa today. Incremental innovation requires little or no expenditure (Rosenberg, 1982), and always remains an intrinsic part of the production setting – so much so that it sometimes goes unnoticed. This sort of piecemeal intervention is a sure way of creating habitats that people truly identify with and that evolve commensurately with available resources. Further to this, incremental innovation does not involve major investment risk (see for example Budworth, 1996). Rather, investment is given in small doses tailored to community needs and resultant benefits arguably become part of an evolving locally produced culture.

Alternative technology

The term “alternative technology” was popularised by Peter Harper in the 1970s in the Undercurrents magazine to as part of efforts to propagate a vision of “science with a humane face”. (see www.intertype.co.uk/undercurrents/index.html). Alternative technology is defined by contrast from what are perceived to be prevalent environmentally destructive practices. Alternative technology is aimed to be environmentally friendly, affordable, and to offer people greater control over production processes. In this paper, alternative technology is used synonymously with appropriate technology to cover the wider ethical, cultural and social concerns of sustainable development (see Schumacher, 1973). Alternative technology is acquiescent to incremental innovation because it is, by definition, small-scale and locally embedded – characteristics that provide opportunities for a people-led habitat improvement drive. Alternative technologies can produce better habitats while also nourishing the local poor communities with jobs, income as well bringing other socio-economic and environmental benefits.

Building lifecycle

A building is the final stage in a long process cycle. A building is habitable space with a definitive boundary of walls, floors and roofs/ceilings. The quality of a building is judged in functional, technical and aesthetic terms as related to the human need for health, comfort and welfare.
Hence, the sizes and relations between spaces, the indoor environmental quality (IEQ), durability and spatial-aesthetic appeal are key considerations in assessment of judging a building. In sustainability thinking, a building is conceptualised in terms of its full lifecycle stages with the following process stages respectively: raw-material extraction, building material preparation/manufacture, building construction, building use/maintenance, demolition and disposal/recycling (with inputs of energy, labour, capital and transport in each stage as needed).

Architectural and other forms of design are central for the benefits of innovations to be realised. Each new design is a universe of one – a unique product that combines previously known or unknown building materials into a whole which is more than just a sum of the parts. As per the above definition therefore, any unique design is essentially an innovation. Hence, there is immense potential for innovation via design. This potential is increased many times over when designers don’t just focus on the final product (the building) but open their minds to the opportunities available in all the lifecycle stages of a building. The following arguments and examples illuminate how exploring opportunities for reconceptualisation of product and process at the different lifecycle stages opens more avenues for creativity in the construction process while also saving costs, creating jobs, building communities and saving the environment.

**Sourcing Raw Materials**

Building materials can either be used in their raw form (i.e. without conversion) or after undergoing transformation. From a sustainability viewpoint, using a material in its raw form is the most sustainable alternative especially if such a material is locally available. This is because such a material would be cheaper and impose a lower environmental load. Examples of materials used in raw or near-raw form include wooden poles, bamboo, uncut stone and earth. Though most of these materials are generally deemed to be inferior to the industrially produced ones, experience shows that they are just as capable, through innovative design, of producing functional, durable and aesthetically pleasing architecture. They also offer extra advantages in terms healthier and more comfortable IEQ. For example, the author of this paper has experimented with building with unbaked earth in Uganda with community participation. Pecuniary savings were realised as well as advantages in community networking, training, and minimising consumption of dwindling tree and swamp resources in the locality. There are many earth buildings in the world that have lasted for centuries and new interest in the material in the western world is producing earth architecture as modern as any. CRATerre is an earth construction research in Grenoble (France) that has done extensive work in documenting earth building practices from antiquity to the present, and in creating and disseminating training material (see for example Houben and Guillaud, 1986; and Rigassi, 1995).

Conversion of raw materials into building materials can be done at a number of scales ranging from craft-based through light cottage industry to heavy industrial ones. At the craft-based and light industrial end of the
scale would be such facilities as small brick and lime kilns, timber mills, adobe block making. At the heavy industry end is included cement and steel industry, and the factories for production of highly processed building materials. According to Emmit (2004), the nearer to the heavy industry end of the scale the more expensive, and the more destructive to eco-systems and societies the technology is. In South Africa generally, the predominant materials for construction of government-provided houses are mainly sourced on from the heavy industries. The incremental innovation suggested by this paper is more aligned to the raw-form materials, craft-based and light industries end of the scale. Sourcing building materials through small-scale, local firms nourishes the intended beneficiary communities with jobs and money. The process of housing provision would not only directly contribute to alleviation of poverty in this manner, but would also have multiplier effect of spurring economic activity in other local production sectors. Apart from the above economic advantages, this approach would be beneficial for getting people to socialise together, to develop social cohesion, and become part of the formation of an evolving urban culture. Arguably, working together like this can contribute to people developing mutual trust and respect. Such community building activities can start countering against the debilitating and aggravating culture of crime, idleness and substance abuse.

From Building Materials to the Building

Design gets to finally crystallise into a building through a construction process. Good designers direct the combination of different materials and components into an aesthetically pleasing building that is useable, safe, affordable, comfortable, and durable. They use materials in refreshingly new ways to produce a varied and interesting built environment – which is the opposite of the bland uniformity offered by government today. They orientate buildings to simultaneously fit into, be sheltered and benefit from nature. They locate buildings to form positive outdoor play and socialisation. They have no problem with involving the community in making apriori design decisions and use whatever challenges they come up against as yet another design opportunity.

Examples abound of projects in South Africa that have successfully involved communities. The Mapungubwe Interpretation Centre (by Peter Rich Architects), which won the 2009 World Building of the Year Award, was realised with the significant participation of the community. Major public buildings can be used to teach the community new technologies on the job – technologies which they can later apply to building their own houses. There are further design opportunities in creating innovative ways of using space, for example by creating efficient multi-use spaces in a process of collaborative work between say an architect and furniture denser (for instance as presented in Low [ed], 2008: 60-62). Additionally, there are possibilities for designing kits of parts (such as doors, parts of walls, built-ins etc) that communities can eventually start prefabricating and erecting. Above all, good designers can open local people’s eyes to routinely unnoticed possibilities. A case in point is MMA architects who used bags
of sand, a material so ubiquitous that it is routinely undervalued, to create affordable storeyed houses in Cape Town. In similar vein, architect Jo Noero interpreted four ordinary prototypes of free standing buildings to create a varied dense urban architecture in the Lenasia low-income housing project (see Sorrell, 2009).

Using and Maintaining the Building

Many decisions done at design stage in terms of passive measures and technologies can achieve good buildings with high levels of comfort and low environmental load without much initial expenditure.

Reuse of Existing Building

Reusing existing buildings makes a lot of economic and environmental sense. The locked in embodied resources are not wasted and the no new resource demands are made. To be reusable, buildings must be designed to be adaptable to different users and uses based on flexibility in space sizes and configurations as well as on possibilities for altering the envelop.

Demolishing

When buildings get to finally be demolished, reuse of components is an alternative that can be explored. This particularly requires forethought in terms of designing for disassembly. In this regard for example, bolted connections can be better than nailed ones. Components of buildings which can be reused include bricks, windows, doors, wooden/structural structural members. The rubble itself can also be reused in numerous other ways. It is possible for communities to self-organise to recover as much from demolished buildings as possible. Apart from the usual definition of raw-materials as those unprocessed ones from nature, an innovative approach also includes (demolition and other) garbage as a potential source of raw-materials. Using garbage as a construction resource offers a number of advantages. It reduces the amount of garbage that must be thrown away/treated, it usually freely and locally available, and it can provide employment opportunities for the jobless. In a sense also, use of garbage for construction is a sure way to recover embodied resources and pre-empt consumption of more. The opportunities for innovation in seeing garbage as a building resource is immense. That a good designer can put garbage to refreshing architectural use is evident in the works of Nina Maritz (a graduate of the University of Cape Town) such as at Twyfelfontein Rock Art Museum Visitor Centre in Namibia. Another example is the Wat Pa Maha Chedio Kaew temple in Thailand where monks used approximately 1.5 million bottles to build a temple. More recently, a floating dining room was constructed in Vancouver with empty plastic bottle. Successful incorporation of garbage as a useful resource in the construction process is a sure way of achieving a sustainable system of construction over the entire lifecycle of building in a closed cradle-to-cradle loop.

Government empowered self-help efforts

To catalyse the incremental innovation activities described above, this paper recommends
recommends efforts be diverted from the current housing-provision-centred model to a government-empowered self-help one.

Turner (1976) advocated for self-help approach to informal settlement upgrading because, he argued, personal scale and local variety are natural and even inevitable functions of local and personal decisions. Self-help is a system of production, financing or maintenance in which a significant part is organised and carried out by the beneficiary. “Usually it involves them (the beneficiaries) in an incursion into functions that would normally be the responsibility of either the public or private sectors who are either unable, or unwilling to provide that service” (Ward [ed], 1982:7). This quotation from Ward leads to identification of a third sector which is neither the private nor the public sector. This sector has been termed as ‘the popular sector’ by Turner (1976). Self-help is about facilitating the role of the popular sector in provision of housing. To many, the concept of self-help automatically conjures images of the beneficiaries doing the manual labour such that the so-called ‘sweat equity’ is the key to achieving cost saving in self-help housing. However, the concept does not necessarily require direct labour provision by the housing user. Most self-help builders actually hire labour (see Turner, 1976 and Sanya, 2000). In such a case, “… the owner-builders (act) as their own general contractors, employing much of the labour, buying the materials themselves, and supervising the work” (Ward [ed], 1982:103). What is important is not direct labour provision, but self-determination and autonomy of control by the housing user. Self-help therefore emphasises that the people must be involved in the making of decisions that shape their habitats.

Self-help is not only economically viable (as it mobilises people’s innovative resources in the provision of housing) but it is also a sure way of providing the necessary flexibility and variety in living environments. No authority can anticipate the immense variety of household situations, priorities and specific housing needs. Centrally supplied housing is bound to lead to mismatches between people’s housing priorities and the housing they get.

However, self-help cannot in isolation solve the housing problem. Without any support, self-help means will surely fail as the exacerbating situation of informal settlements attests. Many types of large scale infrastructure and certain public services demand heavy investment and high level coordination the kind of which cannot be provided by self-help means. Self-help can only successfully operate as part of larger system consisting of three levels each with a corresponding scope of responsibility as identified by Turner (1976:117). The central government is the highest authority and its level of action should be to guarantee equal access to resources (land, finance, training and appropriate tools); the intermediate level is the municipal government whose level of responsibility should be provision of infrastructure; and the lowest level is the local community and individuals whose level of action ought to be building and maintaining houses and their immediate surroundings. Thus actions that are targeted at larger catchment populations demanding more stability are better handled at higher levels while those for smaller catchment populations lending themselves to flexibility are better
The central government is the highest authority and its level of action should be to guarantee equal access to resources (land, finance, training and appropriate tools); the intermediate level is the municipal government whose level of responsibility should be provision of infrastructure; and the lowest level is the local community and individuals whose level of action ought to be building and maintaining houses and their immediate surroundings. Thus actions that are targeted at larger catchment populations demanding more stability are better handled at higher levels while those for smaller catchment populations lending themselves to flexibility are better handled at local or individual level. Closely related to self-help is a more fundamental approach termed as ‘the popular approach’ by Hardoy and Satterthwaite (1989). This approach advocates for full participation of communities in determining the form of tenure and property rights, involvement in determining how land use will be defined in settlements, control over which houses (or shacks) have to be moved to pave way for infrastructure etc. It also means giving the poor more access to finance, information and know-how, which can make their participation more effective. The approach calls for formation of community organisations and close collaboration between the government and these organisations. It also requires enhancement of the role of NGOs to act as liaison between the community and government, and provide technical advice and training for the community. Thus, government through scaled-down intermediaries finances and facilitates numerous small self-help projects at community level. In short, the popular approach is a bottom-up one.

The popular approach also advocates that the problem of housing is not looked at in isolation but is put in the broader social and economic context. This requires innovative ways of organising government and other role players in the building construction sector.

In this paper, the specific proposal is that the municipality government gets decentralised in a three tier system. Under this proposal, the role of the municipality is decentralised and its core functions get more streamlined to those that can feasibly be accomplished at a city-wide scale of operation. The lowest level of government (Level 1) would be in direct contact with people and would be responsible for about 500 households. Level 2 would comprise of about 40 Level 1 units. This level would oversee the L1 units below it while also being responsible for more complex buildings and for infrastructure facilities with a high catchment population. And finally all L2 units would fall under the municipality (L3). The municipality’s functions would then include provision and safeguarding of infrastructural facilities with city-wide catchment populations, synchronisation of the activities of L2 units under it and approval of very complex building plans. The current administration system, which expects the municipality to provide housing and regulate all aspects of urban development at neighbourhood level is unworkable and is prone to inefficiencies. To directly concern itself with each individual plot subdivision and house construction as is the case today, the municipality is taking an approach that can only be made successful by heavy expenditure of resources to create a police-state. Such resources are unavailable and a police-state is obviously undesirable.
What is needed is to create more relevant urban management organs at L2 and L1 to oversee the smaller scale aspects of urban development while limiting the role of L3 to a more feasible one of coordination of the L2 units below it and safeguarding of the appropriate category of infrastructure.

Each level of governance should be vested with the powers and enabled to make decisions about the built environment within its area of jurisdiction. L1, which has the most immediate contact with the communities, can be staffed with a core staff of technicians with relevant qualifications in urban and environmental planning, architecture, and health. This team could then, for example, be responsible for the following functions within the L1 area:

- enablement of community participation in decision
- approving of simple building plans; identification,
- demarcation and safeguarding of environmental areas and networks of green;
- safeguarding of village-level communal areas and facilities;
- dissemination of knowledge and information to the community,
- gathering and incorporation of community views in the formulation (or adjustment) of a minimum framework for urban development;
- enforcement of the minimum urban development framework

This would all be in a framework where the municipal government empowers people by ensuring they have access to necessary knowledge, resources and information. As a basic requirement to make the above described system of decentralised operation workable, it is suggested that the municipality sets aside land for public infrastructure elements such as roads, schools and networks of green. This proposal, unlike the acquisition of large chunks of land for public housing or sites-and-services schemes, requires much smaller amounts of land and should therefore be easier to undertake. For a city like Cape Town, which is the largest landowner in its area of jurisdiction, such a process would be further simplified. With the strategic areas thus safeguarded, landowners may now be free to subdivide their land and build as they please as long as they remain within certain reasonable predefined limits (it is preferable that such limits are formulated with the active participation of the community through the decentralised hierarchical administrative units as described).

Additionally, to ensure a reasonably harmonious environment and guide the interactions amongst the various role-players in the housing construction sector, the municipality needs to put certain laws in place.

**Proscriptive not Prescriptive Planning**

Such laws should be proscriptive laws instead of prescriptive laws (see Turner, 1976). As opposed to prescriptive laws, which specify lines of action that must be followed, proscriptive laws define limits within which actors have maximum freedom to operate. Furthermore, current laws and regulations are formulated in legal jargon that even the most seasoned building professionals struggle to
interpret. The new proscriptive regulations should be packaged into formats that are readily accessible and comprehensible by the common man who, under the proposals of this paper, is the main builder of his own habitats. The simplified format can then be disseminated to the people through public seminars and use of brochures. The regulations should be tools with which individuals can create a decent living environment other than means of restricting what people can do.

**Contextualising with Other Role Players in the Housing Sector**

Design professionals do not work in isolation and the last part of this paper is aimed at suggesting a framework for how the diverse role-players in the construction can work together with innovative alternative building technologies to improve habitats. Apart from the community (clients and users) and design professionals, other role-players include government, funding agencies, education institutions, NGOs, contractors and subcontractors, builders and constructional professionals. How these interact with each other is highlighted in the diagram below. In the diagram, the community (the people) are at the centre. The rest of the role players are grouped into three: 1) government and NGOs 2) the education institutions and building professionals 3) the funders, producers and builders.

As per the self-help approach, the producers, builders and artisans would mainly be part of the community; and would in many cases be the actual beneficiaries of the housing. The role-players not only interact with the community but also with each other. Thus the government interacts with producers and builders through empowerment of small BEE
firms to produce materials, or supports the artisans with training.

To facilitate self-housing efforts, each of the three groups must have big overlaps with the communities – meaning that government needs to delegate certain powers to a much lower level as described above. This contrasts with the status quo whereby the lowest authority that can approve a building plan in an urban area is the municipality. The overlap also represents the grassroots NGOs actively engaged in community activism and mobilisation. Such groups remain in touch with people, understand their needs, dispense advice, and undertake advocacy on the community’s behalf. An additional proposal here is that innovative funding methods that are embedded in the community be used to avail credit to people. Here, the Noble-Peace-Prize-winning GRAMEEN Bank microfinance model suggests itself as a possibility for government to work closely with NGOs to get credit down to the grassroots. In this model, small loans are given to the very poor people with no collateral prerequisite. These loans are coupled with education of the recipients and strong encouragement to save. Through small self-organised groups (consisting of family, neighbours and friends) the loan recipients support each other in their poverty alleviation activities. Also, the peer-pressure from the groups ensures high loan repayment rates. Compared to providing a finished house, this micro-credit approach offers obvious advantages in terms of lower investment as well as the fact that government eventually recoups the money. The GRAMEEN model is also interesting because, although it includes shelter as one of its aims, it is only incorporated as part of a broader range of others such as clean water, basic hygiene and health, small-scale agriculture, and financial propriety (see www.grameen-info.org). The government would need to make funds available on good terms to kick start and maintain the micro-credit process. This micro-financing model can bring banking ownership right down to small communities in the informal settlements so that they too start accumulating wealth through savings-based credit creation.

In this proposal also, education institutions need to leave the comfort of the ivory tower to start having community presence and to impact positively on the communities. This requires a shift from exclusively elitist curricula to those that are more responsive to the needs of the majority poor. Community involvement would require that different disciplines work together – sociologists, doctors, social scientists, economists, architects, product designers and mass-communicators working with community participation to find ever innovative ways of imagining, designing, financing and coordinating the improvement of human habitats and life quality. Student projects could start getting them to engage with the society around them, to apply their minds to human settlement problems, and to create and disseminate innovative ideas in doses communities can digest. In this ethical role, university education does not just aim at transmitting knowledge but also at imparting values to graduates; values that will spur them into empathising with the indigent. The young minds can take full advantage of the self-organising possibilities in the internet to network with each other and to avail communities with useable information similar
to, for example, the system of developed by Open Source House (see www.os-house.org. The graduates would emerge into ethical professionals with the will and skills to play a meaningfully role in solving the problems of urban informal housing. There is plenty of opportunity for government and education institutions to liaise to in terms of strategic visioning, priority setting, forging of bilateral and multilateral links, and research funding.

CONCLUSION

There is a housing deficiency in South Africa that is, to a large extent, being fulfilled by burgeoning informal settlements. The government strategy of providing completed houses to beneficiaries is failing to meet the deficiency. Moreover, this approach is also prone to a range of qualitative problems. This paper has proposed an alternative method based on incremental innovative intervention as a more efficacious approach in South Africa’s context. The approach suggested hinges on government-empowered self-help as an avenue for unlocking the currently latent resources and innovative energy in communities. Government should limit its role to that of a provider of a guiding framework within which the people have the liberty to innovate at all levels of the production chain to create sustainable habitats while saving money, creating jobs, building social networks, and preserving the natural environment.

It is appreciated that the reality on the ground is such that the proposals herein cannot be realised overnight or even in a couple of years but could take decades. There are powerful vested interests to contend with and the poor masses would probably be driven to riot by any suggestion that they include something as “dirt” cheap as earth or reclaimed waste as part of the solution for self-building their abodes. After all, recent “toilet riots” in Cape Town demonstrate that in present day South Africa, even the very poor prefer to have concrete walls for their toilets.

Mindset change takes a generation – which is approximately 30 years. Starting today, incremental innovation can lead to greatly improved and improving human settlements by 2050. Perhaps above all, people need to be imbued with a pride that will open their eyes to the riches within their seemingly hopeless communities. A richness so profuse that world famous architect Jo Noero took the shack and the informal as thegenesis of his design philosophy which, in a refreshingly wicked twist that only gifted designers are capable of orchestrating, he has successfully applied to informal and upmarket buildings alike. This underscores that within the slums is the power; the power to innovate liveable habitats for the people, by the people, of the people.
Bibliography


A Sustainable Housing Calculator: Demonstrating the long term benefits of sustainable building interventions

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ABSTRACT

“While the environmental and human health benefits of green building have been widely recognized, [research reveals that] minimal increases in upfront costs of 0-2% to support green design will result in life cycle savings of 20% of total construction costs – more than ten times the initial investment. In other words, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of $1 million in today’s dollars over the life of the building.” Aileen Adams commenting on “The Costs and Financial Benefits of Green Buildings,” a report to California’s Sustainable Building Task Force, October 2003.

Introduction

The preconceived notion that sustainable building interventions are too expensive to be considered for possible use in subsidy housing developments has been challenged for many years. During the past decade, the cost of many of these interventions has been falling rapidly, and the need for a reduction in water and electricity use has become more acute. The result of this intersection between the questioning of old assumptions, falling costs, and growing environmental concerns has been the increased use of sustainable building interventions, particularly in the commercial/industrial and high income residential sectors. However, there has been little uptake of these interventions in the low income, mixed income and subsidised housing sectors. There is therefore a pressing need for tools that can enable government officials, developers, and housing contractors to measure the viability of more sustainable methods of construction, particularly in these lower income sectors. A significant step in this process was taken with the life cycle assessment case study that was previously published in the first edition of the Sustainability Institute’s “Sustainable Neighbourhood Design Manual” (SI, 2009). It demonstrated that even a development that included a full range of sustainable interventions would be cost effective when measured over a 30-year life cycle. By its very nature of being a case study, its findings were directionally very important, albeit somewhat limited due to the use of data from a particularly expensive case.

The next natural step in the process of defining financial viability in settlements was to find
ways of efficiently calculating the true costs of sustainable interventions over the full life cycle in a variety of unique situations. The need for such a tool led to the creation of the Sustainable Housing Calculator, which we will introduce later in this paper. The first section of the paper repeats the background information on the need for sustainable building materials and the life-cycle cost assessment methodology used in both the original case study and in the new sustainable housing calculator. The second section provides an overview of the functioning of the calculator and a section on how to use it. Finally, the paper will conclude with some of the key findings that were generated by the calculator when tested with live data by the Sustainable Neighbourhoods Programme at the Sustainability Institute in 2010.

Section 1  Background and Methodology

There is now an emerging global consensus that unsustainable resource use (global warming, the breakdown of eco-system services and the depletion of key renewable and non-renewable resources) will threaten the existence of large numbers of human and non-human species. These threats have been well documented in several major international reports, including inter alia the impact of human-induced global warming (Intergovernmental Panel on Climate Change. 2007), the breakdown of the eco-system services that humans and other living species depend on (United Nations. 2005), the depletion of oil reserves (International Energy Agency. 2008), the ecological threats to food supplies (Watson et al., 2008), the threat of water scarcity (Gleick. 2006; United Nations Development Programme. 2006), and the negative impacts on the poor of the global crisis of unsustainability (United Nations Development Programme. 2007). The result is a global consensus that the continuation of unsustainable modes of development will need to be replaced by what the Johannesburg Plan of Implementation adopted at the World Summit on Sustainable Development (WSSD) in 2002 defined as “sustainable consumption and production”. This broad framework has led to a focus on cities because it is generally assumed that the construction and operation of the built environment is responsible for approximately 50% of all CO2 emissions. There is a growing consensus that cities have to play a leading role in the transition to a more sustainable socioecological regime (United Nations. 2006).

Significantly, recent empirical research commissioned by the United Nations Environment Programme (UNEP) has identified three priority challenges, namely transport, food supplies and the construction of buildings/urban infrastructure, which together account for more than 60 percent of total energy and materials used by the global economy. This brings into focus the technical aspects of the design and construction of buildings. More sustainable use of resources means reducing CO2 emissions, using less primary material resources and reducing unproductive waste outputs. Sustainable living is made possible when the built environment is configured to achieve these objectives. There is, however, a common – and sometimes offensive – opinion that sustainable built environments will remain the preserve of the affluent and/or developed economies, while minimum standard conventional housing provision remains the only affordable
option for the poor. This common assumption is based on hard facts about what it costs to construct the physical structure of the house and related infrastructure, but it ignores the cost of operating the house over its entire life-cycle. This is highly problematic in light of the fact that life-cycle operating costs are projected to rise faster than inflation due to declining supply of key input resources.

The objective of this research was to demonstrate that a life-cycle approach rather than the more traditional once-off capital cost approach generates results that demonstrate that sustainable living is more affordable for both the household and the tax base of the city. This has been achieved by collecting data and information on life-cycle costs of both minimum standard conventional housing provision (hereafter referred to as the “current approach”) as well as a package of “sustainable living” applications. Conclusions were reached by measuring and comparing 40-year life-cycle cost effectiveness of the two alternatives. The results are expressed as net present values, using a discount rate of 9%. According to Wrisberg, there are several “life-cycle” methodologies that are in use in the world today that have emerged in response to the global demand for “tools” to determine the material and energy content of particular production and consumption processes, as well as environmental impacts (Wrisberg et al. 2002).

A “life cycle” approach is necessary because it has become imperative to take into account the full capital and operational costs of a given production or consumption process over the life cycle of the process. Without this kind of analysis it will not be possible at the design stage to determine which process will contribute most towards achieving a more sustainable socioecological regime; or alternatively, which one will do the least damage. However, a wide range of life-cycle methodologies have emerged for different purposes. These included the following: Life Cycle Assessment, Material Input per Unit of Service (MIPS), Environmental Risk Assessment (ERA), Material Flow Accounting (MFA), Cumulative Energy Requirements Analysis (CERA), Environmental Input-Output Analysis (env. IOA), analytical tools for eco-design, Life Cycle Costing (LCC), Total Cost Accounting (TCA), Cost-Benefit Analysis (CBA) and Cost Effectiveness Analysis (CEA). It is not possible to describe and analyse these different methodologies here.

Suffice it to say that a CEA approach has been adopted because this makes it possible to compare the “conventional approach” to housing delivery to a “sustainable living” alternative across the life-cycle. The essence of this approach, according to Wrisberg, et al (2002), is that it does not quantify benefits like CBA, even though they regard it as a derivative of CBA. Citing a report by RPA (1998) entitled Economic Evaluation of Environmental Policies and Legislation, Final Report for DG III of the European Commission, Contract Number: ETD/97/501287, Wrisberg, et al (2002) states that CEA aims at determining the least cost option of attaining a predefined target after the fundamental decision process has been finalised.
CBA, by contrast, is used to assess viability of an investment by quantifying the future realisation of costs and benefits, generally through discounted cash-flow analysis. An investment is viable if the present value of all benefits exceeds the present value of all costs. The net present value (NPV) should therefore indicate a positive return. The following sections will cover, first a definition and description of housing, including the current approach and sustainable living alternatives; second a description of what was included in the measurement and how the measurement was executed; third the actual measurement of data collected on the current approach; fourth the actual measurement of data on the package of sustainable living applications; and fifth an interpretation of the results and formulation of recommendations.

The intention here is not to recoup on housing literature through the ages, but it is of relevance to firstly refer to John Turner’s 1972 benchmark work where housing is defined as both a noun and a verb (quoted in Spence, Wells & Dudley. 1993). When considered as a verb, the focus is not on the physical structure of the house, but on the processes of how people came to be housed and how those people continue to sustain their existence in and from such a house. Bourne (1981) defines housing as a ‘flow of services’ with inputs, a matching process and outputs. On the outputs side, shelter is only one such output and is supplemented by equity, satisfaction and status, environment, access, services and social relations, all of which have a bearing on sustainable living. This agrees with Turner’s laws of housing, which emphasize that housing is not what it is, but what it does in the lives of people (Spence et al. 1993). Even though such conceptualisations of housing find many practical manifestations in various systems taking care of the livelihoods of the poor in South Africa, they are not taken to the logical conclusion of one integrated cost effectiveness framework for evaluating housing delivery in its entire life-cycle.

When turning to the sustainable living construct – or sustainable development to make it a delivery construct – it is once again not the intention to reflect on the growing volumes of literature, but as with the brief return to seminal housing definitions, the watershed Brundtland Report (World Commission on Environment and Development. 1987) and its definition invoking the needs of future generations counterbalanced by the as yet unmet current needs of a large proportion of the world’s population is of relevance. The three mutually reinforcing and critical aims of sustainable development conceptualised in the Brundtland Report, namely improvement of human well-being, more equitable distribution of resource use benefits across and within societies and development that ensure ecological integrity over intergenerational timescales (see Sneddon, Howarth & Norgaard. 2006) serves as reality check when reflecting on how to improve the livelihoods of literally millions of South Africans. It is an undeniable fact that South Africa’s total ecological footprint is already between 15 and 20 percent higher than its total biocapacity (World Wildlife Foundation. 2006) and that signals like power outages and water restrictions clearly reveal that it is impossible to keep on expanding business as usual as the current approach to housing delivery is doing. The National Framework for Sustainable Development that...
was adopted by the South African Government in June 2008 (by Cabinet resolution) explicitly stated that South African cities and housing construction must adopt sustainable resource use guidelines.

The National Department of Human Settlements is responsible for housing delivery. Since 1994 it has adopted and implemented two quite different housing policies. The first was articulated in the 1998 White Paper on Housing which essentially provided for a capital subsidy to drive housing delivery for poor households. Because this subsidy included the land cost, the urban poor that received houses landed up on the outskirts of the urban system far from places of work and connected via expensive transport systems. Since 2004 the Department of Human Settlements (known at that time as the Department of Housing) has implemented a new housing policy known as Breaking New Ground. This policy recognises the need to provide for a range of interventions aimed at creating integrated human settlements rather than marginalised ghettos. Significantly, the current approach does not ignore sustainable development – at least not in policy and strategy development. Since the promulgation of the Housing Act, 1997 (RSA, Act 107 of 1997), housing policy development has increasingly emphasised the importance of sustainable livelihoods. Such conditions were defined in the Act and subsequently further clarified with policies and strategies and also given content with new funding arrangements.

The Comprehensive Housing Plan for the Development of Integrated Sustainable Human Settlements (otherwise known as Breaking New Ground) as announced by the Minister of Housing, Dr Lindiwe Sisulu, in September 2004 (RSA, National Department of Housing. 2004) provides for not only the development of low-cost housing, medium-density accommodation and rental housing, but also the promotion of the residential property market through stronger partnerships with the private sector; social infrastructure; and amenities to promote the achievement of a non-racial, integrated society. Since late 2008, the Minister and her Department have emphasized the need to include “sustainability”. This current approach entails making available a top structure subsidy of R43 506 (2008/09 amount) that must provide as a minimum a 40m² gross area, 2 bedrooms, separate bathroom with toilet, shower and hand basin, a combined kitchen/living area, “Ready Board” electricity supply and it must adhere to NHBRC technical specifications (Provincial Government of the Western Cape (PGWC), Department of Local Government and Housing, 2007). These technical specifications are quite comprehensive, but nevertheless distinguish between Level 1 and Level 2 User Performance parameters, with Level 1 “intended for houses, where for reasons of access to initial capital a user is able to tolerate more frequent maintenance cycles, limited penetration of water to the interiors, discernable deflections, minor levels of cracking etc.” (RSA, National Department of Housing. 2003: 38). Even though the specifications also prescribe a design working life of 30 years for structural systems and non-accessible components and 15 years for repairable or replaceable components, the existence of a Level 1 illustrates that it remains a tendency to shift as many costs as possible
later into the life cycle of the asset.

This invariably means lightening the financial burden for tax-funded housing providers, but increasing the burden for tax-funded infrastructure operators and self-funded households. The sustainable living applications package for the sake of this research project moves from the premise that the initial tax funded provision should be substantially increased in order to reduce tax funded and self-funded life-cycle operating costs, but simultaneously achieve better total life-cycle cost effectiveness. Although the emphasis is therefore on cost-effectiveness measurement (as explained in the next section), the sustainable living package selected for this comparison requires a much higher initial investment in order to introduce qualities indispensible for social, socio-economic and ecological sustainability. The original research project that created the foundation for the sustainable housing calculator described in the remainder of this chapter used data from a package of sustainable building interventions used in the Kosovo housing project in the Western Cape and the Lynedoch Ecovillage.

As identified in that project, the main limitation was that it only measured one specific case to prove the point that sustainable building interventions are cost effective over the full life cycle of the development. We now need to go to the next step and show that this is possible in other settings, and to assist planners in choosing the optimum combination of sustainable building interventions. Also, the costing will vary over time as the cost of existing interventions comes down when technologies become more developed.

A possible solution would be to expand this research to a comprehensive set of case studies in different settings and using different interventions. Although this would present a directionally compelling case that would increase the likelihood of the consideration of sustainable building interventions, it would not help to make individual project decisions on the best combination of interventions and which would give the best economic payback with the most environmental benefit.

This clearly leads to the need for a calculator that will have the flexibility to allow the user to input the local criteria, and test the effectiveness in that local situation through various interventions. This should allow outputs which can lead to optimized solutions, as well as calculating the length of time to reach economic payback and quantifying the environmental benefits.

With assistance and cooperation from Standard Bank and the National Department of Human Settlements, the Sustainable Neighbourhoods group at the Sustainability Institute has developed just such a Sustainability Institute has tool. This paper includes practical guidelines which will enable developers, government officials and built environment professionals to use the financial calculator, and to understand and utilise final outputs. More detailed instructions are included with the electronic versions of the calculator.
Cost effectiveness analysis

Cost effectiveness analysis is a technique for investment appraisal prescribed in the South African National Treasury directives. The "Medium Term Expenditure Framework Treasury Guidelines: Preparing Budget Proposals for the 2007 MTEF" (RSA, National Treasury. 2006), expresses the following intention: “It is the intention of the National Treasury to progressively require more detailed analyses as funding requests are becoming larger compared to available resources. Under these circumstances it is appropriate to prioritise requests which can demonstrate the largest benefits to our country.” Since the 2007 MTEF, all new infrastructure projects or programmes require some form of appraisal to demonstrate advanced planning. Such appraisal may include needs analyses, options analyses, cost-benefit analyses, lifecycle costs and affordability analyses. Cost-effectiveness analysis (CEA) was specifically identified by National Treasury as a tool that can help to ensure efficient use of investment resources in sectors where it is difficult to value benefits in monetary terms. They specifically identified CEA as useful for the election of alternative projects with the same objective (quantified in physical terms), and it is most commonly used in the evaluation of social projects – e.g. in the health or education sectors (RSA, National Treasury. 2006). It is therefore a logical deduction to use CEA for measuring the long term costs of settlements and housing. A critical factor is the selection of a discount rate to convert future money into present value in order to compare costs and benefits spread unevenly over time. The higher the discount rate, the smaller the weight of future costs in the NPV. Seeing that the majority of costs in a capital investment are incurred early in the life-cycle and benefits are accrued over the longer term, it is advisable to use a higher discount rate in order to rather have a pessimistic view on future benefits. Another factor influencing the choice of a discount rate is the economic situation of the particular source. Winkler, Spalding-Fecher, Tyani and Matibe (2002) for example used the social discount rate (then 8 percent) for tax-funded investment, but a consumer discount rate of 30% for investment by poor households in their cost benefit analysis of energy efficiency in urban low cost housing. The authors argued that poor households do not have money to invest upfront, forcing them to rely on very punitive sources of capital.

In cost effectiveness analysis, benefits or returns are not quantified. The costs incurred over a period of time for two or more alternatives serving the same purpose are discounted to a NPV and the alternative with the lowest NPV therefore represents the most cost effective investment. It stands to reason that conservatively future costs should be weighed heavier in the NPV, meaning a lower discount rate. Similarly, future costs for poor households with their lower than inflation increase in revenue should be weighed conservatively more than present costs by means of the use of a lower than social discount rate. However, for the sake of simplicity and because we may be accused of deliberately favouring the sustainable living alternative with its higher capital and lower life-cycle operating costs, we used the 2007 National Treasury prescribed 9% social discount rate for all sources.
Section 2 Using the Sustainable Housing Calculator

In this section, we will provide guidelines for the use of the financial calculator; we will list several types of costs and various funding sources within the calculator. These sources contribute to the financing of life-cycle costs. We will also provide some thoughts on potential uses for the calculator in this section.

To ensure the accessibility and transparency of the calculator, it has been developed in Microsoft Excel. All of the calculations can be accessed without a password, although some sheets remain in the background in order to reduce the complexity of the tool. Built environment professionals, officials, students and people with the required technical skills can quite easily work through the calculations and make desired adjustments. The development of the calculator has been funded by Cordaid, Standard bank and the NDHS for the purpose of assisting government officials, contractors and built environment professionals in measuring sustainable interventions in settlements. The tool is open-source and is therefore meant to be used and adapted as widely as possible.

Working with the input items:

1. Interventions

The calculator comes with a number of pre-programmed sustainable building interventions. These interventions resulted from research carried out by the Sustainability Institute, Stellenbosch University, Standard Bank, Jefarres and Green Consulting Engineers, Meshfield Sustainable Innovation, and ACG Architects in 2009 and 2010. A number of the most cost-effective and environmentally beneficial interventions were selected, and costs were based on costs in the Western Cape at the time of the study. Although costs may vary in other provinces and over time, the selected interventions provide a good starting point for cost-effectiveness calculations. Because the calculator is built in Excel without locked cells or complicated programming, it is not overly difficult to replace the base values with other values that are relevant to any particular project, in any province. If a Quantity Surveyor is available to the project team this task can easily be assigned to the QS.
2. Costing

Within the calculator worksheet (or “tab”) labelled “Input”, there is a heading called “Costing and NPV Assumptions.” There are costs for 15 pre-selected sustainable building interventions in this section, covering a range of best practice options for reducing electricity and consumption, and alternate, sustainable sewage treatment interventions. The calculator can easily measure the effectiveness of other interventions by renaming one of the rows and replacing the cost variables with the relevant data for that intervention. The column for Current Cost reflects the capital purchase cost of each intervention.
3. Source of funding

Within the costing section there is also a column which allows the user to select the source of funding. Several pre-selected funders have been loaded into a drop down box (funders including the municipality, the Department of Human Settlements, the household, and a private developer). It is also possible for the user to add additional funding sources in the spaces provided. This step is important as it allows for a summary to be made of costs per funder, and it compares these costs to the party(ies) receiving long-term benefits. Openly calculating these costs makes it easier to identify funding gaps.
4. Start/end dates

Within the “Costing and NPV Assumptions” section of the Input worksheet are start and end dates, which will, in most cases, be “0” and “0” respectively. This illustrates capital investments that are made only once. However, it may be necessary in some developments to retrofit or add interventions after the initial construction is complete. An example of this may be the post-project inclusion of solar water heaters. If interventions have a limited life cycle (for example, one could argue that the life cycle of SABS approved solar water heaters is generally about 20 years), it also becomes necessary to include replacement costs in the calculations by adding the cost again at the end of the life cycle (for example year 20 for solar water heaters).
5. **NPV**

The value for the NPV column represents the Net Present Value discount rate. When items are entered that have a future cost, such as the solar water heater replacement, they require a value for NPV to discount them to an equivalent present value.
6. Base development costs

The base development cost columns allow you to control the values entered into the calculator for land, top structure, and infrastructure. It is important to have these items listed separately so that the results can be kept up to date. For example, land costs will vary significantly from site to site, so adjustments in this column can allow you to compare the costs of projects without having to use a misleading average. Another example would be the amount for the basic top structure. This amount can be updated each year as the new subsidy amounts are announced by government, and as costs increase.
7. Operating expenses

If the user scrolls to the right within the “Input” worksheet, he or she will find an “Operating Expenses” section. This section allows the user to enter the expenses that will occur after construction for the ongoing maintenance of the building and its utilities. A key difference from the preceding section on Base Development Costs, however, is that there is also a space here for NPV or cost escalation. This has been added to allow the user to factor in future increases in operating expenses. Each line provides separate entry points for maximum flexibility so that realistic estimates can be entered. As stated in the previous section of this paper, simply using an overall NPV discount rate (of 9% for example) might reveal a much more rapid increase than a projected rise in inflation over time.
Adjust intervention list

When all of the data points are entered and/or reviewed, the calculator is ready to produce results. The main interface needed for this task is the first section of the Input worksheet, namely the list of the sustainable building interventions on the left-hand side (with Y or N options). Although the calculator was designed to be used to compare sustainable options to conventional options, it can also be used to compare any two combinations of housing developments with one another. This can be done by selecting scenarios (Yes or No scenarios in the drop-down box) to indicate whether that intervention will be included or not. There are separate columns providing up to five different housing typologies within a development. To indicate whether a type should be included or not, simply enter the amount of units that will be built for each type in the row below the name of that type (e.g. RDP, GAP, MID). The abbreviations are defined as follows in the base case: RDP is used for basic subsidy housing, GAP columns are used to allow for three different types of houses aimed at the gap market. MID indicates market-priced housing, typically the lower end of the market which is targeted towards those who narrowly qualify for a housing bond with the banks.

Making Changes to more advanced inputs

1. Calculations – as mentioned previously in this chapter, the calculations are all included in excel spreadsheets that are not locked or password protected. A few rows and columns may be hidden in the main input sheet to make the calculator less complicated,
but these can easily be revealed by an advanced user who wishes to examine or change the methodology. Everything has been left open for the sake of transparency, and to allow the tool to be adapted easily by advanced users.

2. Energy use assumptions – the worksheets on the extreme right (Subsidy, GAP, and MID) contain the energy use assumptions. If a new intervention is added, or an existing one needs to be modified to update newer versions of technologies for cost or environmental benefit, the values can be updated in the appropriate cells there.

3. Adding new interventions – The calculator allows for the use of up to 15 interventions. If a different intervention is required, the user can simply overwrite one of the existing interventions’ names, costs, and environmental benefits in these worksheets.

Examine Output

With all of the above items reviewed or modified, you are ready to proceed with using the calculator to evaluate a proposed development.

1. Single use comparison – In its simplest form, the calculator can be used for the original purpose, i.e. to compare the inclusion of a package of sustainable building interventions to more conventional standard interventions.

2. Stress testing a plan – Once all of the data has been entered and results generated from the calculator, users will find that it is very easy to “play around with” the input screen by including or removing various interventions to explore the impact on financial and environmental costs and benefits of a proposed development. This allows users to find the ideal combination for a specific site. Users can also stress-test the sensitivity of the calculator to various theoretical assumptions, for example by changing the NPV discount rate for future electrical costs to reflect a higher rate of Eskom rate increases.

3. Post analysis/case studies/proposals – The calculator can also be incorporated into case studies and proposals in order to illustrate the benefit of particular development interventions as compared to what would have occurred if a different package of interventions had been used.

Personalizing the Tool

Users are openly invited to modify the tool as they wish, and to use it for any purpose. Users are, however cautioned against making modifications other than those specifically outlined above as it may lead to incorrect results. This can be controlled by ensuring that if any changes are made to the calculation methodology or formulae
in the cells that you also include some quality assurance testing to validate that the results are still being calculated accurately.

**Conclusion**

To test the results that would be generated by the calculator, we used actual data for the Western Cape generated by Quantity Surveyors. Fifteen sustainable building interventions were assessed through the calculator, measuring the capital costs, the operating costs, and the environmental impact of each. The findings of this process confirm the conclusion of the original life-cycle assessment case study in that sustainable building interventions were proven to be more cost effective over the full life cycle of a housing development. Although this was again as directionally important as the findings from the first study, the result of an examination of the break-even point of each of the individual interventions was also highly illuminating. Many of the interventions broke even over a surprisingly short period of time even without consideration of their environmental or health impacts. The following are the highlights of these findings:

1. The following interventions pay back within one year of construction:
   - Hold-flush Toilets
   - CFL Bulbs
   - Aluminium Windows
   - Duplex - Shared Walls
   - Compressed earth blocks (If not locally available, Block 90//90 are also highly cost effective)

2. The following interventions pay back within less than 15 years:
   - Low-flow Fixtures
   - Basin to feed cistern
   - Solar Water Heater
   - Efficient Design

Though ceilings and ceiling insulation were not found to be particularly economical interventions, the significant health and comfort benefits they provide outweigh the costs of the interventions.

Greywater Recycling is cost effective within a 15 year horizon, but only on middle-income housing that currently utilise potable water for garden irrigation.

Though rainwater harvesting is not particularly economical, it does provide environmental benefits and in water poor areas should be considered regardless of the costs.

In summary, our analysis revealed that nearly all sustainable building interventions were economic over the life cycle of a building. If ecological benefits and savings to local government are also calculated, the benefits of implementing these interventions become even more decisive.

With the use of the Sustainable Housing Calculator, the long-standing debate on the cost-effectiveness of sustainable vs. conventional building interventions can finally be examined objectively for improved decision making.

Contact information at www.sustainabilityinstitute.net).
‘the major problems in the world are the result of the differences between the way nature works and the way people think.’
Gregory Bateson

“We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.”
Aldo Leopold

“If everyone helped their neighbour then who would be without help”
Graffiti on a Salt River factory, Cape Town

“Science enables humans to satisfy their needs. It does nothing to change them. They are no different today from what they have always been. There is progress in knowledge, but not in ethics. This is the verdict of both science and history, and the view of every one of the world’s religions”
John Gray Professor of European Thought at the London School of Economics 2002

“There is but one way to save ourselves from this hell: to leave the prison of our egocentricity, to reach out and to one ourselves with the world”
Erich Fromm

“However fragmented the world, however intense the national rivalries, it is an inexorable fact that we become more interdependent every day”
Jacques Yves Cousteau

“It takes generosity to discover the whole through others. If you realize you are only a violin, you can open yourself up to the world by playing your role in the concert”.
Jacques Yves Cousteau
This article will explore issues of sustainability and culture and attempt to deal with some deeper questions interdependence, fairness, decency and wholeness raise. The aim of the article is to deepen the conversation about sustainability and the establishment of sustainable human settlements.

We live in a paradoxical and perilous time rendered more so by a deficit of vision (Orr, 2009: 9). We live in a time of transition, a time when all is changing and being challenged – weather systems, ecosystem, our interaction with nature, our understanding of other beings. Decades of exploitation of natural resources and a dominant culture of consumerism has culminated in us living in a time of environmental crises, a time of progressive and accelerating destabilization of our entire planet. As a result, we have forced ourselves into a situation whereby changes in the way we manage our natural resources is not only inevitable, but is essential to our survival.

Addressing the current state of the built environment and ensuring new developments and buildings are designed to the highest standards, is thus becoming increasingly urgent as the negative environmental impact of humans is better understood, and our complete dependence on ecosystems is more apparent. Sustainability in architecture and planning is generally thought of in terms of resource efficiency, pollution reduction and mitigating impacts on the natural ecosystems. It can be argued, however, that human wellbeing and planetary wellbeing are intricately interwoven and that any effort to teach about sustainability presupposes the resurrection of the natural world and its value.

Assertions about environmental problems are created and interpreted by people with different perspectives and interests and thus very different ways of evaluating the same issue.

Because environmental problems and solutions manifest differently depending on your perspective, we must include different perspectives and methods - economic, ethical, cultural, scientific, phenomenological and epistemological - to understand and ameliorate them.

Persuasive talk about environmental problems and solution misleads by conveying the impression that these challenges are merely a problems that can be quickly solved by technological fixes without addressing the larger structure of ideas, philosophies, assumptions, and paradigms that have brought us to this moment in history where the world is in the grip of multiple crises. The point is the same as one that has been attributed to Einstein: “significant problems we face cannot be solved at the same level of thinking we were at when we created them” (Calaprice (in Orr) 2004:292)

In a very dynamic and changing context for environmental knowledges and in order to bring to fruition important visions of sustainability, scientists, architects, planners and built environment professional must attend to personal and cultural interiors – including values, worldviews, and religious beliefs – because they all play a role both in creating and resolving environmental issues. It is the aim of this paper to explore the more indeterminate and ambiguous nature of the
issues. It is the belief of the author that great benefit would be derived by a more conscious acknowledgement and awareness of how cultural forces are influential and how they pattern our everyday activities and responses. We should explore the emerging economic and ecological issues as well as matters that are deeply cultural, ethical and spiritual.

This article further attempts to highlight issues of sustainability in an unfair world and attempts to deal with some inconvenient questions fairness, decency and wholeness or interdependence raise. The aim of the paper is to deepen the conversation about justice and solidarity.

There is incoherence between the dominant paradigm and our experience of increasing complexity, interdependence, and systems breakdown in our lives and the world – in terms of helping us perceive the world clearly, describe it adequately or act wisely. For human development to be placed on an ecologically sustainable path, the relationships between people and nature will have to change. It’s an extraordinary time, a time where we have remarkably little knowledge about the future.

There is increasing recognition that global conditions of unsustainability, inequity and environmental degradation can only be adequately addressed through a fundamental change towards more relational thinking and an integrative consciousness which is both critical and deeply connective (Sterling 2003,8). Ecologically sustainable development requires an extension of thought beyond that which was the norm for most of the 20th century, towards a much more integrative perspective that brings together (at least) society, economy and the environment with present and future dimensions. This paradigm change, needed for a sustainable future, has yet to be embraced by the mainstream of designers and built environment professionals.

Exploring the goals of sustainable development

In its limited form the word sustainable simply means “long-lasting”. We know, however, from global and local debates, that the word is multi-layered and has come to represent the interconnectedness of the social, economic, political and environmental. Sustainability is no longer the preserve of the environmentalists. Sustainability has become the focus of governments as they seek to act on deepening levels of poverty and inequality.

Largely irrespective of the definition one chooses to use, ‘sustainability’ appears to be something we are rapidly moving further away from, rather than towards. All the measures we currently have, from a plethora of different studies and approaches across the spectrum, and at scales from local to global, whether, for example the 2005 Millennium Ecosystem Assessment (MA), WWF’s annual Living Planet Index, the IPCC’s Fourth Report in 2007 and various updates thereto, UNEP’s 4th Global Environmental Outlook (GEO4) in 2008, the Organisation for Economic Co-operation (OECD) 2009 Factbook on Economics, Environment and Social Statistics, the World
Bank Cities and Climate Change Report 2010, the UNEP 2010 Green Economy report, the UN Habitat State of Cities Report 2008, the 2010 State of the World report by the Worldwatch Institute for example “Transforming Cultures – From Consumerism to Sustainability”, or national level studies such as South Africa’s Environmental Outlook’ in 2007, to name a few, all return the same message - that we are mining our natural capital, that we are compromising the future functioning of natural systems and that we are putting more and more people into vulnerable positions of compromised health, wellbeing and livelihoods.

In 2006 the World Conservation Union’s (IUCN) ‘renowned thinkers group’ stated that “Evidence is that the global human enterprise is rapidly becoming less sustainable, not more”.

By all accounts then the planet is in a growing ecological deficit and we absolutely need new approaches, we need to be changing course, changing mindsets, and changing measures.

As so eloquently expressed by Kofi Annan, then Secretary of the UN at the 2002 World Summit on Sustainable Development, “…and let us face an uncomfortable truth: the model of development we are accustomed to had been fruitful for the few, but flawed for the many. A path to prosperity that ravages the environment and leaves the majority of humankind behind in squalor will soon prove to be a dead-end road for everyone.” (as quoted in King, 2009: 1)

American author and environmental activist Derrick Jensen states that the fundamental truth of our time is that our dominant western culture is killing the planet. Further he maintains that we can quibble all we want – about whether it is killing the planet or merely causing one of the six or seven greatest mass extinctions in the past several billion years, but no reasonable person can argue that industrial civilization is not grievously injuring life on Earth (Jensen, 2010).

What then, is the ultimate goal of striving for ‘sustainable development’? It must surely be human wellbeing, because it is only when the majority of people alive at any point in time are satisfied with their lot, that the planet will be adequately taken care of and will in turn, provide adequate underpinning ecosystem services for humankind.

Changes in worldviews, institutions and technologies will be necessary not only to achieve lifestyles that are better adapted to today’s ‘full world’ context (Costanza et al., 2010) but to achieve life and survivability for many. Adam Kahane expands on this idea of a full world and states that “the fullness of our world produces a threefold complexity. We can pretend that we are independent and that what we do does not affect others (and what others do does not affect us), but this is not true. We can pretend that everybody see things the same way, or that our differences can be resolved purely through market or political or legal competition, but this is not true. And we can pretend that we can do things the way we always have, or that we can first figure out and then execute the correct answer, but this is not true (Kahane, 2010:5).
We are living in a pessimistic period but the knowledge that change is necessary is perhaps grounds for optimism: maybe we do, at last, have the chance to make a better world.

At the current moment then lots of normative shifts are underway as we know that we need radical change. We are thus living in momentous extraordinary times: times where we have remarkably little knowledge about the future; times when change is accelerating, and when the horror of what could happen if we do nothing and the brilliance of what we could achieve if we act can both, at times, be overwhelming. The current uncertainty, however, is also part of the challenge that makes the built environment professions such fascinating and absorbing professions. The work of designers and built environment professionals I would argue is thus entering a critical and most important phase.

The human-nature split, or nature-culture divide – ecological unintelligence?

Bill Mc Kibben (2008, 19) argues that “partly we have failed to act because we have become pretty denatured.” “The economy seems more real to us than the ecosphere” (McKibben 2008, 20). Embedded within the mantra of sustainable development is a largely unquestioned embrace of the economic growth principles. There is a disconnection in Western thinking between the well-being of two intertwined life-systems – that of humans and the planet (Thompson 2008, 94). ‘Development’ has become such a part of economic discourse that other renditions of its meaning we might bring to the table, renditions that would challenge and conflict with the prevailing discourse – for instance cultural development, personal development, spiritual development – are all too easily drowned or, at best marginalised. We have also failed to act as the problems are so big. In our modern western world we have learnt to break issues down into ever-smaller pieces and have separated nature and culture. Grappling with fundamental threats to creation, however, requires moving in the opposite direction. There is a lacking of a sense of the wholeness and interrelatedness of things. “Organicity must be reintroduced with a postmodern system where living systems are not reducible to components and where nature is considered to be alive” (O’Sullivan 2008, 140). “The awe and reverence toward nature, so prevalent in pre-modern worldviews, is totally absent in the modern world” (O’Sullivan 2008, 138).

An either or thinking has historically governed our approaches, i.e. culture versus nature, civilisation versus wilderness, and city versus country. These oppositions are fierce and counterproductive and deserve much of the blame for the current bankruptcy of our current approach to the environment (Capra 1996; Orr 2004). According to Gregory Bateson, whom Fritjof Capra regards as one of the most influential thinkers of our time – our worldview is founded on an ‘epistemological error’, a perception or belief in separateness that makes it so. We need to attempt to move beyond this nature-culture impasse and merge development and conservation. One could argue that we have lost our sense of place in the world. In Ian McCallum’s (2005) words we have to stop speaking about the earth being in need of healing. The earth doesn’t need
healing, we do (14).

As Ian McCallum (2005) argues, having turned a blind eye to the fact that we are part of nature’s great diversity, we have become ecologically unintelligent (14). We have steadily distanced ourselves from our biological past. “We have ignorantly, if not arrogantly, placed ourselves at the apex of creation. It is time to come down from that precarious pedestal” (McCallum, 2005, 14) “Let’s become conscious of the animals that we have on board with us and of what they mean to us” (McCallum 2004, 229).

Urban people tend to have less and less contact with nature and as a result, they may be less inclined to behave responsibly towards the environment, however unwittingly, as they become more removed from the very natural systems that underpin their survival. If sustainability and humanity’s continued survival on this planet is the project, we need to start imagining and implementing the notion of nature into those domains of the ‘civilized’, the urban and industrial centres and the way they work.

The idea of human as separate from nature is a binary deeply rooted in western civilization. It is present in the Judeo-Christian traditions which describe an origin in which man was given dominion over the beasts. In ancient Greece and in the Tale of Gilgamesh, the forests were the representation of all brutishness and evil, the domain of wild irrational female forces which contrasted with the city state that was associated with rationality and maleness. In middle ages Europe, the image of an ordered world of culture managed by civilized men surrounded by a chaotic wilderness inhabited by savages, pagan warlocks and witches who drew their power form nature itself continued (Colchester 1994). An idea that continued, and still continues, to inform the activities of fundamentalist Christian missionaries, that see the practices of shamanism by indigenous peoples as “devil worship” as such, the project of taming the wilds and civilizing the savage became a fundamental truth and clear destiny (Chidester 1996, Colchester 1994). The flip side of this was that with white expansion and increase in urban dwelling, a notion of the wilderness as a refuge from the ills that accompanied civilization arose. John Muir, one of the driving forces behind the national parks movements in America insisted that wilderness as primitive and natural, be preserved as untouched. Wilderness was thus set to become the sphere of recreation (for definite sections of the population). This philosophy was then put into law with the 1964 U.S. Wilderness Act which states that wilderness is a place “where man himself is a visitor who does not remain” (Gomez-Pompa and Andrea 1992, 271). This idea has persisted in the global creation of parks and protected areas. That these old notions of nature as separate have informed many policies makes the finding of solutions, at a policy, and on-the-ground level, an immense challenge. The images are potent. Attempting to unpick the dynamics of this so-called conundrum is akin to wading through thick mythological soup. Scott (cited by Parajuli 2001) identifies ingredients of this “soup” as created by the modern state: “firstly, an administrative ordering of nature and society, plus a confidence in scientific and technical progress, add the authoritarian state that used its full weight and power to bring high modernist designs into being, as well as a.
disabled civil society.”

In this nature-culture divided world discussed above, the “myth” around nature has been turned into reality which is well illustrated by our role of language. Nature in our current predominant mindset is made in the image of a commodity, a ‘natural resource’, underpinned by a philosophical stance that views humans as standing apart from the rest of the living world. This is a good example of ‘shallow ecology’ or ‘weak sustainability’ whereby only instrumental, or ‘use’ value is ascribed to nature. We need to be careful of our language and careful not to be seduced by jargon and slogans such as ‘eco-friendly’, ‘ethical hunting’, ‘sustainable utilisation’, ‘downsizing’, ‘transparency’, ‘biodegradable’, and ‘growth’. Jargon and slogans can illustrate the dilution of the ‘sustainable development’ concept, i.e. are we simply ‘sustaining development’ or working towards sustainable development?

“We are accustomed to thinking about the Western cultural synthesis as a developmental endpoint which points towards the control of all natural forces by human decisions” (O’Sullivan 2008, 132). The development of modern Western science and expertise is suffused by the underlying belief that all forces can be contained and controlled by scientific inquiry and technological advance. It is critical to question some of our assumptions, and some of the things that we think of as normal. Edmund O’Sullivan (2008, 132) in ‘Re-enchantment of the natural world’ tells us that it wasn’t always this way. Understanding the historical roots of our dominant mode of thinking allows us to see that this is not the only way of thinking and, indeed, that we live in a different historical moment with a different challenge facing us. Instead of considering ecological thinking as fringe or alternative and reductive scientific economic thinking as normal, we should ask which type of thinking or worldview is best suited to the challenges we face. Is it normal to face a global ecological crisis in a divide and conquer (reductive) way while separately treating a global crisis of human rights, of increased militarisation? Questions of sustainability have in general become pertinent to many more disciplines than we would traditionally associate with it.

Enough is now known to upset profoundly our everyday notions of space, time, matter and energy. Design is the discipline entrusted with the construction of space. Humans have torn themselves from the rest of nature, and sustainable design is a way to repair the rift. As planners and designers we need to design so artfully and carefully as to help reconnect people to nature and to their places (Orr 2007, par 11). As design professionals we hold the keys to creating a far better world than that in prospect, but only if we respond creatively, smartly, wisely and quickly to these facts (Orr 2007, par 11).

**Resurrection of the Natural World and Values Revisiting Concepts, revising Paradigms**

The concepts and arguments underpinning a sustainable future and the need for society as a whole to revisit and rethink the way in which we utilise our natural assets have been in the mainstream for decades. Yet even with the strongest ecological evidence supporting these concepts, i.e. that there are
limits to resource use as well as the receiving environment’s ability to absorb pollutants, globally, society has been unable to make the change towards a more sustainable and ecologically conscious and intelligent future. The environmental movement, arguably one of the largest movements in the history of the world, appears to have had little impact in driving fundamental changes in world economics, governance and environmental justice. One can argue that the movement has had little impact even in the context where never before in the history of the planet have as many resources been applied at any single time to drive the sustainability agenda.

Much current practice is still based on decades old concepts, despite advances made in theory. The ‘three pillars’ model of sustainable development, despite still being widely promoted, has long since been discredited in seeking sustainability – to be replaced by the ‘cascade of dependencies’ a far more realistic approach. This shows that human society is dependent on the environment, and economics is dependent on both society and the environment and all three are today dependent on ‘governance’ to understand the issues, develop sustainability policies and enforce them, as depicted in Figure 1 from South Africa’s National Framework for Sustainable Development and Department of Environmental Affairs and Tourism (DEAT) (2007), where it has been attempted to bring this enhanced appreciation of ‘cascades of dependencies’ to the political table.

Figure 1: The interactive model of sustainability and the interdependence model of sustainability (adapted from DEAT 2007).
It is important to stress that current patterns of economic growth and genuine sustainability are wholly contradictory concepts - economic interests usually ride paramount. Further economic growth implies quantity while development is a critique and a search for quality. Sustainable development as conceived by economist by and large fails to consider any reduction of material standards of living and any attempt to slow down the accumulation dynamics. “In short alternatives to development are blackballed, alternatives within development are welcome” (Sachs 1995, 436 as quoted in Selby, 2008). If we accept the finiteness of the planet – that the planet is not an inexhaustible cornucopia – and if we interpret “sustainable development” as “sustainable growth” then the terms becomes an oxymoron, a contradiction in terms. Sustained growth within a planet that is finite is not possible unless one limits the timeframe within which the growth intention applies and/or is selective about where the growth should happen. We cannot continue with just enriching the already rich; if only economic performance counts, trade-offs will continue!

Within South Africa with Environmental Impact Assessment practice where different alternatives and no-go alternatives have to be explored it is not untypical to get the following decision: “the no-go alternative could not be adopted as the developer would lose his opportunity for economic investment and resultant gain” Provincial MEC, 2005

At a plenary address of the International Association for Impact Assessment conference in Calgary in 2008 Ian Lowe rattled the cage a bit and asked the audience how best to achieve ‘unsustainable development’?

He answered this question himself and said by pursuing:

- Increased per capita consumption
- Rapid depletion of non-renewable resources
- Over use / extermination of renewables
- Disrupt global climate change
- Produce more waste
- Widen inequalities
- Embrace materialism
- Trash our ‘adaptation insurance’… [biodiversity]
- Encourage population growth

Arguably this is exactly what we are doing and the trajectory we are on. We are living beyond the carrying capacity of the earth – the assumption of economic growth being able to continue forever or be somebody else’s problems is illogical and denialism. We’ve reached the limits of a ‘FULL EARTH’ – our economy is too big for our earth (Costanza et al., 2010).

The rhetoric of sustainable development has thus been used by environmental organisations and global economies alike and the conflict between development and protection was neutralised – the euphemism reassured us that we can have our cake and eat it too. The key issue was how to get a share of the cake, not the limits to the size of the cake. While development is made “sustainable” – able to be continued – capitalist models of progress and resource exploitation were often challenged but not notably changed. There exist staggering statistics such as that the
assets of the three richest people in the world alone exceed the combined GNP of all least-developed countries and their 600 million people (Capra 2002).

As Paul Hawken, Amory Lovins, and Hunter Lovins argue in Natural Capitalism, there is a better economy to be created that does not depend on drawing down natural capital, imposing costs on the poor or posterity, confusing prosperity with growth, and risking global catastrophe (1999). But the development of that economy will require clarity about the fair distribution of wealth and risk shrewd public policies. It will require us to relearn the art of frugality, sufficiency, sharing and neighborliness. It will require a bit of ingenuity to craft what Howard and Elisabeth Odum call a “prosperous was down” (2001).

A shift is required from the goal of standard of living to that of quality of life, transforming the drive to simply get and consume into the profoundly different one of pursuing deep psychic fulfilment – a step forward, not backwards as it is too often portrayed. Achieving sustainability then requires attention to psychology and even spiritual issues, to satisfy values deeper than advertising induced desire. **Sustainability is not only about curbing environmental abuse – it is more about enjoying a saner and more just way of life.** The universe is not a dead clockwork mechanism but a living process, constantly unfolding and creative. A profound psychological impact of such a shift could help us to no longer feel alienated from the world, nor compelled to defend against this feeling through acquisitive consumption, but can instead disencumber ourselves to open up and feel an integral part of this astounding and benevolent planet.

Perhaps in the end, it will not be a change in technology that will bring is to a sustainable future and to the development of a more responsible society, but a change of heart, a humbling that allows us to be attentive to nature’s lessons. As author Bill McKibben has pointed out, our tools are always deployed in the service of some philosophy or ideology. If we are to use our tools in the service of fitting in on Earth, our basic relationship to nature - even the story we tell ourselves about who we are in the universe – has to change.

**Environmentalism, architecture and the role of designers - from egosystem to ecosystem**

The environmental design disciplines – architecture along with urban design, regional planning and landscape architecture – will inevitably play a key role in the quest for sustainability. It is after all an environmental crisis that looms, and the design of the current built environment contributes immensely to the crisis, in its wastefulness of land, energy and commuting time and in the lifestyles it facilitates. It also constrains how much we can change these lifestyles.

In terms of architecture and design, Peter Buchanan (2008) describes it “as sustainability’s greatest and exciting gift to return the profession to its purpose and dignity as it addresses very real and urgent issues so that it will inspire influence in the shaping of our environment and culture” (128).
Architecture schools and practises need to accept the challenge and pick up the sustainability gauntlet. Education in particular has an enormous responsibility as the next generation of architects, designers, thinkers and doers needs to be prepared. “Until a realization of the relationship between humans and their environment has become part of our education and a principle basis of its orientation, a long range improvement of land use is improbable” (Hall, Hebbert and Lusser 2000).

The architecture and planning profession is searching for new ethics and understanding, an ethics that espouse attitudes and behavior for individuals and societies which are consonant with humanity’s place within the biosphere; an ethics which recognizes and sensitively responds to the complex and ever-changing relationships between humanity and nature and between people. The professions are articulating new visions and attitudes in its search for new kinds of planning.

The built environment disciplines, thus, are forever evolving and being challenged to adopt new visions, reaffirm and reinterpret their core values to meet changing circumstances and new challenges. Never before has the pace of change - social, technological, economic, environmental and political been so fast nor on such a large scale. There are new forces driving spatial organization and change and professionals need to engage with the complexity of socio-spatial dynamics which requires deep and critical thinking. Managing the spatial dimensions of this change depends on working with a growing variety of organizations and individuals and these relationships are becoming increasingly complex.

The new visions that are emerging sees architecture and planning as being about people and places, the natural and the built environment and long-term stewardship. Focus on people and relationship is key rather than the material things and images.

In the past planning focused largely on land use management and physical development and sometimes quite abstracted design approaches. Past planning has been criticised as primarily reactive, short-term, partial, and as an opportunity driven activity. Planning is becoming less technocratic than in the past, not as slender and narrow. Planning is seen to be more of a thoughtful reflective and creative activity. Traditionally ecology and society have been approached separately – it is increasingly clear that we need to include the presence of humans and human experience.

Today principles of sustainability, inclusion and equity are at the centre of built environment profession’s concerns. Increasingly and more than ever before have sustainability and the environment been recognized as key underlying elements and concerns of the disciplines. In addition more and more solutions must not only reduce our impacts on the environment but also help to restore and regenerate it. There is a need for a new design methodology for regenerative human settlement.

This is what Peter Buchanan (2008) describes as the big choice we face: the move from ego to the eco (egosystems to ecosystem), from acting on the world to acting with it (128).
“It is about understanding the unfolding and dynamic interplay between nature and culture and treating design as if it is a process of participating in and reconciling these processes as they flower into forms that best benefit people and the planet” (Buchanan 2008, 128).

Design also needs more of what Albert Borgman terms “spacious awareness and humility” (Borgman 2008, 6). He discusses how premodern cultures were keenly conscious of space – they could and did inhabit, at least conceptually, the whole universe (Borgman 2008, 6). “In contrast, the semantic space most people in our rich Western democracies inhabit is just the surface of the earth” (Borgman 2008, 6). Borgman states that we live in ambiguous space (2008, 14). Many of the technological and economic advances often considered as evidence of our cultural vitality are smoothing and accelerating private forms of transportation, information and consumption and are thus fomenting the feeling of restlessness and unreality that is the curse of destitute space. We are largely unaware of the destitution of space, because we think that the threat to space is material poverty rather than experiential destitution.

David Orr (2007, par. 17) suggests that we need a standard for our work, rather like the Hippocratic Oath or a compass by which we chart a journey. For that David Orr (2007) proposes that “designers should aim to cause no ugliness, human or ecological, somewhere else or at some later time” (par. 17).

“That standard will cause us to think upstream from the particular design project or object to the wells, mines, forest, farms and manufacturing establishments from which materials are drawn and crystallized into particularities of design. It will cause us also to look downstream to the effects of design on climate and health of people and ecosystems. If there is ugliness, human or ecological, at either end designers cannot claim success as a designer regardless of artfulness of what is made” (Orr 2007, par 17).

Orr (2007) further suggests that we must think of ourselves firstly as place makers not form makers – this difference he stresses is critical (par.18). He argues that design has conventionally or traditionally been mostly indifferent to human and ecological costs incurred elsewhere (Orr 2007, par.18). Place making he argues must honor and preserve other places, however remote in space and culture (Orr 2007, par. 18).

Paradigm Shift

Questions of sustainability typically center around energy usage, consumption patterns and issues such as water scarcity. We must, however, keep in mind much deeper questions that rarely find their way into political debate or public discourse and there will need to be attempts to integrate economics with ethics, culture and spirituality. Such conversations about changes in governance, economics, social norms and daily life that must be made to avoid the worst of what lies ahead are only beginning.

We in the comfortable middle class must be prepared to “give up”, give up cars, rethink and reimagine cities and be prepared to share
our spaces - we must be able to think differently and boldly. These are conversations we rarely have energy for here in SA given the daily complexities of life here. We each have to abandon our comfort zones, think differently about space and sharing it.

Although we are experiencing a period of extraordinary commitments and statements, to reduce dependencies and ‘solve problems’, it is the author’s belief that culture does not feature in story enough.

There are many examples of minimizing environmental damage – the so-called ‘green’ agenda. Around the world, cities are becoming more sustainable through resilient buildings, alternative transportation systems, distributed and renewable energy systems, water-sensitive design, and zero-waste systems – with all the cleverness of a new industrial green revolution.

From new cities like Masdar in Abu Dhabi to redeveloped areas like Treasure Island in the United States, Vauban in Hanover in Germany, BedZed carbon-neutral development and social housing experiment and the new Olympic village in London, Munich Sustainable Development Plan, to plans for a new eco-city Dongtan on the island of Chongming in Shanghai, China – there are many ecological innovations but the argument is that this is not enough! The key question now is whether cities can not only reduce their impact on Earth but also contribute to its regeneration.

Sustainability initiatives fail or aren’t as transformative as they need to be as arguably we are trying to rescue and bail out a discredited and bankrupt model, philosophy and theory. The point is the same as one that has been attributed to Einstein: “significant problems we face cannot be solved at the same level of thinking we were at when we created them” (Calaprice, 2005:292).

The article does not argue that this failure is necessarily the result of bad intention on any person or organisation’s part. It does, however, contend that there is an ongoing failure to address deeper shortcomings.

Glib talk about climate “solutions” for example misleads by conveying the impression that climate is merely a problem that can be quickly solved with technological fixes without addressing the larger structure of ideas, philosophies, assumptions and paradigms that have brought us to the brink of irreversible disaster (Orr, 2009: xiv).

Some thought-leaders such as for example James Lovelock independent scientist, environmentalist and futurologist (possibly best known for the Gaia theory) have given up hope for sustainable development and believe that retarded collapse is the best we can hope for.

The “hangover” for conservation and environmentalism

Environmentalism has done little to build the broad base – both political and cultural – that it needs to succeed. The environmentalists’ strategy of alarmism and scarcity the last 50 years hasn’t worked.
Environmentalism has allowed itself to be defined in a way that is too narrow, that resonates with too few people, and does not connect enough with the real aspirations and concerns of the average South African.

Environmentalism is also not helped by other realities such as long-standing efforts to save land in remote places that few of us will ever see or experience. A general hypocrisy further can muddy its most basic proclamations – for example its support of a concept of alternative energy, alongside its record of opposing specific alternative energy projects (such as wind farms) because they conflict with traditional conservation objectives having to do with preservation of land and wildlife.

It’s too easy to call a big oil spill an “environmental catastrophe”, the resulting loss of fishery and tourism jobs and “economic disaster,” and men who die in deepwater rigs that exploded a “human tragedy”. In truth, these are not different things – they are parts of a single reality our culture has created for itself.

The sequel to environmentalism must grow out of that recognition, and be rooted in the perpetuation of all life – human and nonhuman. Many indigenous people remain hostile to environmentalists despite often sharing their goals. Some environmentalists’ elitism, purism and good-versus-evil worldviews still reflect attitudes of their intellectual ancestors. Norms live in cultures like genes, manifesting themselves unexpectedly.

By putting a scientific spin on the crisis, scientists become the authoritative spokespeople for an entire movement to ‘save nature’, having as its fundamental goal the ‘preservation of intact ecosystems and biotic processes’ (Escobar, 2008: 139). While there is much to be admired there is also much questionable including the base orientation of the concern because of its origin in particular scientific traditions. There are for example limited analyses of the causes of environmental destruction and destabilisation and consequently the built-in proposed policy formulation. Until recently rarely is mention made of capitalism, the endless resource need to satisfy the lifestyle of rich countries, or of the market framework.

This politics of division cannot help the earth now. Nature is endangered by threats that come from no specific villain or location. The oceans grow warmer and more acidic, marine mammals are contaminated, dead zones spread, plastic debris flips from wave tops to beaches and into the guts of birds. No one is innocent. Categories won’t help – nations, race, good and evil – for they have little to do with humanity’s need to fit within a global ecological niche. Power alone without love won’t help us either. Power itself is a good deal of the problem, as coercion divides the people who ultimately must work together.

The solution has to come from the people, through persuasion, enlightenment, and the creation of new norms, until the powerful are swept irresistibly along in new social reality. This is a better job for the weak, who often have more at stake in the loss of nature, a closer relationship to its gifts, and a greater capacity to recognize when a certain level of material wellbeing is enough. This is what Paul Hawken calls “blessed unrest”.

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Understanding the history of racism in the conservation movement will be important, not to assign blame, but to diagnose our unhealthy relationship with each other and with nature, learn from our mistakes, and begin cooperating in the ways that we must in order to reverse our destruction of the Earth's ecosystems.

**Beyond the mechanical**

An indication of how hard the cultural shift required would be, becomes clear when one examines the mechanistic mindset that pervades our society and our institutions. Our institutions are governed by habit – notably by industrial, “machine age” concepts such as control, predictability, standardization and “faster is better”. The industrial age management model breaks the system into pieces, creates specialists, lets everybody do his or her piece, and assumes that someone else makes sure the whole works.

We have difficulty in seeing whole systems in a culture shaped so thoroughly by finance, capital and narrow specialisation. How does one build partnership among all the different specialists and experts and a sense of collective responsibility? This way of thinking is still unfamiliar, an effort rather than a habit of mind. When only the superficial symptoms of complex problems are addressed, the underlying problem typically remains unsolved, and even can be exacerbated if the solution feeds into a cycle. An integrative awareness whereby one unites technology, ecology, society, matter, mind and spirituality has been lacking in the twentieth century.

Historically our problems, however severe, were relatively local, close in time and space and to where we lived. Today many of the negative social and environmental side effects manifest on the other side of the world. Cause and effect are no longer close in time and space and not immediately tangible. The case for sustainability remains frustratingly elusive, partly because many of the suggested benefits are intangible (for example “the future”).

Seeing things in their wholeness is socially threatening. To understand that our manner of living, so comfortable for some, is linked to climate change, to cancer rates, to poverty, to the disappearance of biodiversity, to hazardous landfills and toxic wastes, to the depletion of the ozone layer, is the need to for a change in our way of life.

**Inhabiting different worlds – the faith in a single natural world comprehensible through science**

It is a time of increasingly dire news and seemingly unsolvable social and economic problems. The scientific evidence suggests that the years ahead will test our present and coming generations in extraordinary ways. We are all frustrated by our limited understanding of the challenges. While some see it as a set of technical problems there is a danger that superficial approaches give a false sense of progress.

While cities of the “north” debate their quality of life, many cities of the south struggle for life itself. While some people are already dying due to climate change the experience
is not yet personal for many more affluent citizens around the world. We need to explore deeper how we can be with that information in a place of intensity and chaos. It seems clear that we need to find new ways to problems solve – be more soft, spongelike and receptive.

The latest UN Climate Change Conference in Copenhagen in December 2009 failed to agree on a deal to tackle Climate Change. The failure of Copenhagen makes it clear that Copenhagen is read in very different ways by different people and that there is no common path towards change. There is the issue and challenge as to how to connect scientific research to legal and political measures - a gulf between law and all sciences seems to preclude such an exchange. Law has a very difficult time absorbing science and jurists reinterpret scientific work through a legal lense often obfuscating the results. So while some make sense of the failures at Copenhagen (also referred to as “Brokenhagen”, “Tokenhagen” or “Hopenhagen”) as the climate negotiations being highly complex and too technical for the politicians and lawyers, the author argues that we need to look still deeper than that.

To many people it was no surprise that Copenhagen failed, given a negotiation process of such Byzantine complexity and the fact that most negotiating teams are mandated to defend the rights of their country to continue using oil and coal to fuel economic growth unless they are paid not to (Cullinan, 2009).

For some critics the mainstream prescriptions amount to a complex politics of cooptation that leaves intact the underlying framework of economics and the market that is inimical to nature in the first place. Although the climate challenge is receiving a lot of attention these days, the global temperature increase is but a symptom. The planet has a ‘fever’, and it is essential to identify the disease in order to prescribe the right medication (Dahle, 2010: 87) (Lovelock, 2006). Those who focus exclusively on solutions are rather like doctors who only prescribe and never diagnose (Orr, 2009:xv).

The solutions most talked about are technological and so neither require nor result in any particular improvement in our behavior, politics, or economics that brought us to our present situation in the first place (Orr, 2009:xv). That some corporations have got the new religion on energy efficiency or greening their operations or carbon-trading schemes pales besides the fact that none is capable in Korten’s words of “voluntarily sacrificing profits to a larger public good” (Korten, 2007).


A view from the World People’s Conference on Climate Change and the Rights of Mother Earth in Cochabamba, Bolivia in April 2010 for example is that the corporations and governments of the so-called “developed” countries, in complicity with a segment of the scientific community, have led us to discuss climate change as a problem limited to the rise in temperature without questioning the cause, which is the capitalist system. In other words COP is viewed as an attempt to only deal with effects, better allocating the pollution pie so to speak – using science to allocate maximum levels of pollution. The current international negotiations focus on political agreements
The knowledge of nature is not a simple question of science, empirical observation, or even cultural interpretation. To the extent that this question is a central aspect of how one thinks about the present environmental crisis, it is important to have a view of the range of positions on this issue. What lies in the background of this question—besides political and economic stakes—are contrasting epistemologies and, in the last instance, foundational myths and ontological assumptions about the world (Escobar, 2008: 120). While nature is a distinct ontological domain, it has become increasingly hybridized with culture and technology and increasingly produced by human’s knowledge. There cannot be one true account of nature’s nature (Escobar, 2008: 129).

Bruno Latour (2004) argues that for most sociologists and political scientists wars rage because human cultures have (and defend) differing views of the same world. If those views could be reconciled or shown to differ only superficially, peace would follow automatically. Bruno Latour (2004) in a piece on “Whose Cosmos, which Cosmopolitics?” portrays how Viveiro de Castro has persuasively shown that the question of “the other”, so central to recent theory and scholarship, has been framed with inadequate sophistication. There are more ways to be other, and vastly more others, than the most tolerant soul alive can conceive” (Latour, 2004:453). That way of understanding cosmos and cosmopolitics is limited in that it puts a limit to the number of entities on the negotiating table. We seem unable to establish dialogues between science and local knowledge. Modernity rejects the integration of the natural, human and supernatural or...
spiritual worlds which is an incommensurability of global knowledge systems.

We can’t think that religion is ignorable. Many scientists and westerners have no inkling that humans have always counted less than the vast population of divinities and lesser transcendental entities that give us life (Latour, 2004: 456). Latour argues further that whenever cosmopolitanism has been tried out, such as for example by the United Nations, it has been during the great periods of complete confidence in the ability of reason and, later, science to know the one cosmos whose existence and solid certainty could then prop up all efforts to build the world metropolis of which we are all too happy to be citizens. The problem we face now is that it’s precisely this “one cosmos” or what Bruno Latour calls mononaturalism that has disappeared and therefore we need to abandon the beautiful idea of cosmopolitanism since we lack what our ancestors had, a cosmos (Latour: 2004: 453)

Society has always meant association and this has never been limited to humans. What is in question between us is the extent to which we are ready to absorb dissents not only about the identity of humans but also about the cosmos that we live in (Latour, 2004: 451). The eco-philosopher Joanna Macy throughout her work stresses the theme and need to reconcile false dichotomies and polarities. We need to expand our perspectives big enough to encompass both in new ways (Macy, 1991).

For most people, in most places, during most eons, humans have “owners” to use Tobie Nathan’s terms and those proprietors take precedence over humans at whatever cost (Latour, 2004: 456). At international negotiations of the UN or UNESCO there are assumptions that humans of good will must agree that gods are no more than representations. Escobar (2008) argues that it would be pretty to think so but to some it is not humans who are at war but gods. Escobar (2008) argues that we should entertain the possibility that ‘enemies’ can be separated by disagreements that wide.

Escobar argues that we need to decolonize knowledge as ways to decolonize nature and the land and natural resources (2008:12). The dominant western mechanistic views of nature that sees the universe as a dead machine is lacking in reverence for life and interconnections. The modern project of economic growth and domination of nature has gone badly awry and is threatening the living system of planet. The recent bombing of the moon in October 2009 by the United States in the name of science in order to discover whether there is water on the moon (while India had already discovered this) surely depicts that something has gone wrong in the name of science. Does this “reflect a prior disorder in thinking” (Orr, 2010:75) about humanity’s role in ecological systems? We need to explore how better to integrate science and wisdom.

Allan Kaplan states that because we have achieved so much success in our use of the material world which lies outside of ourselves, the way of thinking which supports such usage has come to be taken as the legitimate way of approaching the world. It has come to be taken as given. Yet simply because a particular way works with respect to certain
phenomena does not mean that it is universal, it does not mean that all phenomena should be regarded in the same way (Kaplan, 2002:xiii). Vaclav Havel noted, in an address to the World Economic Forum many years ago, that “What is needed is something larger (than the scientific method). Human’s attitude in the world must be radically changed. We have to abandon the arrogant belief that the world is merely a puzzle to be solved, a machine with instructions for use waiting to be discovered…” (Havel as quoted in Kaplan 2002: xv)

Abandoning the need to control and shape the world – acknowledging that we need new institutions

There exist tremendous contradictions and incompatibilities. While global climate stability and ecological resilience are global public goods that require cooperative global solutions, fossil fuels are market goods that promote competition and resource struggles. The transition to sustainability requires new energy sources that are “non-rival”. Yet we have systems that give priority to private market goods and services at the expense of public goods. If societal goals shift from maximizing growth of the market economy to maximising sustainable human wellbeing we need new or different institutions to better serve these goals to broaden acceptance and credibility.

In recent months there has been much talk of “redesigning capitalism” and a “new financial architecture” as evident in the title of the 2010 State of the World report by the Worldwatch Institute for example “Tranfroming Cultures – From Consumerism to Sustainability.

Certainly organizations and institutions that shape our world are increasingly revealing their inability to address the challenges of our time. These organization are experienced, both by those outside of them and those inside them, as driven by the need to control and shape the world rather than respond creatively to new impulses and needs. There is great need for creativity and innovation in the way we organize the world. An economic renewal tailored to the 21st century would establish institutions committed to fitting the human economy to Earth’s limited life-support capacity.

According to the capitalist perspective the Earth is not seen as “capable of experience” because it is reduced to a service provider, not a living system. A “right” human-Earth relationship would recognize humans as part of an interdependent web of life on a finite planet. The economy must recognize the rights of the human poor and of millions of other species to their place in the sun. In a world awash in money, addressing poverty only with growth reflects a tragic lack of moral imagination. Indeed, in pushing for more “free” trade as it is currently understood, we would entrench an ongoing addiction to consumption, pursued in a manner that often ravages the bio-productivity of developing countries (Mofid, 2010).

Logjam in legal Systems and governance regimes

As the grip of climate change tightens, and other problems... we are discovering that present law is inadequate to protect present or
future generation. We are entering the opening years of difficult times with no adequate political framework or philosophy.

As Amory Lovins, co-founder of the Rocky Mountain Institute and well known author, puts it “We lack a theory of governance…” “we need to invent whole new institutions, new ways of doing business and new ways of governing” (Gould and Hosey, 2007:32).

Beyond issues of democracy and inclusiveness are other questions about how well our Constitutions work relative to the climate and the environment (Orr, 2009:14). The environment is a complex, interactive, and nonlinear system (Orr, 2009:14). Yet most of our legal framework favor decentralised, fragmented and incremental lawmaking and as a result, laws, policies, agencies, and whole government departments often work piecemeal and at cross-purposes, without due regard for long-term consequences (Orr, 2009:15).

Eco-philosopher Thomas Berry attributes that flaw to the preoccupation of the writers of our constitution and legal systems with property rights, “with no recognition of the inherent rights of nature and no defense of the natural world” from Corporations (Berry, 2006:108-109).

Seemingly benign scientific discourse ends up as a basis of a complex system linking organisms and ecosystems, powerful tools, social institutions, private interests, and even the hopes and aspirations of millions. As many analysts have indicated, when linked to exclusionary property rights enforced by World Trade Organization, the consequence of this tight system of truth telling, linking science, policy and economy can be devastating for the maintenance of our natural systems.

As argued throughout the article shifts can be driven by collapse or through conscious and integrated changes in worldviews, institutions, and technologies. New goals, rules and tools can be developed.

The rapidly intensifying challenge of climate change has exposed how ineffective international and national governance regimes are in dealing with the side-effects of consumerism and the excessive use of fossil fuels on which the industrialised human cultures are based. However, there are still major differences regarding how best to respond. At present most governments appear to favour a combination of new technology and improving the application of existing regulatory systems (e.g. intensifying the enforcement of existing laws and expanding carbon trading).

“In the context of rapid climate change, which is already making it more difficult for poor people to survive in many countries (particularly in Africa!) negotiating for a bigger slice of the global carbon emissions budget is like fighting for a better deckchair on the Titanic”(Cullinan 2009).

“The only sensible way forward is to firstly abandon any arrogant beliefs that our civilizations are unsinkable and secondly to focus on saving the ship, not our deckchair and thirdly to change course as rapidly as possible” (Cullinan 2009). There are thus also many hopeful people that believe
that the Copenhagen process was an important milestone in the huge cultural transition which is continuing to gather momentum (Cullinan, 2009).

There is a movement in Latin America around “The Rights of Mother Earth” pioneered by Ecuador and Bolivia. The Bolivians supported by at least nine other Caribbean and Latin American countries are arguing that the reason why we have climate change and a host of environmental and social issues is that most political systems (whether based on capitalism or socialism) are inherently destructive because they do not take account of the needs to strike a balance between the interests of humans and those of other members of the Earth community (Cullinan 2009).

Ecuador is exceptional in opting to make a fundamental change to the architecture of its governance system by recognising rights of Nature and redefining its concept of development. There the existence of a large number of people who had not wholly adopted Western consumerist values, appears to have been a crucial factor in securing the recognition of the rights of nature in the Constitution. Calls for a Universal Declaration of the Rights of Mother Earth to the United Nations indicate the potential for these ideas to spread rapidly. “In Latin America thus ‘defend the rights of Mother Earth’ is a battle cry not only for environmental protection but also for social justice and freedom from destructive cultural imperialism (Cullinan, 2009).

“They point out that in the same way that a leaf will only flourish if it is part of a healthy plant growing in fertile, well-watered soil, so individual human wellbeing can only be sustained by building healthy communities within healthy ecological communities. This traditional wisdom is as valid today as it ever was. Human rights are meaningless and cannot be sustained if Earth has no rights. The right to life is an empty slogan without food and water which can only be provided by the Earth” (Cullinan, 2009)

This movement appears to understand that mindless pursuit of GDP growth and material accumulation is a fatally defective developmental model. Recognising that the community of life which sustains us has a right to integrity and health and enforcing those rights is a precondition to maintaining healthy human communities, not a competing interest (Cullinan, 2009)

Ecuador’s Constitution which aspires to “Living Well” is a strong indicator that a centuries-old logjam in legal and political thinking and practice is beginning to break-up. Pioneering work is being done around the world to replace laws and governance systems that facilitate the exploitation of Earth with systems based on the recognition that human well-being is a consequence of the well-being of the Earth systems that sustain us.

The reasons why legal systems are failing to protect the Earth community is because they reflect the underlying beliefs that humans are separate from, and superior to, all other-than-human members of Earth whose primary role is to serve as “natural resources” for humans to consume. These beliefs are demonstrably false. Humans are of course, but one of many species of mammal that have co-evolved
within a community or system (“the Earth community”) on which they are wholly dependent. In the long-term humans cannot thrive in a degraded environment anymore than fish can in polluted water (Cullinan, 2010:143)

Just as colonial laws did not recognise the rights of indigenous peoples and facilitated the exploitation of them and their land, so most contemporary legal systems do not recognise that any other-than-human indigenous inhabitants are capable of having rights (Cullinan, 2010:1). The law defines land, water, other species, and even genetic material and information as “property” which entrenches an exploitative relationship between the owner (a legal subject with rights) and the property (legally-speaking a “thing” which is incapable of holding rights) as surely as defining one person as a slave-owner and another as a slave (Cullinan, 2010:144).

One of the most exciting contemporary developments in human governance then is this simultaneous emergence on several continents of initiatives to bring about a fundamental change in governance systems (Cullinan, 2010:144). These initiatives all share the belief that one of the primary causes of environmental destruction is the fact that our governance systems are designed to perpetuate human domination of Nature, instead of fostering mutually beneficial relationships between humans and the other members of the Earth community (Cullinan, 2010). They all advocate an approach to law and governance known as “Earth jurisprudence” (Cullinan, 2002). Earth jurisprudence is a philosophy of law and human governance that is based on the idea that humans are only one part of a wider community of beings and that the welfare of each member of that community is dependent on the welfare of the Earth as a whole (Cullinan, 2002). According to this perspective human societies will only be viable and flourish if they regulate themselves as part of this wider Earth community and do so in a way that is consistent with the fundamental laws or principles that govern how the Universe functions (the ‘Great Jurisprudence’) (Cullinan, 2010:144).

This approach requires looking at law from the perspective of the whole Earth community and balancing all rights against one another (as we do between humans) so that fundamental rights like the right to life take precedence over less important ones such as rights to conduct business (Cullinan, 2010:144). Currently the rights of humans, and particularly corporations, automatically trump the rights of all others (Cullinan, 2010:144). Natureculture theory also offers a challenge to the centrality of humanness for realising reality in much representational thinking. A natureculture is an assemblage of people, things, laws, politics, techniques and ethical strategies (Muecke, 2008), which means that no one participant in this ever-moving network has an omnipotent purchase on the truth of the matter.

A few prescient commentators have for several decades drawn attention to the need for legal systems to take an evolutionary leap forward by recognising legally enforceable rights for Nature and other-than-human beings (Cullinan, 2010).
Perhaps the clearest calls for the development of a new jurisprudence have come from the eminent American cultural historian, religious scholar and eco-philosopher Thomas Berry. He argued that the legal systems in countries such as the United States of America, legitimised and facilitated the exploitation and destruction of Earth (Cullinan, 2010). Berry (as quoted in Cullinan, 2010:146) argued that: “We need a jurisprudence that would provide for the legal rights of geological and biological as well as human components of the Earth community. A legal system exclusively for humans is not realistic. Habitat of all species, for instance, must be given legal status as sacred and inviolable.”

Conclusion

In order to turn the current crises into an opportunity for a successful, sustainable and everlasting change, where all people, wherever they may be, can live fulfilling healthy and yet more ecologically compatible lives we need to all take action within the sphere of our own consumption and ecological behavior.

This article has tried to shed some light on how to transcend and include and unpack some deeper issues of behavior, culture, politics and economics.

In much of our response and engagement with sustainable development there is still little connection between deeper levels of human motivation and ecological problems. Many of our problems represent fundamental challenges to our institutions and organizations philosophies and paradigms and demand a “change of culture” (The Worldwatch Institute Report 2010).

The author believes that the coming change is not primarily about climate change and sustainable development but more importantly about the fundamentals of human civilisation that generate climate change and social exclusion as a by-product. Our existing compartmentalised sciences and epistemologies are utterly unable to describe the current complexity. A common world if there is going to be one, is something we will have to build tooth and nail together with a willingness to use new methods of thought and many levels of thinking. A common world is not something we come to recognize, as though it had always been here.

To quote David Orr (2007) again “as design professionals we hold the keys to creating a far better world than that in prospect, but only if we respond creatively, smartly, wisely and quickly to these facts” (par.11). The profession should be impatient for the means of incorporating the ‘new’ nature of nature into the “old” methods of design – this is the essential adventure of our time. We need to accept the learning challenge that draws upon the complementary physical, mental, emotional, spatial and spiritual dimensions of the learner, that enchant the learner and designer to cultivate earth-mindfulness necessary for sustainable living.
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1. Introduction

Before one begins to specialize in alternative building technologies and their role in sustainable human settlements, which is a very relevant topic, one needs to understand that the study around the sustainability of any concept needs an integrated and holistic approach. The aim of this study is to give a brief philosophical discourse on the basis of sustainability, the reason behind the worldview of why sustainability came about. This is achieved by comparing the mechanistic/Cartesian worldview advocated by Rene Descartes, Isaac Newton and Sir Francis Bacon, and the systems worldview that was set off by quantum physics and later lead to holistic approaches being taken within a wide range of disciplines. This goes on to show that when one specializes and narrows in on a topic, one returns to the methods that created unsustainability.

This is followed by reasons why a holistic worldview needs to be incorporated within all studies surrounding the sustainability of any concept, such as housing, agriculture, etc. This basically means that within one’s own discipline, one cannot exclude the other disciplines as all are inextricably integrated. While we cannot include all the disciplines in one study without it having enough depth, one does need to remember that there are links between one’s own discipline and other disciplines. This paper seeks to remind the reader that the conceptual paradigm of sustainable human settlements is not just about housing and alternative building materials, but includes a host of other disciplines that revolve around satisfying the various human needs, such as food, work, enjoyment, etc.

Following this analytical discourse, practical examples of sustainable housing and links with other disciplines, which stem from Mollison and Holmgren’s Permaculture, are discussed and these include sustainable energy, re-use of grey water, home gardens and home industries, and the integration of the above. Lastly, two housing developments are discussed. These development projects focus on the use of available materials with specific reference to natural and recycled materials. These two development projects follow a holistic approach as they also focus on Permaculture gardens, use of grey water and renewable energy. These two development projects and their holistic view is what this paper aims to promote.

2. Metaphors and our Conceptual Thought System

It is of vital importance to include metaphors
within the scope of this study as will be explained. There is a common understanding among people that metaphors are just a poetic device and metaphors are left as just that. This is not correct as metaphors have a much greater role than just operating within poetical contexts. It has been found that metaphors are commonly used in language as a descriptive device. They are used to describe concepts that dominate our thoughts and so form an integral part of our actions and perceptions too (Lakoff & Johnson, 1980).

One’s conceptual thoughts will determine how one will think about a concept, one’s perceptions on a given concept and the actions one will take. This all takes place on a subconscious level. Language usage is one method of analysing how one thinks and acts, language also identifies which metaphors are used in one’s conceptual thinking and thus helps identify which metaphors influence our perceptions, thoughts and actions (Lakoff & Johnson, 1980).

One’s own conceptual system is not necessarily a result of one’s own thoughts, but rather as a result of outside influences that have influenced one’s thoughts. An example of an outside influence is the common worldview that is held by society; which is often on a subconscious level and it is not noticeable easily.

This study examines the metaphors surrounding nature as a machine and nature as a mother or as a system, and is followed with the metaphorical meanings and usages. Mother Nature is a common metaphor due to women’s association with giving birth to life and nurturing life. The other metaphors follow in the proceeding chapters.

3. The Degradation of the Earth

Mankind over the past few centuries has destroyed the earth through development. This has been achieved through various activities such as agriculture, industries, transportation vehicles and construction. This destruction has occurred at a subliminal level and the destruction is of such magnitude that the earth’s regulatory system could fail.

With the help of the great forests, oceans and weather patterns, the earth is able to regulate itself and this is what provides pleasant conditions to live in. This complex regulatory system is known as Gaia. With mankind’s burning of fossil fuels, through industry and transportation, have helped to accelerate global warming – which is a natural phenomenon. This acceleration could lead up to a threshold point where after Gaia could cease to work along with its associated weather patterns (Martin, 2006).

Coupled with this, we have depleted natural resources as if there was an unlimited supply. Mankind has over-fished, over-hunted and mined excessively to the point of depletion. This cannot continue if mankind wants to live on this planet into the future (Martin, 2006).

4. Sustainability

The concept of sustainability came about due to the above mentioned degradation to the Earth. The mainstream concept of sustainable development originated in 1972 at the
United Nations Conference on the Human Environment, whereby the connection between the quality of the environment and the quality of human life was explored. By 1987 the term sustainable development was coined and defined as development that meets the needs of today without compromising the needs of future generations. Sustainability is a holistic study that encompasses economic development, socio-cultural equity and environmental quality. Sustainable economic development can be defined as the maximization of income while concurrently maintaining a constant or enhancing capital. From the ecological perspective, in terms of sustainable development, one needs to maintain the robustness and resilience of physical and biological systems, while from a socio-cultural perspective it is meant as maintaining the stability of cultural and social systems (Rogers, Jalal & Boyd, 2008).

The core of sustainability remains with economic development, socio-cultural equity and environmental quality, but there are other criteria and principles that apply to different fields of study. The following principles are adapted from Pretty (2006):

1. The integration of biological and ecological processes into housing development;

2. Minimization of the use of non-renewable inputs that harm the environment and human health;

3. The productive use of human knowledge and skills so that self-reliance is improved and human capital is substituted for costly external inputs; and

4. The productive use of people’s collective capacity to solve common problems by working together. In this way, housing and natural resource problems can be solved.

In terms of economic development, the modern concept of economic development first emerged in the 1920s and by the 1950s, the concept was popularised as a solution for eradicating poverty. The concept was based upon the economic reconstruction that occurred in Europe after World War II. Common to the concept were the terms rapid industrialization, modernization and urbanization (Max-Neef, 1991).

As early as 1973, economists such as Dr E.F. Schumacher – and later, Hazel Henderson – recognised the inherent problems with the western economic development model and its implementation in developing countries (Capra, 1988). Schumacher (1983) put forward the proposition that an intermediate technology – between low-cost indigenous technology and high-cost intensive technologies – is needed to solve developing countries problems, such as housing. This technology, in this case building material, should be relatively cheap and enhance living conditions. This would form the start of an alternative and effective model for economic growth. Max-Neef (1991), the development theorist from Latin America, proposed that development should be based upon self reliance and in this way dependence on developed nations or other people is broken and the debt that is related to this dependence. These points form the basis of an
alternative economic development model that Max-Neef has used to create sustainable economic development in Latin America. He termed this model Human Scale Development. Sustainable livelihoods is a concept that has become increasingly important in the realm of development. This concept is central to poverty reduction, rural development and environmental management. Its importance lies in the analysis of what combinations of resources will enable livelihood strategies to be achieved, and what will be the outcomes. Sustainable livelihoods also take into account the various needs of society, such as shelter (housing), and the management of these needs sustainably (Scoones, 1998).

Max-Neef (1991) outlines various needs that need to be satisfied in order for a decent quality of life. In the list of needs, is the heading subsistence, which is inclusive of food, shelter and work. Shelter (housing) is the broad topic of this study.

5. The Role of Physics as the Basis of All Study

The study of physics and all Western science have as its roots in Greek philosophy during the sixth century B.C. The culture at the time did not separate science, philosophy and religion. This study was termed physis, which originally meant the endeavour to see the essential nature of all things. Physics is derived from this Greek word physis. Physis had a very holistic worldview whereby it examined life and the world in its entirety. In the same century, another school of thought emerged that promoted dualism. This school made a distinction between mind and matter, and the holistic worldview was broken (Capra, 1975).

A worldview is basically how one person or the whole of society view the world we live in. Examinations of worldviews are a philosophical task by nature. It is important to note that the entire world does not necessarily believe in the same worldview, this can easily be seen by looking at the differences between Eastern and Western philosophies in modern times.

6. The Mechanistic Worldview

Eastern philosophies, comprising Hinduism, Buddhism and Taoism among others, are vastly different but their basic features of their worldview are the same. This worldview is the same as that of early Greek or Western philosophy, which held a holistic and organic view of the world: man, plants, animals and their environment with their various components were viewed as a single entity and studied as this accordingly. As stated earlier, the basis of Western sciences, including physics, was based in a culture where science, philosophy and religion were studied without distinctions between them (Capra, 1975).

The holistic worldview was held until the start of the Renaissance when the scientific study of nature began. Experiments to prove theories were conducted and results were expressed in mathematical language. At this point, Rene Descartes advocated the dualistic view of mind and matter, with matter being considered as dead. This was known as the Cartesian division and this became a worldview which allowed scientists to separate themselves from the world and thus be able to analyse
the world as different objects operating as part of a large machine. Thus the mechanistic worldview was born. Isaac Newton also held this mechanistic worldview and these two people became synonymous with the mechanistic worldview (Capra, 1975).

This view did not only examine oneself mechanistically, but also nature and society were viewed mechanistically or as separate parts. Separate parts to be exploited by different interest groups, which has lead to various environmental and social crises over the years. There have been positive aspects to this mechanistic worldview, both classical physics and technology developed from this worldview, although they have often lead to detrimental conditions (Capra, 1975).

It should be remembered that a patriarchal worldview also dominated societies' views on life from that time to modern times. Around that time, a man named Francis Bacon who formulated a clear theory for making experiments and he became famous for this. He also viciously attacked nature through phrases containing metaphors referring to nature as women and that one should enslave and torture nature in order to learn, use and abuse. This image of nature was concurrent with witch trials, which were held frequently in his time. The effect of Bacon’s attack was that the view of the nurturing earth was disappearing to be replaced with the view of the earth as a machine coupled with patriarchal views of society (Capra, 1983; Capra, 1988). Metaphors promoting the domination of nature prevailed under the mechanistic worldview, at the same time women were put under male domination through a paternalistic worldview. This illustrates the effects of metaphors on society’s conceptual thought system.

The mechanistic worldview has lead to a technological revolution in an attempt to put nature under greater domination and to make use of nature in a more efficient manner. This need for technology advancement and domination over nature shows symptoms of being ideological, with technology and economic advancement being elevated to hyper-normative status with disregard to the other normative values’ true natures. This is coupled with a relationship of domination with technology dominating nature (Schuurman, 1983).

7. Change of Worldview and the New Paradigm

Solutions to the problems associated with the paternalistic and mechanistic worldview need to be formulated and a good first step is to change the dominating worldviews to metaphors that do not promote degradation and fragmented views of what is true nature.

A new worldview has been formulated on the old worldview that existed before the mechanistic worldview. It focuses on a holistic view of nature and life, and follows what is known as systems thinking or a systems view of life. It looks at life in its entirety and includes the interrelationships and the interdependencies that make up life. For while mechanistic science studied the basic building blocks, systems science focuses on the basic principle of organization (Capra, 1983).
This new systems view can be seen within modern physics where there is now emphasis on processes, interrelationships and interactions. It follows after a “bootstrap” philosophy which has abandoned the idea of fundamental building blocks as well as fundamental entities such as laws. It rather focuses on the dynamic interactions between the different parts, which is ironic in a sense, as this was the starting point of physics or ‘phasis’ as it was termed then (Capra, 1975). Physics did of course leave this holistic view point to examine smaller and smaller parts of life until physicists got to a point when they realised the interconnectedness of all parts they studied. This realization of interconnectedness came about when physicists did different experiments with atoms and sub-atomic particles. Certain experiments showed that atoms and sub-atomic particles were particles while other experiments showed that they were in fact waves (Capra, 1982). The same is true of light particles or photons which also have both particle and wave-like properties (Davies & Brown, 1988). This became known as quantum theory. This phenomenon bewildered scientists with their mechanistic worldview as when they examined life down to its most basic properties (as mechanistic/Cartesian thinking promotes), it was sometimes there and it was other times wave-like (or not there). This paradox forced scientists to change the way they view the world. Scientists in other fields have also come to realise the interconnectedness of life and have started more holistic approaches to their work, in line with a systems view point (Capra, 1975).

Along with a change in worldview from mechanical to systems are the various protest movements, such as the feminist movement and the ecology movement, which also played a role in changing the mechanistic worldview. A certain kinship is linked between feminism and ecology due to the view of Mother Nature and the dominations exerted upon them under similar conditions. A feministic and ecologistic viewpoint would be an integral part of a systematic viewpoint, with no part, in such a movement taking dominance over other parts (Capra, 1988).

A balance through a systematic viewpoint could greatly improve the quality of our environment and ourselves, and metaphors associated with this viewpoint should be accurate of nature and life’s true natures.

8. The Link with Other Disciplines

Permaculture is a word contraction of both permanent agriculture and permanent culture. It was developed by David Holmgren and Bill Mollison on the island of Tasmania, off the coast of Australia, as a pro-active measure to combat the degradation caused by political and industrial systems (Mollison, 1991).

Holmgren and Mollison developed a lifestyle system which focused on the interrelationships between all the elements within the system. These elements include plants, animals, buildings, water, energy and communications. How these elements interact will determine how the system will be designed. Permaculture is all about design and putting the right element in the right place for efficiency in the functioning of the said element (Mollison, 1988).
According to Mollison (1991), Permaculture design has a set of universal laws and principles that suit all climates and cultures as well as a component of practical techniques to suit specific climates and cultures. The universal principles are as follows:

- Locate each element, in relation to the other elements, for assistance;
- Single elements perform many functions;
- Each element has the support of many elements;
- Effective zonal planning for housing and other elements with an emphasis on energy efficiency;
- The use of biological resources instead of fossil fuel resources;
- On-site recycling of energy;
- Use of natural plant successions for establishment of favourable sites;
- Use of polycultures and diversity for productive and interactive systems; and
- The use of edges and natural patterns to their best effect.

Holmgren (2006) has since advanced the Permaculture principles that were originally developed. Some of Holmgren’s principles are new, while the rest are a refinement of the original principles:

- Observe nature and interact with recognised patterns. This is the foundation of all learning and understanding;
- The capture and storage of energy. The energy that is referred to is inclusive of water, nutrients, seeds, carbon and energy used for power supply;
- The application of self regulation and the acceptance of feedback so that excessive and inappropriate growth is discouraged. In this way technologies do not exploit resources with subsequent damage in the future;
- The use and value of renewable resources. These resources should be used to generate income while non-renewable resources should be thought of and used as capital assets;
- No waste production. The system should be designed so that something that would be considered as waste is used productively by another component in the system;
- Designing patterns and then details. There are patterns in nature that work. These patterns have different details under different circumstances. First the patterns need to be recognised and designed, and then the details can be added;
- Integration of elements rather than segregation. Relationships between the different components in the system should be optimised – so that every component serves the other components’ needs as well as accepting the other components’ products;
- The use of small and slow solutions. Small and slow technologies are more practical and energy efficient;
- The use and value of diversity. Diversity is insurance for the variances in nature and everyday life;
• The use of edges and the appreciation of value in the marginal. The edges of fields, rivers and any other similar elements often provide the most interesting events. Marginal areas often serve functions that are not given enough recognition; and

• Creative use and response to change. One must respond proactively to uncontrollable change by using the change to one’s advantage. This principle links up with the first principle in a cyclic manner.

The principles of Permaculture are within the boundaries of the three principles of sustainability, although the Permaculture principles give direction to achieving sustainability and encompass the principles proposed (and adapted by the author) by Pretty.

An example of a Permaculture system, encompassing the house, will be given. The house should be made of natural and recycled materials that are locally available so that transportation of materials is kept to a short distance as possible, thus limiting pollution. The position of the house is important, so the house should face north (in the southern hemisphere) to make the most use of available heat from the sun. This position will also enable maximum use of solar power, whether it is in the form of photovoltaic cells or solar water heaters. The house should be on a slight slope so that waste water from the house can be used to water crops via gravity. The roof should be used to capture rainwater for drinking and washing. Waste from the kitchen can be turned to compost or fed to chickens and pigs. Trees should be planted to block wind and provide shade. Some of these trees should be a mixture of fruit trees to provide food for the residents of the house as well as any animals while leguminous trees should be planted to improve the soil’s fertility. Home gardens close to the house are also an essential element in Permaculture as these provide food to the people living in the house. Elements such as a herb garden, which are often used, are placed as close to the house as possible while elements that are seldom used are placed further from the house.

One will also notice micro-environments around the home and one should make use of these as they will provide conditions for different plants to flourish. An example of this would be to grow lettuce (a winter crop) on the south of a house (in the southern hemisphere) during summer as this side is colder than the north side and thus allowing one to grow crops out of season. Another part of Permaculture is to make full use of all available space. In this way, one should plant different crops together, although one must take note to plant crops that complement each other as some crops do not grow well together. The last important point of Permaculture is to make use of any available resources that are unique to the area, but without degrading the resources.

9. Housing in South Africa

At the end of Apartheid, the approximate backlog of housing at that time was estimated to be 2 million houses, with population growth increasing the need for housing by 150 000
houses per annum (Ramabodu, 2004).

According to Statistics SA (2007), the population is continuing to grow. The population was 40.5 million people in 1996, 44.8 million in 2001 and 48.5 million by 2007. The survey also found that housing conditions have improved from the previous survey in 1996. In 1996, only 64% of households lived in formal dwellings and this has increased to 71% by 2007. Households living in informal dwellings were accounted for at 15%, while 11.7% live in traditionally-built houses. Service delivery has also improved since 1996 with more households having access to electricity and the majority of households, at 88%, have access to piped water.

If 15% of the South African population live in informal dwellings, it calculates to being 7.275 million people who still require adequate housing. This number increases annually as the population grows. Adequate solutions are required to reduce this number.

10. Sustainable Housing

According to Engela (2006), there are principles that guide ‘green’ or sustainable housing developments with key emphasis on reducing energy consumption, providing a safe and healthy working and living environments, and reducing waste. Beyond these, the following also help in the guidance of building in a more ecologically-beneficial way:

- Energy consumption must be minimised and, natural and renewable sources of energy should be used;
- Minimization of site impact to the ecology of the area;
- Utilization of less resources by recycling and by using improved technology;
- Minimization of the effects of building materials on the environment;
- Utilizing less harmful chemicals;
- Minimization of waste through recycling;
- Maximising the use of public transport to reduce the use of additional vehicles;
- Utilizing existing buildings to preserve land; and
- Increasing the quality of indoor environments by using natural light and air, and building orientation.

Having set the ground work for determining the sustainability of buildings, two building systems are proposed as sustainable due to their consideration of the environment and their social awareness. Both of these building systems promote self-reliance, which means that people who do not have adequate housing can use these systems to build their own houses with the use of natural and recycled materials. These building systems are the Tlholego Building System and the Earthship Biotecture.

10.1 Tlholego Building Systems (TBS)

“The TBS is a flexible, owner-built, low-cost, high-quality housing system.” It aims to avoid the serious shortcomings of the present low-cost housing projects in South Africa as it addresses social, environmental and resource problems that are not considered in the construction of the country’s low-cost houses.
TBS houses conform to modern standards, but use natural materials so that environmental degradation is minimised. This system was initially aimed at solving the problem of supplying low-cost houses, but the principles are applicable to all sectors of the housing market (Tlholego, 2001).

In conjunction to the houses themselves, the houses lend themselves to using unburnt mud bricks, passive solar designs, collection of rainwater, compost toilets, solar water heating, grey-water irrigation and food self-reliance through Permaculture gardens. The project coordinators believe that one of the most important accomplishments of TBS is the sustained transfer of skills in innovative building techniques to the Tlholego community. The community now has a building team that is competent and capable of transferring TBS to other communities (Tlholego 2001).

The TBS have replaced low-quality houses at Tlholego and the system was chosen by the National Department of Housing as the most appropriate system or model to represent South Africa at the Africa “Solutions Towards Sustainable Development” Conference in March 2000. This conference was held by the Council for Scientific and Industrial Research (CSIR) (Tlholego, 2001).

10.2 Earthship Biotecture

Earthship Biotecture is a worldwide phenomenon of self-reliant housing made from natural and recycled materials. The organization has 40 years of research and development experience behind it, which have helped them to build Earth-friendly and human-friendly houses that require little to no mortgage payments and utility bills. They define an Earthship as a passive solar home constructed of natural and recycled materials that have thermal mass for stabilising temperature and make use of renewable energy and integrated water systems that allow the Earthships to be off the electricity grid, thus having little to no utility bills. Their definition of Biotecture is a combination of biology and architecture that allows the design of sustainable buildings and environments (Reynolds, n.d.).

The mission of Earthship Biotecture is to evolve the way people live on this planet by evolving how we live as well as slowing down and reversing the degradation to the Earth that is caused by human development. In addition, they want to present a way to achieve the above and to inspire people to live a sustainable lifestyle. These buildings are designed so that they make use of natural heating and cooling via solar and thermal dynamics, they are energy self-sufficient via the sun and wind, the buildings harvest their own water from rainfall, they treat and dispose of their own sewerage on site, they produce a large amount of food and they are built from the by-products of society, such as glass bottles, cans and tyres. These are the Earthship design principles (Reynolds, n.d.).
11. Conclusion

The mechanistic worldview has had a very destructive history and it would seem wise to move away from such a model to a model that does not lead to serious negative consequences. The systems viewpoint which looks at life and nature in its entirety sounds to have good prospects for humanity. Such a model would need to balanced, without any elements dominating the model. Mankind is entering into a crises period and to improve mindsets and worldviews could greatly change mankind’s predicament. Having said that, to exclude elements from a study would be unwise as this is cause of the initial problem, that of the Earth’s degradation.

The information of alternative options that are holistic is available. Permaculture is a prime example of the holistic integration of the different elements into a sustainable livelihoods framework. Permaculture principles and practices should be integrated into low-cost housing developments as it offers the inhabitants of such housing developments a better quality of life. The two examples provided under the topic of Sustainable Housing give evidence to the fact that the integration of natural and recycled materials are sustainable and can not only improve the quality of life of inhabitants, but also improve the quality of the environment. This is also achieved at a lower cost. The fact that the Tlholego Building System and the Earthships make use of Permaculture principles and practices gives further evidence for the need to integrate other elements – such as renewable energy, grey-water use and home gardens – into housing development projects. With such actions, sustainable livelihoods can become a reality for recipients of housing developments.

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