

University of Pretoria, etd - Human, M (2003)

baseline document



Non-renewable resources are being depleted and there is increasing environmental damage as a result of human activities. It is therefore increasingly important that this is addressed, and sustainability becomes a key issue in the way we live and work. Buildings can play an important role in supporting sustainability. This is done through careful planning in which design decisions, material specifications and so on are carefully evaluated in terms of their long term impact on the economic, social and environmental sustainability of a society and the natural environment (Gibberd, 2002; 1).

The baseline document is to be managed as a multi faceted approach to the construction of the proposed buildings, highlighting certain points to create an overall understanding of what should be achieved with the design.

Social issues

Occupant comfort

Intelligently designed and operated buildings, sometimes erroneously called “intelligent buildings”, are distinguished not by the presence of a high degree of linked information, communication and building automation systems, but rather by the fact that they can serve user needs directly from the environment and avoid the use of technical installations. Natural lighting, natural ventilation, variable thermal transmittance, changeable total solar energy transmission values, adapted by daylight etc., decrease the energy requirements in the operation of such buildings by approximately 30% - 40% by comparison with today's buildings (Daniels, 1998; 9).

Personal comfort is the most important user need to be satisfied, especially in the parts of the building where people need to be creative and engage in physical activities. Standards of comfort grow out of a range of conditions with determining factors categorized as follows (Daniels, 1998; 90-104).

Thermal comfort:

Human performance is negatively influenced by room temperatures above 28°C or below 18°C. Thermal comfort is achieved when occupants find the temperature, humidity, air movement and heat radiation in the environment ideal, and wish neither to be warmer nor cooler, or to have drier nor more humid air.

Hygienic comfort:

The air quality in a room is determined by the quality of air intake and by air-contaminating factors such as room usage. Intake air consists mostly of outside air. Natural ventilation should ensure sufficient filtration of pollutants through outside air intake

Acoustic comfort:

Acoustic discomfort can be clearly define in cases where a very high noise level is produced on the other hand, soundless rooms are equally acoustically uncomfortable. We usually inhabit rooms that are neither the one nor the other. Rooms for sedentary activities, such as offices should have a noise level of about 35 dBA regardless of room size and number of occupants.

Visual comfort:

Depends on sufficient light in the area of visual focus and the avoidance of glare. Lit rooms should exhibit sufficient shadow effects to enhance the plasticity and three-dimensionality of objects and surfaces. Visual comfort also means contact from the outside in and from the inside out. People should not be more than 6m away from a window.

Access to green outside spaces should be provided

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Inclusive environments

Buildings can be designed to accommodate everyone, or specially designed buildings need to be provided. Ensuring that buildings are inclusive supports sustainability as replication is avoided and change of use supported (Gibberd, 2002, 3)

The building should be designed to not only include the students who attend this institution but the broader community. It is foreseen that through the schools programme, allowances will be made to cater for programmes for underprivileged children by Doxa Deo. Specialised facilities like the auditorium will be available to other institutions to assist in the financial sustainability of this building.

Public transport

A taxi and bus drop-off point are proposed in Visagie Street, next to the main pedestrian spine connecting Burgers Park with the ISDF proposed Skinner Street boulevard. This drop off should also be accessible for disabled persons.

Routes, signage and level changes

All pedestrian routes should be of smooth even surfaces that are easily navigable by wheelchair. Edges should be clearly distinguishable through the use of colour, material and finish. There should be lifts or ramps of 1:12 fall between all changes in level. Level changes can also be used as space defining elements in the building as well as the landscape.

Toilets

Provide the number of male, female, and disabled toilets according to SABS 400.

Participation and control

Environmental control

Users of the building should be provided with options for environmental control e.g. opening windows and blinds, control over light.

Social spaces

Spaces should be designed to accommodate comfortable social interaction. Users should be offered multiple choices for social interaction. These should include public places (open outdoor green furnished spaces, coffee shops, cafeteria, and a restaurant), semi-public spaces and private spaces such as staff areas and meeting rooms. Circulation spaces, the library and exhibition spaces should be designed to accommodate casual, unplanned social interaction.

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Community involvement

The community will use space such as the auditorium, amfi-theatre, lecture rooms and computer room. Programs such as adult and computer literacy courses will be implemented by Doxa Deo, utilizing the building after hours.

Social upliftment

Use basic construction techniques and simple detail design that can be associated with the local building industry. Another important criteria that should influence the design process is the implementation of purpose designed prefabricated items such as composite slabs, treads and pre-cast concrete panels. If this approach is followed it would limit wastage and transportation of goods, therefore not only having a social implication on sustainability, but also environmental. Details and materials that require a fair amount of maintenance, which can be carried out by relatively unskilled people from the community, should be used to provide social sustainability. For the above to work a maintenance policy should be set.

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Education and safety

Education

Amongst others, one of the main aims of the institution is to provide a facility that will enable individuals to improve their current situation through providing them with a skill and education that can steer them in a direction to determine their own future. The Performing Art Centre should be designed to encourage this educational process through the encouragement of participation, involvement and contribution. As discussed under the school programme, Burgers Park and the amfi-theatre will be used for open-air performances, which will introduce people from the local community that might not have money to attend the theatre to performing arts.

Security

- Located within the inner city security has to be considered as one of the big concerns for the safety of the students as well as the public spaces. The following design aspects should be employed to provide a safe and secure environment.
- a spatial accessible layout should be provided with no inconspicuous and unsafe spaces
- informal occupant surveillance should be promoted for all spaces inside and outside the buildings
- adequate lighting should be provided, keeping in mind the user parameters set for energy efficient lighting appliances
- visual links and linkages across open spaces should be a prime concern if informal surveillance is to be promoted

Economic issues

The design and construction of these buildings is not only to provide for the bettering of the immediate area, the students and the public who make use of this facility, but also to provide for the community and local economy. Basic material usage and the restriction of hi-tech construction methods should be limited where possible, to allow, create and provide opportunity to the local community for involvement in this project.

There should be a realisation that not all work can be carried out by local contractors and laborers, therefore outsourcing will be needed in specialised situations. Local material from easy accessible and renewable sources should be used.

For the project to be economically sustainable one would tend to design details and use materials which needs the least maintenance possible, however there should be a balancing act between this and social sustainability, as discussed under social upliftment.

Efficiency of use

Maximum use of space needs to be achieved for the building to be sustainable. This can be achieved through a constructive management program that will enable most of the spaces in the building to be used after hours as well.

Adaptability and flexibility

The design should be able to accommodate possible change in the future, if necessary. Design parameters that should be adhered to include: minimum structural dimensions of 3m, the use of non-load bearing elements and partitions where possible and the design of services that will provide easy access and modification.

Ongoing costs

Detailing, material selection and system selection should be done to keep the ongoing cost to a minimum. Instead of specifying low maintenance materials, low costs maintenance materials should be specified where possible, so that job opportunities are created for the local community. However, specialised cleaning should be kept to a minimum.

Security usually forms a large part of the ongoing costs nowadays. This can be limited by ensuring informal surveillance through having the buildings occupied as much as possible.

Environmental issues

Rainwater

Rainwater should be controlled and harvested in two different levels. Storm water on ground level and rainwater on roof level. Rainwater should be collected, stored, tested and be used as a grey water supply.

Water consumption

- devices that can minimise water usage from the main water supply should be specified. Devices that can be used are:
- dual flush toilet system, connected to the grey water supply
- auto flow automatic taps in all toilets, runoff water from these taps should be reintroduced in the grey water system from where it can be used for landscape irrigation
- aerating shower heads

Runoff

The site slopes 2% to the north, which means that runoff can be considerable. Minimizing hard landscaping and using pervious or absorbant surfaces can reduce this.

Planting and landscaping

- planting and landscaping to be designed and coordinated by a landscape architect adhering to the sustainability guidelines which have been laid down for the project in terms of:
- water consumption
- top soil utilization
- indigenous plants to be planted

Energy

Buildings consume about 50% of all energy produced. Conventional energy production is responsible for making a large contribution to environmental damage and non-renewable resource depletion. (Gibberd, 2002; 9)

Ventilation system

Natural ventilation uses the natural forces of wind and buoyancy to deliver fresh air into the building. Fresh air replenishes oxygen for respiration and increase thermal comfort. Natural ventilation systems rely on the ability of air to move through a building, in order to equalize pressure. The pressure differences within a building can be caused by wind or the buoyancy effect created by stratified warm air. In either case, the amount of ventilation will depend critically on the size and placement of both external and internal openings.

Passive solar heating systems

Direct gain:

The sun is admitted directly into spaces in the building through windows, skylights etc. This principle is especially applicable to buildings orientated to the north. Through the use of solar shading sun can be kept out during summer and allowed into the building during winter. The mass of the building fabric itself is used as thermal storage material, storing excess solar energy during the day and releasing it back during the night. In building s where all the spaces do not have direct exposure to the sun, effective air circulation is necessary between "solar" rooms and "non-solar" rooms.

Factors affecting the performance of direct gain buildings are:

- orientation and location of the solar glazing
- size and type of the solar glazing
- the amount and design details of the mass available for thermal storage
- heat loss coefficient of the building as a whole
- arrangement of the furniture in the "solar" rooms
- thermal coupling between "solar" and "non-solar" rooms
- control options of heat gain and loss through the glazing

(Givoni, 1998; 150)

Solar glazing should face north but a deviation of up to 30° is acceptable. Clerestories can be used for spaces without any north facing windows, but from an energy aspect may be less efficient. The most common materials for thermal storage are masonry materials. The necessary thickness of the elements can be calculated by considering the daily cycle of the building.

Trombe walls:

Trombe walls combines into one building element the functions of solar energy collection, heat storage, and heat transfer into the interior. In its simplest form it consists of a glazed facade in front of a massive, conductive wall with an air gap in between. Solar radiation penetrating the glazing is absorbed into the wall, raising the external temperature of the wall and that of the air in contact with it. The time lapse between storage of thermal energy and its release into the interior are determined by the thickness and thermal conductivity of the wall. If vents are provided, at the top and the bottom of the wall, the heated air in the airspace rises and flows into the building through the upper vents. A thermosiphonic airflow forms, transferring heat to the room by convection, in addition to the conductive heat transfer.

Advantages of Trombe walls are:

- the indoor temperatures are more stable than in most other passive systems
- excessive sunshine, and its associated functional problems, does not penetrate into the inhabited space
- installation is relatively inexpensive where construction would normally be masonry

(Givoni, 1998; 161)

If windows are provided alongside or within the wall direct gain can provide light and quick heating in the morning, while the mass is still cold. For each 10cm of concrete there is a time lag of 2-2.5 hours between peak solar absorption, and heat delivery on the inside. 300 to 400 is the optimum thickness. Vented walls are about 10% more efficient, but it is important that the vents should be closed at night to prevent a reversed flow.

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Passive cooling systems

The Trombe wall will be used as a cooling system during summer, by routing the airflow passage to the outside. Heat inside the building is stored in the wall at night. When it reaches the outside of the wall, it supplies heat to the air gap. Warm air rising in the gap escapes to the outside through a vent at the top of the glazing, drawing out warm air from the building.

Evaporative cooling towers

The "Arizona" tower consists of a downdraft tower that has at its top vertical wetted cellulose pads impregnated with anti-rot salts and rigidifying saturants. Water is distributed at the top of the pads, collected at the bottom by a sump, and recirculated by a pump. The complete system also includes a solar chimney at the opposite side of the building, to enhance the airflow rate through the cooling tower and the building.

Appliances and fittings

Energy efficient fittings and devices should be specified. 80% of light fittings should be fluorescent or low energy consumption.

Recycling and reuse

Inorganic waste

All recyclable waste should be sorted and stored on site, provision should be made for this in the basement.

Organic waste

Large quantities of organic waste will be produced by the restaurant and cafeteria. An agreement should be made with someone to collect this on a daily basis, for instance the owners of a piggery.

Construction waste

- modular design will reduce off cuts and other material wastage
- pre-fabricated elements reduce transportation costs as well as material wastage

Site

The proposed design should not be damaging to the site, but rather uses its qualities of location and attractiveness to add to the quality of the surrounding area and contribute through the design proposal to the local community.

The buildings themselves should not detract but rather add to the existing structures existing in the area to create a more interactive urban environment. New buildings should not have a harmful effect on neighbouring buildings, for instance over shading where access to sunlight is important or taking away parking without making provision for that.

The new landscape, designed by a landscape architect, should not require heavy artificial input such as fertilizer, insecticide and pesticide.

Materials and components

Embodied energy

At least 80% of the building materials and components should be made from materials and components with low embodied energy. Low embodied energy materials include locally made and sourced timber, concrete, concrete blocks, timber windows and doors (Gibberd, 2002; 10).

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Material and component sources

At least 90% of materials and resources should be renewable.

Construction processes

The building and construction process should be designed to minimally impact the environment. This requires a construction programme that takes into consideration elements such as the monthly rainfall for erosion and runoff to be minimised.

Material selection

Materials can be divided into categories of permanent and non-permanent. Materials, which are in our culture perceived to be non-permanent, such as timber, lifespan can be prolonged through the correct treatment and maintenance. The use of such materials in buildings helps users to perceive the building as a living element in the urban context. The permanent materials should be of a very durable and robust nature, requiring little maintenance.

Preferably most of the permanent materials used for the structure should be able to serve a dual function such as structural functions and mass insulation.

- The construction methods, materials and techniques should be selected for the following reasons already explained in the baseline document:
- social and economic sustainability
- locally produced materials
- complexity of construction methods (simple methods equates to a high labour intensive workforce)
- speed of construction (reduced time period equals reduced cost)
- empowerment of NGO's

Steel, brick, timber, concrete and glass have been selected as the main materials to be used in the construction of the buildings, creating a robust structure as well as serving the needs of occupants.

Steel

Advantages

- recyclable and reusable
- trusses and beams can be manufactured off site, which will decrease the construction period
- good structural properties
- requires very little maintenance if well detailed

Disadvantages

- non-renewable resource

Steel is chosen mostly for its tensile qualities, which concrete and to a lesser degree timber lacks. Steel will be used in most of the joint-work and the reinforce timber and concrete.

Brick

Advantages

- recycleble and reusable
- good structural properties
- good thermal storage

The use of brick in stack bond will establish a relationship with the Lutheran Church and Doxa Deo, but contrasts in relation to the Unisa Little Theatre. Brick and mortar construction is labour intensive, cheap and empowers people through use of local labour.



1 Stack bond - Lutheran Church



2 Stretcher bond - Childrens Art Centre

Timber

Advantages

- renewable resource
- excellent insulating properties and ideal material for low-energy buildings
- low-tech with high-tech performances
- requires the least amount of energy to manufacture, transport and distribute include costs arising from environmental damage
- re-use increases if wood treatments are used which does not include heavy metals
- combination of finishes
- timber is supple and can absorb movement
- timber frames can be fabricated off-site

Timber has unique qualities, a building material that is completely recyclable, and its stocks are naturally replenished. As a source of energy it doesn't disturb the ecological balance of our environment. As a natural material, it is the perfect physical expression of our intimate connection with the world in which we live (Stungo, 1998; 8). Stungo compares the tree to a human being. It has its skin, the bark; the roots are its head and its hair; it has its distinctive markings and its senses and its sensitivity in the trunk. When the trunk is wounded, it dies. It has leaves, flowers and fruits as decoration, just as humans have hearing, facial features and language...

Visually timber buildings are perceived as temporary erections. This couples with the idea that people forms the most important element of the building.

The most important development in timber construction during the 20th century is the invention of glue-laminated timber, as a huge advance in bridging wide spans.

Preservation is compulsory and detailing to keep moisture out compulsory. Timber is mostly pressure treated with chromated copper arsenate (cca). Although this is considered much safer than many other processes, cca-treated wood does contain arsenic, and it should therefore only be used when the timber is in direct contact with the ground. Using chemically treated wood can be limited, however, by following a few rules: (i) eaves can protect the facade if extended far enough, (ii) water drips on horizontal boards will ensure that water runs off more quickly, and (iii) timber should rest on metal shoes, rather than to come in direct contact with the ground. Alternatively finishing wood with beeswax or repeated layers of approved woodoil, sanded inbetween applications, will suffice.



1 Naoshima Contemporary Art Museum - Tadao Ando

2 Juxta positioning of materials - Lutheran Church

3 Smooth and brushed off-shutter concrete

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Concrete

Advantages

- good thermal storage
- can achieve large spans
- easily moulded into desired profiles
- different finishes possible
- can be precast or cast in-situ
- precast panels can be reused

Disadvantages

- sand and cement is a non-renewable resource
- in-situ cast concrete can't be recycled except if crushed and used as a fill material

Tadao Ando treats this building material with true architectural passion, giving it a unique scale. His perfect concrete blocks measuring 90 x 180 cm wide with six drill holes each left exposed like the concrete itself are arranged in a grid of 40 x 60 cm, with a height of 22,5cm and a width of 30 cm. The drill holes have a diameter of 25mm. This pattern, which is consistent on the exterior and in the interior, is in measured, agreeable proportion to the human scale. The wall as a readable surface (Blaser, 2001; 52)

Concrete is chosen as medium to establish a visual link with the Doxa Deo building and the Lutheran church, but to be in contrast with the Unisa Little Theatre, which is the heart of this development. Concrete elements will either be precast panels as mentioned above, or concrete brut walls. Different finishes to off-shutter concrete e.g. power floated or brushed to expose aggregate can be used to define differences in scale and rhythm, which can be used to either lead people quickly through spaces or let them pause in certain areas. As a structural material it also has enough mass to serve as thermal storage elements.

Glass

Advantages:

- allows natural light into a spaces
- recyclable and reusable
- good heat energy conduction
- Allow views to the inside and outside

Disadvantages:

- glass admits solar radiation frequencies above and below the visible spectrum
- can pose a security risk
- little structural properties

Tadao Ando infuses us with breath through the depths and layers of spatial design flooded with light. He shows us the reflections of light. All is flowing light, without abstraction. It is a weaving and flowing of air and light as if there were no fixed spatial composition. All is continuous metamorphosis, a constant transformation, and a reflection of the seeing eye and the thinking brain (Blaser, 2001; 17)

Glass gives the ideal opportunity to introduce natural light into the building, merging interior and exterior into one scene. Through using shading devices, keeping in mind the orientation of the facade, can eliminate most disadvantages associated with glass.

1 Off shutter concrete structure, defining the Entrance - Doxa Deo



Critical performance

Facades

- exterior facades should respond to orientation and traffic
- the east and west facades should not be more than 20% glazed without sun protection
- reflected glass should be avoided, to alleviate the negative effect of direct solar radiation and reflection on neighboring buildings, spaces and places surrounding the building
- white or light colours and materials should not be used where direct reflections will result in glare on the streets and surrounding buildings in harsh sun-light on the north and west orientated facades
- where privacy and security permit, the building must allow the passer-by to see the activities inside
- attention to be given to the use of materials and the degree of detail on the ground floor level where most people come in close contact with the building
- create narrow shop units on ground floor level which can be surveyed internally
- ensure flush and continual frontages which eliminates recesses and alleyways
- prevent positioning of trees, gates, or other elements that could provide footholds for illegal entry to balconies and windows above ground floor
- define thresholds between interior and exterior as well as between different functions
- counteract dead frontages by locating active places with clear views in these areas
- use building elements that will assist surveillance on streets, like baywindows and balconies

Vehicles

No vehicle movement is allowed on site, except for occasional deliveries to the Unisa Little Theatre area. This decision was taken to highlight the idea that people forms the most important element of this development. Vehicular entrance into the basement is only from Visagie Street. The high level of pedestrian traffic in Van Der Walt Street and the proposal of the Skinner Street Boulevard influenced this decision, so that these main pedestrians spines won't be interrupted.

Design guidelines for basement

- floor to ceiling height should be a minimum of 2500 to enable light delivery vehicles into the basement
- parking for the new buildings, as well as the theatre, church and the two apartment blocks will be provided in a basement
- the parking garage entrance is in Visagie Street and should be clearly defined
- aisle widths 7,2m
- typical bays 2,5m x 5,4m

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1 Noashima Contemporary Art Museum - Ando

2 Studio Archea - Double facade

3 London Contemporary Dance School

4 Zoological Gardens - Denmark

Exhibition space

Design guidelines:

- the space should be well lit suitable for the display of art
- double volume space with the possibility of a mezzanine
- interior should have a 'silent' character in order for the exhibited artwork to be the main focus

Theatre

The theatre would be used as a secondary theatre to the Unisa Little Theatre. It will serve a dual function and can serve as an auditorium as well. As a theatre it would mostly serve for smaller productions and musical performances.

Design guidelines

- audience not more than 20m from stage
- maximum gradient without steps is 1 in 12, with steps it is 35°
- stage should be raised by at least 800 in order for the performer to have a close relationship with the audience
- a noise criterion of NR 30 should not be exceeded
- reverberation time for speech should be between 0.7 and 1.2 second, and for music between 1 and 2 seconds (aim for 1.2 seconds)
- 5m³ per audience seat gives about the right total absorption to provide a satisfactory reverberation time for mixed used auditoria
- if the maximum distance to an audience seat exceeds 18m ceiling reflectors should be used
- materials for reflectors must be smooth and non-porous and should weigh not less than 5kg/m³ for speech only, or 40 kg/m³
- at least to exists should be provided
- doorways should not be less than 1070
- back-to-back distance between rows of seats is 760 minimum
- width of seats with arms is 500, without arms is 450 minimum
- unobstructed vertical space between rows is 300 minimum
- width of gangway is 1100 minimum
- the basement under the stage should have at least 2400 minimum clear height
- the stage floor must have some flexibility in its construction
(Ham, 1987; 8-49)
- because of the acoustical quality needed the theatre will need to be mechanically ventilated

Library

Activities within this facility differ from the usual quiet library environment, realising this, special attention should be given to the separation of activities. Providing relevant acoustic qualities to areas that require alternative measures e.g.. audiovisual section and study sections. Although different functions need to be incorporated into the library, there are not extremely diverse requirements to be incorporated to achieve performance required.

Speech intelligibility, acoustic comfort and noise privacy are the most important factors to consider. To achieve the necessary requirements in the above mentioned the ambient noise level should be kept between 20 and 30 dBa, in all spaces.

Dance studios

The studios should have sprung floors and adequate floor to ceiling height. As much as possible natural light should be provided without compromising privacy. It might be necessary to use mechanical ventilation, if the required number of air changes can't be met through using only natural ventilation.