

# **Project Proposal**

Construction of the Sai Education Centre at Plot 68 Uniaville,  
South of Johannesburg

by

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Project Proposal presented in partial fulfillment of the requirements for the degree of  
MPHIL (Sustainable Development Planning and Management)  
at the University of Stellenbosch

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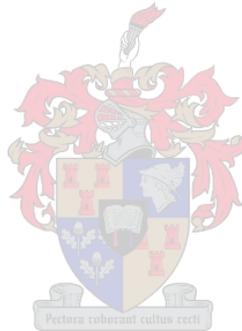
March 2007

## Declaration

I, the undersigned, hereby declare that the work contained in this project proposal is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

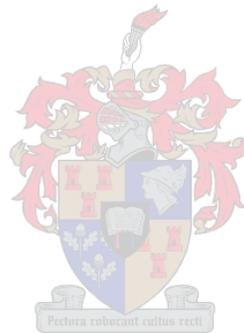
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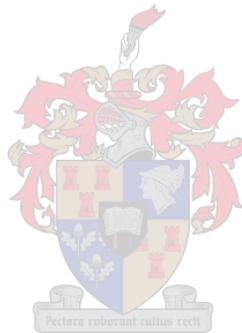
## **Abstract**

This project proposal looks at the construction of a high school for the Sri Sathya Sai Organisation in South Africa using ecological design principles and Vastu Architecture as guiding strategies. The document discusses the need for sustainable development in relation to the built environment. The mechanisms, objectives and reasons for existence of the Sri Sathya Sai Organisation are also discussed. The proposal also introduces the science of Vastushastra as a science that can benefit human beings on both material and spiritual levels. The proposal lists the various alternative technologies that are available to make the built environment more sustainable and then goes further to present the relevant technologies that will be used in the project.



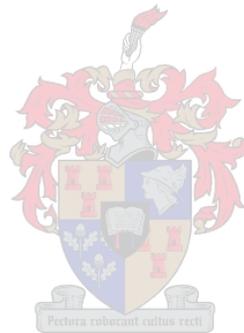
## Opsomming

Hierdie projekvoorstel kyk na die oprigting van 'n hoërskool vir die Sri Sathya Sai Organisasie in Suid Afrika met ekologiese ontwerpbeginsels en Vastu- argitektuur as basis. Die dokument bespreek die noodsaaklikheid van volhoubare ontwikkeling met betrekking tot die geboude omgewing. Die meganismes, doelstellinge en redes vir bestaan van die Sri Sathya Sai Organisasie is ook bespreek. Die voorstel stel ook die wetenskap van Vastushastra bekend as 'n wetenskap wat mense kan bevoordeel op beide materiële en geestelike vlakke. Die projekvoorstel noem verskeie alternatiewe tegnologieë wat beskikbaar is om die geboude omgewing meer volhoubaar te maak en bespreek verder die toepaslike tegnologie wat gebruik sal word in die projek.



## Acknowledgements

I dedicate this research proposal to my guru, guide, teacher and master, Sri Sathya Sai Baba. Thank you swami for all the love and grace you have afforded me in this lifetime. My love and gratitude goes to my beautiful wife Pria and my precious children Saieshka, Chian and Tashavia. I am also deeply indebted to my mother who has always believed in me. Thank all of you for the love, sacrifices and support. I am also deeply grateful to my supervisor, Dr Daniel Irurah for his knowledge, guidance, patience and belief in me. My sincere thanks to Mark Swilling who introduced me to the subject of Sustainable Development, which has awakened my passion and purpose in this lifetime.

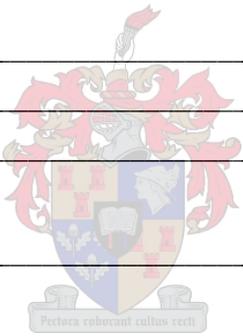


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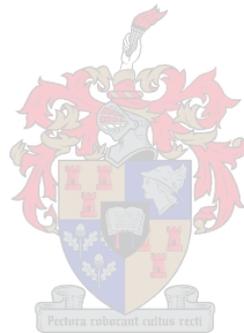
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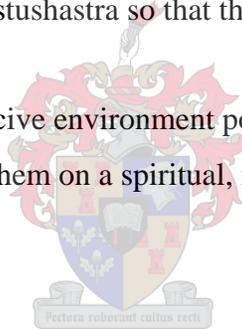
## Chapter One – Introduction

### 1.1. Research Problem

The report presents the draft project proposal for the design and construction of a high school for the Sri Sathya Sai Organisation using ecological design principles and Vastu architecture.

### 1.2. Key Objectives of the Project

- To be a worth instrument of Sri Sathya Sai Baba and his teachings.
- To build a school using ecological design principles to reduce the ecological footprint of the school. Research available technologies and ascertain the practicality of implementing those technologies.
- To build a school using Vastushastra so that the school can heal the community, students and teachers.
- To provide the most conducive environment possible to nurture the future leaders of this country, benefiting them on a spiritual, mental and physical level.



### 1.3. Objectives of the Proposal

- To provide a reference towards the realization of the project.
- To provide a framework towards the realization of the project.
- To appraise/interrogate the approach for the proposed project in view of the objectives.

### 1.4. Method of Generation

The writer used the below mentioned resources to compile the proposal:

- Published sources from course material of the various modules.
- Additional readings suggested by lecturers on various modules.
- Meetings with the structural engineer, builder and Vastu master.

- Project meetings with the board of management of the Sri Sathya Sai Education Centre.
- Internet research
- Discussions with the writer's supervisor
- Research from the writer's personal collection of resources.
- Project team meetings
- Informal discussions with core team members of the project team

## **1.5. Summary of Chapters**

### **Chapter One**

The first chapter looks at the background and rationale for the project. Citing the work of Brown & Flavin the first part of the chapter looks at the state of the world today with specific reference to the ecological and socio-economic problems facing many communities. Looking at leadership in government to affect a shift in consciousness towards the sustainability paradigm and using Europe as an example of leadership in action, the next section looks at the South African government's approach, attitude and programmes for sustainable development. The last section looks at how the proposed school fills the gap left by government, helping society build the physical, mental and spiritual needs of our future leaders.

### **Chapter Two**

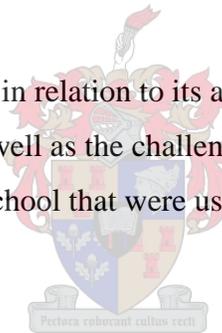
Chapter two discusses the state of the world's resources and ecosystems as well as the social and environmental problems (leading to economic problems) facing many communities. Sustainable development in relation to the built environment is discussed and the need for ecological design is argued. Most of the literature sources are from the course notes provided by the University and a few additional sources from the suggested additional reading list presented on the Ecological Design module that the writer attended in 2005. Case studies and good practices of ecological design cited in Europe are presented. The next section of the chapter investigates the link between ecological design

and spirituality. The ancient science of Vastushastra is then introduced and discussed in detail. Mainstream authors and their most relevant publications have been sourced from India via the International Vedic Society (a humanitarian organisation based in Cape Town with international links especially in India where the Vedic knowledge originates from). The benefits of adopting Vastushastra principles in designing the built environment are put forward.

The latter part of the chapter introduces the Sri Sathya Sai Organisation, presenting its objectives, goals and projects, providing a clearer picture of why the school is being built and the principles behind the entire concept. This information was drawn from the two main websites of the organisation as well as the writer's personal experience as a member of the organisation for the last thirteen years.

### **Chapter Three**

The third chapter discusses the site in relation to its attributes, including the topography of the site, the Vastu of the site as well as the challenges of the site. This chapter also discusses the requirements of the school that were used to inform the architect during the conceptual design phase.



### **Chapter Four**

The fourth chapter discusses the resource issues of the project with specific reference to extraordinary manner in which the project will function in relation to the financial resources, the skills and building material requirements. The information was drawn from the files of the writer who is currently the project manager of the project and a member of the board of management of the Gauteng Education Trust of the Sri Sathya Sai Organisation.

### **Chapter Five**

The fifth chapter discusses the design framework of the project that will inform the master plan. A master plan of the ecological design technologies that will be considered is then presented. A useful table is presented which provides a comparison between

ecological design and conventional design considering the various issues one would take into consideration when planning a project such as the high school in question. Sources of information are again the writer's own knowledge, sources from the Ecological Design module workbook and suggested additional readings from the course lecturer.

## **Chapter Six**

This chapter presents the detailed interventions chosen to be implemented in the design and construction of the school. This chapter also provides the latest draft of the project time line (prepared by the project team) as well as the last updated quantity surveying report (prepared by Tony Smith's firm, the structural engineer on the project).

## **Chapter Seven**

The conclusion sums up the underlying need and reasons for the project.

### **1.6. Background and Rationale for the Project**

The planet has been subjected to major changes over the last few decades. Research into sustainable development has shown ecological and social problems to be interconnected. Solving one problem without addressing the other is simply not feasible. In fact, poverty and environmental decline are both embedded deeply in today's economic systems. Economic successes and social failures are now found side by side. Economic growth has brought prosperity, education, health care and wealth for many, yet the number of people living in poverty has risen from 1.2 billion since 1998. "In some parts of the world, including sub-Saharan Africa, South Asia, and the former Soviet Union, the number living in poverty is substantially higher than the figures recorded a decade ago"(Brown & Flavin, 2001:4).

The battle to sustain the planet ecologically has drawn similar results. Small pockets of projects and success stories have been motivating but at no real value to restore the planet's health. "Double-digit rates of growth in renewable energy markets, plus a two year decline in global carbon emissions, for example, have failed to slow the rate of global climate change. Indeed, recent evidence, from the rapid melting glaciers and the declining health of heat-sensitive coral reefs, suggests that climate change is accelerating.

The same pattern can be seen in the increased commitment to protection of wild areas and biological diversity: new laws are being passed, consumers are demanding ecofriendly wood products and eco-tourist resorts are sprouting almost as quickly as dot.com companies. But foresters and biologists report that this host of encouraging developments has not reversed the massive loss of forests or the greatest extinction crisis the world has seen in 65 million years” (Brown & Flavin, 2001:4).

Inequality in income has increased over the years. “World bank figures show that 2.8 billion people, nearly half the world’s population, survive on an income of less than \$2 per day, while a fifth of humanity, 1.2 billion people, live on less than \$1 per day. An estimated 291 million sub-Saharan Africans, 46 percent of the region’s population, now live on less than \$1 a day, while in South Asia, the figure is 522 million. This is a staggering number of people to enter a new century without income needed to purchase basic necessities such as food, clean water and health care. Worldwide, some 1.1 billion people are currently estimated to be malnourished. In some African countries, such as Kenya, Zambia, and Zimbabwe, as much as 40 percent of the population is malnourished. Roughly 1.2 billion people do not have access to clean water. In China, the portion that fall in this category is 10 percent (125 million people), in India it is 19 percent, and in South Africa, 30 percent. Toilets are even rarer in many countries: 33 percent of Brazil’s population does not have one, nor does 49 percent of Indonesia’s or 84 percent of India’s” (Brown & Flavin, 2001:7).

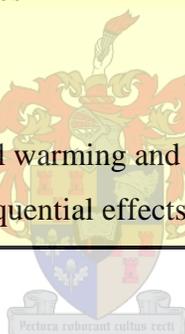
The body of knowledge that the writer has been exposed to suggests that limits to growth along linear, mechanist and unsustainable means is evident by indicators such as the depletion of the ozone layer, mass extinction of fauna and flora species, deforestation, flooding, depletion of non-renewable energy resources, global warming from climate change etc. The table on the next page highlights the environmental concerns of developing and industrialized countries as cited in (Bartelmus, 1994:12).

**Table 1: Environmental Concerns of Developing and Industrial Countries**

<i>Environmental Concerns</i>	<i>Developing Countries</i>	<i>Industrialized countries</i>
<i>Natural Environment</i>		
<b><i>Air</i></b>	Air pollution in major cities	Air pollution
<b><i>Land, Soil, mineral resources</i></b>	Soil erosion and degradation, desertification	Soil loss and deterioration; dumping of waste, risk of radioactive contamination from nuclear-power production
<b><i>Water</i></b>	Freshwater shortage; freshwater pollution, pollution of coastal waters	Freshwater shortage; inland and marine water pollution
<b><i>Fauna and Flora</i></b>	Deforestation (especially of tropical forests); loss of genetic resources; endangered species)	Loss of genetic resources; endangered species
<b><i>Ecosystems</i></b>	Pollution of coastal ecosystems	Disruption of mountain, wetland. Freshwater (especially forest damage from acid rains and eutrophication) and coastal ecosystems
<b><i>Natural disasters</i></b>	Floods, droughts, storms, earthquakes, volcanic eruptions	Floods, earthquakes
<i>Man-made environment and living conditions</i>		
<b><i>Bioproductive systems</i></b>	Loss and degradation of arable land; pests and pest	Loss of croplands to urban sprawl; pests and pest

<i>Environmental Concerns</i>	<i>Developing Countries</i>	<i>Industrialized countries</i>
	resistance, water shortage, pressures on fish population (over fishing); impacts of fuelwood consumption; food contamination, post harvest losses	resistance; contamination of crops and fish; over-exploitation of fishing grounds
<b><i>Human settlements</i></b>	Marginal settlements (rural-urban migration, urban growth)	Urban sprawl; noise; land contamination, traffic congestion
<b><i>Health</i></b>	Mal- and under-nutrition; infectious and parasitic diseases	Cancer, cardiovascular diseases; genetic and long term effects of toxic chemicals and hazardous waste
<b><i>Global problems</i></b>	Global warming and consequential effects	Climate change; depletion of the ozone layer

Source: Bartelmus (1994:12)



### 1.7. Population Explosion

Increased demands have been placed on the planet’s natural resource base over the last few decades with insurmountable increase in the human population. “The combination of population growth and deforestation, for example, has cut the number of hectares of forest per person in half since 1960 – increasing pressures on remaining forests and encouraging a rapid expansion in plantation forestry” (Brown & Flavin, 2001:11). The increased numbers of humans on the planet has increased the demands for energy, food, water and materials. The table on the next page shows how people in developing countries face the most serious challenges due to environmental stresses. The statistics for South Africa do not look healthy at all.

**Table 2: Ecological Health of E-9 Nations**

<i>Country</i>	<i>Share of land area that is forested, 1995</i>	<i>Change of Average Annual Deforestation, 1990-1995</i>	<i>Share of Mammals Threatened, 1996</i>	<i>Share of Flowering Plants threatened, 1997</i>	<i>Share of Land area Nationally Protected, 1996</i>
<b>Russia</b>	22	0	11.5	-	3.1
<b>Brazil</b>	16	0.5	18.0	2.4	4.2
<b>U.S.A</b>	6	-0.3	8.2	4.0	13.4
<b>China</b>	4	0.1	19.0	1.0	6.4
<b>Germany</b>	3	0	10.5	0.5	27.0
<b>Indonesia</b>	3	1	29.4	0.9	10.6
<b>India</b>	2	0	23.7	7.7	4.8
<b>Japan</b>	0.7	0.1	22.0	12.7	6.8
<b>R.S.A</b>	0.2	0.2	13.4	9.5	5.4

**Source: World Bank, World Development Indicators 2000 (Washington DC; 2000) cited in (Brown & Flavin, 2001:11)**

Another dimension that has magnified the ecological problem is the rising consumption patterns and resultant increased levels of production. This has placed significant strain on the environment for the supply of raw materials and natural resources as well as the amount of waste generated and dumped into ecosystems. “Meat-based diets and automobile centred transportation systems are among the highly consumptive practices first adopted by the billion or so people living in rich countries, and now proliferating quickly in many parts of the developing world” (Brown & Flavin, 2001:12).

There are many definitions on sustainable development, but the best known is the World Commission on Environment and Development's. This definition suggests that development is sustainable where it "meets the needs of the present without

compromising the ability of future generations to meet their own needs” (Bruntland, 1987).

In writer’s opinion sustainable development is about maintaining a delicate balance between socio-economic growth and prosperity on one hand, and preserving natural resources and ecosystems (which we depend on for survival) on the other. Humanity must not take more from nature than nature can replenish. Each side of the scale must be balanced, with both sides continually reinforcing each other. A stable relationship between human activities and the natural world does not diminish the prospects for future generations to enjoy a quality of life. In lieu of the aforesaid human beings must adopt lifestyles and development paths that respect and work within nature's limits.

The sustainability paradigm is the only manner in which effective and continual poverty eradication can occur. Pockets of successful projects globally have shown that communities can self-sustain by mimicking nature, recycling and reusing waste, employing renewable energy technologies, employing organic and/or natural farming methods, using alternate sources of fuel, consuming more natural and less meat-orientated diets etc (see appendix three). Reduction or elimination of over-consumptive habits will see more resources and money available for poverty eradication. The sustainability paradigm needs champions to drive, foster and promote ecological design. Government in all instances should take the lead to change the paradigm. The design and construction of the school in question can show government that building along ecological design is possible, a priority and economically viable.

Governments in European countries have embarked on numerous projects and programmes and provided incentives to promote sustainability. These governments have set up financial subsidies, agreements with players in the building industry to set sustainable targets and to incorporate sustainable building practices in all new buildings, and even sponsored pilot projects on a national basis. Beatley (2000) discusses how these governments offer a system of green funds as a source of private funding for a variety of ecological projects and investments. “The funds are operated by private banks, but the

projects are certified and approved by national government. The main financial incentive behind the program is that interest income from those investing in green funds is tax free. While an investment return of around 6 percent is normal, the 2 to 3 percent return from green funds is made quite attractive because of its tax free status” (Beatley, 2000:309). An important lesson from the European experience is the potentially powerful role government can play as a facilitator and catalyst for sustainable building. Many of the European initiatives could easily be adapted in the South African environment.

### **1.8. Sustainability and the South African Government**

Development within municipalities is not looked at holistically. Each section within the municipality has their own agendas to promote and at most times it is related to the political votes, greed and power. There is no real understanding on what social, economic and environmental sustainability entails. “It will be contended that Local Government is not appropriately configured to meet the sustainable development challenge. Instead, it is caught between two mutually exclusive paradigms: the municipal developmentalism that inspires the Municipal Systems Act and Integrated Development Plans (IDPs) in particular; and the environmental conservatism that inspires the National Environmental Management Act and Environmental Impact Assessments (EIAs) in particular. Neither of them define what sustainable urban development means. For example, if a conventional sewerage treatment plant is required to service housing extensions within a given locality, the EIA is interested in impact on local eco-systems, biodiversity, and communities (smell, health, etc). No problem with either in their own right. However, no-one involved in the IDP, the EIA or the Housing Project is required to ask how to re-use the effluent in order to reduce water consumption while meeting the needs of the under-serviced, or how to capture the nutrients for food production” (Swilling, 2006a).

Government in the attempt to rectify the apartheid past has commissioned engineers, architects and town planners to work on two main focal points, i.e. eliminating the housing backlog and fast tracking infrastructural development in poor communities. In

their zeal of rolling out houses, road, sewerage and sanitation infrastructure, government has used conventional frameworks of development as adopted by the first world countries, even though these have proved to be detrimental to social, economic and environmental sustainability in the long term. “The end result, unfortunately, has been the perpetuation of the apartheid spatial form: we now have class-divided towns and cities characterized by racially integrating middle class areas coupled to sprawling low-income ghettos and informal settlements on the peripheries that are eating into valuable agricultural farmlands that used to supply urban food markets – and all presided over by non-racial local governments” (Swilling, 2006a). Swilling (2006a) cites the combined impact of developmental policy frameworks and conventional technology solutions:

- The extension of cheap electricity generated from coal-fired power stations to the large majority of urban households to meet all their energy needs without prioritizing energy efficiency (via building regulations, insulation, correct North-South orientation, eliminating incandescent lighting, etc) and renewable energy options (such as solar water heaters, wind generation, biomass) – the average middle class household consumes 750 to 800 KWh of energy per month, with low-income households averaging 250 – 300 KWh/month and rising as they hit the linear road to urban modernity (see Winkler 2006). Significantly, Local Governments are highly dependent on surpluses generated from electricity sales to subsidize overheads and other services. This means Local Governments are dis-incentivised to promote energy efficiency and households have no real incentive to find alternatives to cheap grid electricity (by, for example, purchasing CFLs rather than incandescent light bulbs).
- Road-based transportation solutions that are biased in favour of the private car and minibus taxi-based systems rather than integrated bus-rail-taxi systems that are less dependent on imported oil, more user-friendly for poor people, and less likely to lead to congested highways and rapidly rising transport costs for poor and middle class households.
- Water and sanitation systems that do not promote water efficiency, rainwater harvesting, re-use of grey water, capture of the methane via biogas treatment systems, nutrient capture for food production and localized sanitation systems. Instead, the

focus has been on expensive, inefficient large-scale end-of-pipe solutions that result in effluents that go into landfills, rivers and the sea with minimal re-use for productive purposes. Have IDPs and EIAs made water saving and efficiency a focus? No. Have IDPs and EIAs suggested zero waste approaches to sanitation? Not likely.

- Solid waste includes all municipal waste and industrial waste (e.g. mining, power generation, etc). As of 2005, the solid waste system managed the disposal of 20 Mt (Mt=1 million metric tonnes or 1 billion kgs) of municipal solid waste (MSW), 450 Mt of mining related wastes and 30 Mt of power station ashes. Solid waste outputs from our cities have grown faster than the average economic growth rate over the past decade. For many middle and upper income areas, waste output per person per day is breaking through the 2kg barrier which is 3 to 4 times higher than the average EU citizen. And in many cities, these elite suburbs can generate half the total domestic waste stream. Costs of disposal over the past five years have doubled in many areas. At most 20% of all our solid waste is recycled, although it is much higher when it comes to industrial waste. Have IDPS and EIAs suggested zero waste alternatives? No.
- South African architects have a very long way to go when it comes to designing sustainable buildings. Instead of depending entirely on air-conditioning and electronic lighting, they could use appropriate design to secure more natural light, maximize passive heating and cooling, improve insulation, introduce more appropriate less toxic materials, and make more effective use of natural landscaping and plants. The cost of cement is directly tied to the rising price of fossil fuels because cement is derived from lime that needs to be baked in kilns that reach temperatures of 2000 degrees. And yet, alternatives to cement are discouraged by the strictures of the NHBRC and the banks who only bond buildings approved by the NHBRC. The construction and operation of buildings accounts for 50 percent of all CO<sub>2</sub> released into the atmosphere. Despite all this, local governments have done little to introduce by-laws governing the sustainability of the houses and buildings whose building plans they approve every day. Even when they try, the well organised professional associations often object, not least because the consulting firms have no financial interest in being

forced to innovate or put their professional indemnity insurance policies at risk. For the professions, the lowest risk solution is the tried and tested one.

What they fail to tell their clients, is that the tried and tested solutions are rapidly becoming high risk from a sustainability point of view.

- Food supplies: Local Government play a major role in ensuring food supplies into the urban system. South African Local Government have done relatively little to promote urban agriculture despite positive evidence about the potential of urban agricultural as a local job generator. Furthermore, sourcing from local small farmers and incentivising organic production has not been a major priority. And now that we have a wall-to-wall Local Government system that incorporates rural areas, which IDP has suggested the preservation of high value agricultural land for farming and the introduction of organic farming methods to rejuvenate the soils to ensure long-term food security?
- Spatial planning: breaking away from our addiction to low density urban sprawl along road transportation routes has – despite many policy statements to the contrary (compact cities, densification, hard boundaries, etc) – been almost impossible. The result has been an increase in the average distance between home and work. Even in American cities, the more European predilection for higher densities and inner city renewal – the so-called New Urbanism – has taken hold. Low density spatial sprawl makes mass affordable public transportation economically unviable, it is mall-centred which destroys the social lifeblood of local communities as neighbourhood commercial centres and ‘high streets’ collapse, it assumes cheap energy to make it work, and that the funds are available to endlessly extend under-used water, sanitation, road, and stormwater infrastructure systems. Local Government infrastructure investments have basically followed the developers over the past ten years via a set of ad hoc decisions justified by unsubstantiated arguments about extending the tax base to generate resources to finance service delivery for the poor.

IDPs have aimed at addressing the basic needs of communities through investment in physical infrastructure and services. These projects were proposed, planned and executed

by right-brained, mechanistic-thinking technocrats. Ecological considerations and the sustainability paradigm was not a key element informing the drafting of the IDP concept.

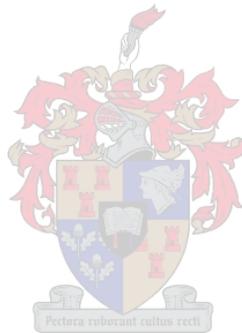
“The consultants and officials involved in the formulation of IDPs came from a generation of development thinking that subscribed to the “development-plus-impact equals sustainable development” paradigm. The environment is often defined narrowly, focusing on biophysical issues, rather than social, economic and natural environmental concerns. This results in a fragmented approach where the relationships between the different components of the environment are considered separately. Consequently, nowhere in the document, nor in the above modification of the steps in the IDP process are there clear references to an integrated approach to sustainability and sustainable resource use challenges (such as renewable energy, zero waste, soil rejuvenation for farming, etc)” (Swilling, 2006a).

The previous paragraphs paint a disillusioned picture of many social, economic and environmental ills plaguing the country at present. Government has attempted to rectify the situation with policies and frameworks and the aid of international organisations with their experts and academic studies.

On the positive side government is looking at becoming more holistic and integrated in their approach to sustainable development. The Strategic Framework for Sustainable Development in South Africa document being drafted into legislation will drive, foster, promote and guide sustainable development in our country. “The purpose of this Framework is to make known South Africa’s (including government, business and civil society) national vision for sustainable development and indicate its intended interventions to re-orientate South Africa’s development path toward sustainability.

The framework does not present detailed strategies or actions, but rather proposes a framework that includes a national vision, principles, trends, strategic priority areas and a set of implementation measures that will enable and guide the development of the national strategy and action plan. It describes in broad terms how the existing activities of Government and its social partners will be strengthened, refined and realigned in a

phased manner to achieve inter-related sustainable development goals relating to the economy, society and the environment, and how governance systems will be capacitated to facilitate this process. Key in this last respect is ensuring that our system of governance will have as its primary purpose the achievement and maintenance of human welfare within the context of well functioning ecosystems. This Framework provides the basis for a long-term process of integrating sustainability as a key component of the development discourse and shows South Africa's commitment to the principles developed at international summits, including the 2002 World Summit on Sustainable Development" (Department of Environmental Affairs and Tourism, 2006:9). It remains to be seen if this will just be another talk shop exercise or whether the leaders in various sections of the government, business and community embrace it as a tool for change.



## Chapter Two – Literature Review and Theoretical Framework

### 2.1. The Need for Ecological Design

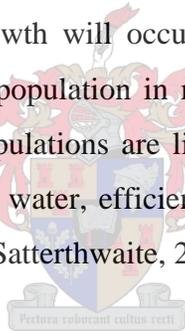
Mankind has created an unjust and unsustainable world that is against nature's principles. The history of mankind is fraught with wars, famine and disease due to greed, jealousy and hunger for power. In all ancient civilizations nature was respected and loved for her selflessness in providing human beings with all the resources to fulfill all of their needs and wants. As time moved on however, human beings lost their love and respect for nature. As Hawken, Lovins and Lovins (1999:97) noted, "The past two hundred years of massive growth in prosperity and manufactured capital have been accompanied by a prodigious body of economic theory analyzing it, all based on the fallacy that natural and human capital has little value as compared to final output." She slowly became just a resource for our driving need for economic prosperity.

As noted by Wackernagel & Rees (1996:206), "All resources come from the earth and go back in degraded form." Goodland & Daly (1996:56) also states, "The global ecosystem is the source of all material inputs feeding the economic subsystem, and is the sink for all its wastes. Population times per capita consumption of natural capital is the total flow-throughput-of resources from the global ecosystem to the economic subsystem, then back to the global ecosystem as waste." We have become an oil-based global community dependent on this scarce resource for fuel, agriculture, health, building etc.

A report backed by 1,360 scientists from 95 countries called the Millennium Eco-Assessment Report warns that the almost two-thirds of the natural machinery that supports life on earth is being degraded. Wetlands, forests, savannahs, estuaries, coastal fisheries and other habitats that recycle air, water and nutrients for all living creatures are being irreversibly damaged. Due to the human demand for food, fresh water, timber, fibre and fuel, more land has been claimed for agriculture in the last 60 years than in the 18th and 19th centuries combined. An estimated 24% of the Earth's land surface is now cultivated. Water withdrawals from lakes and rivers have doubled in the last 40 years. Humans now use between 40% and 50% of all available freshwater running off the land.

Since 1980, about 35% of mangroves have been lost, 20% of the world's coral reefs have been destroyed and another 20% badly degraded. Deforestation and other changes could increase the risks of malaria and cholera, and open the way for new and so far unknown disease to emerge. According to Hawken, Lovins & Hunter (1999:85) three billion tons of raw materials are used annually to construct buildings worldwide. “It follows that the ecologically important flows in the economy are not the circular flows of money but rather the unidirectional and thermodynamically irreversible flows of useful matter and energy from the ecosphere through the economic subsystem and back to the ecosphere in degraded form (Rees, 1999:31).

Another problem facing the planet is global population growth estimated to rise way above 8 billion within the next 20 years. Swilling (2005) suggests that the population growth will occur in urban settings or cities as we know them. He goes on further to suggest that most of the urban growth will occur in developing countries like India, Brazil, China and Nigeria. “Urban population in middle and low income countries are exploding. Most of the growing populations are living in poverty marked by a lack of basic services such as safe drinking water, efficient sanitation, education, safe housing, medical care and waste collection” (Satterthwaite, 2003:73).



“Although urban areas occupy only 2% of the world’s land surface, they use 75% of the world’s resources and release a similar percentage of global wastes” (Girardet, 1996b in Birkeland, 2002: 13). The current manner in which homes and buildings are constructed is wasteful. The processes use up tons of non-renewable resources, use excessive amounts of energy and create harmful toxins that is inherent in the actual materials and their waste by-products. “The construction industry is organised in a manner that is wasteful of energy, resources, land and, increasingly human skills and talent” (Birkeland, 2002:13). “Buildings account for one quarter of the world’s wood harvest, buildings consume one sixth of fresh water supply” (Brown et al, 1996, in Birkeland, 2002:13), “buildings account for a large percentage of carbon dioxide emissions” (Pout, 1994 in

Birkeland, 2002:13), “buildings account for one third to one half of total greenhouse gases emitted by industrialized countries each year, buildings account for over 40% of the world’s energy and raw materials consumption” (Roodman and Lenssen, 1995 in Birkeland, 2002:13), “building waste accounts for 44% of landfill and 50% of packaging waste in industrial nations” (Birkeland, 2002:13).

## **2.2. Challenges facing the urban environment**

The current challenges facing the urban environment as mentioned earlier can be attributed to unsustainable over-consumption, population explosions; pollution, destructive wastes, and a myriad of socio-economic ills from endemic crime to unemployment are often blamed in one way or another on the nature of the city. The following issues must be addressed in order to marry equity, urban economic growth and sustainability:

### **2.2.1. Water**

Water flows from its source usually high up in mountain ranges to the sea. Human beings have interrupted these natural flows leading to many problems including the drying up of rivers, pollution, extinction of fauna and flora, droughts, floods and depletion of water sources. Furthermore engineering and technology has brought along highly unsustainable water management techniques that are energy intensive, wasteful and as mentioned before destructive to the ecology. The demand for water can be greatly reduced in households through the following interventions:

- Watering plants during evening hours is a much more sensible alternative to watering during daylight hours when the sun evaporates much of the water. Water irrigation timers are available on the market which assists in more efficient watering of plants. Reducing the size of lawns is also an effective method of conserving water.
- Rainwater collection from rooftops can be used for watering gardens and can possibly be used for potable supply to communities provided the correct filtration methods are in place.

- Wastewater reuse. Water from showers, laundry, baths, kitchen (grey water) and even toilets (black water) can be effectively reused using filtration methods that are inexpensive and mimic nature such as vertically integrated wetlands (see chapter six on sanitation).
- Water-efficient gardens. Planting indigenous species that are adapted to the weather patterns of the area will greatly reduce the amount of water needed for maintaining the garden. Furthermore endemic species of fauna and flora will nurture local insect and plant species.
- Water efficient appliances and water efficient lifestyle habits can greatly reduce the amount of water used by a household for example dual flush toilets, smaller cisterns, low flow shower heads, more efficient washing machines, solar pool covers that deter evaporation in summer, shorter period of showers, not leaving the tap running whilst shaving or brushing of one's teeth etc.

### **2.2.2. Energy**

The manner in which fossil fuels are extracted, processed, transported and transformed (power stations transforming gas, and coal to electricity), has weakened the planet's immunity system to what some refer to as irreparable. The recently widely acclaimed documentary "An Inconvenient Truth" featuring Al Gore shows how the aforementioned processes have aided in bringing about climate change and global warming. In addition another important consideration is that the primary resource for energy generation is not infinite and resources will eventually run out. The aforementioned points are driving indicators for society to move to new forms of energy generation. Right now there are many technologies already available that promote a more sustainable society. Listed on the next page are some steps one can embark on to use less "dirty" energy:

- Fit buildings with energy efficient devices which include CFL's (compact florescent bulbs which last 5 to 8 times longer than the normal light bulbs and use a fifth of the energy). Some suppliers have already started integrating energy efficiency into air conditioner design and furnace design on account of the large

demand in the Northern countries. Furthermore orienting the building according to the sun and using building materials that are conducive to passive heating and cooling as well as the correct use of landscaping will drastically reduce the need for artificial means to maintain the correct comfort levels in the building. Many manufacturers are either consciously trying to incorporate ecological design into their products or are forced to by sheer demand. Manufacturers of white goods, computers and other appliances have all embarked on energy efficient models that are widely available to the public. In some cases retrofitting a structure for energy efficiency can be costly in the beginning but the investment pays for itself after a few years, putting money back into the consumer's pocket on account of the savings in energy costs.

- Renewable energy. Further to the above point renewable energy technologies can be used to complement the energy supply and reducing the need for fossil based energy supply.
  - Solar energy is a very lucrative option as it is very clean and the sun's energy is widely available. "Solar energy power plants being developed and tested by the U.S. Department of Energy can now produce electricity at a price within 10% of standard fuel burning plants. A three square mile, 200 megawatt solar plant can produce enough electricity for 12,000 homes, the size of a small town. As mentioned previously, the major impediments preventing this technology from being applied widely are energy storage and the great land requirements. Another problem with solar is the energy intensive process needed to produce solar plants and photovoltaics. This however, will inevitably be reduced as the need for alternative energies increase and with technological advances" (Hsin, 1996).
  - Wind Power is another source of renewable energy. However this form of energy generation is controversial due to the large amounts of land required for wind farms and its inability to store energy in periods of less or no wind.

- Water power is another very controversial form of energy generation. Most projects involve damming which involves heavy construction with devastating effects to communities and the environment. It is suggested that hydro power should be limited to natural water courses and applied on a small scale basis. “Dams approximately nine feet in height, in many cases, do not create great environmental consequences and may be able to produce enough electricity for several homes in rural areas” (Hsin, 1996).
- Biogas Power. Biogas fuel is produced from solid waste. The energy produced is totally renewable and the main input is a waste product. Kitchen scraps, food and even human toilet waste can be successfully used. The important aspect here is to design the digester which transforms the waste into gas efficiently.

### 2.2.3. Waste

“The term "waste" is a uniquely human invention. In nature, where everything plays a part in the ecological cycle, waste is a foreign concept. The human perception of waste as useless material to be discarded or forgotten about is contrary to the most basic laws of nature. Specifically, the laws of thermodynamics (Lovelock, 1991:30) which tells us that energy and matter are constant, they may degrade and change form but they do not disappear. Our misconception of these basic laws has led us to discard all solid waste when much of it could be salvaged and reused in some manner. To make matters worse, methods of solid waste disposal have often had extremely harmful effects on the environment” (Hsin, 1996).

Most solid waste will eventually end up in municipal dumps or be incinerated. The environment around the dump is completely destroyed and in the case of incineration heavy metals and toxins are released into the atmosphere causing devastating pollution and contributing to the greenhouse effect. Waste water treatment plants for sewerage are also wasteful and energy intensive processes. Treated water that is re-introduced into waterways erode the quality of the water with devastating effects on the aquatic and non-

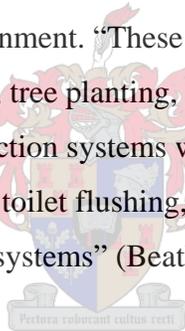
aquatic ecosystems dependent on the water. Sustainable waste management entails the following:

- Composting using ecological processes to decompose organic wastes back into nutrients to benefit other systems within the environment. Compost is used widely in soil restoration for gardening, landscaping and agricultural purposes. This simple yet very effective technology can be adopted by individual households in a very inexpensive manner. This can reduce the waste leaving the individual households by a minimum of 30-40%.
- Recycling. Another manner in which individual households can reduce the waste leaving for the waste dump is recycling of plastic, paper, glass and aluminum and other metal items. Recycling not only reduces the solid waste load, but also saves energy. It takes three times more energy to produce new aluminum than it does to recycle used aluminum. Together with composting households can drastically reduce their waste by up to 80% in some instances.
- Biological sewerage systems have been discussed under water and in chapter six under sanitation. These processes provide a natural alternative to the wasteful conventional sewerage treatment plants. The processes mimic nature in that plants and other micro-organisms break down the waste and cleanse the water several times over as the water travels through the wetlands becoming cleaner the further it travels. These systems do not use any energy and also returns nutrients back into the eco-system whilst cleansing the water.

Using nature as the main informant of design, ecological design involves the construction of a living and breathing building that works in harmony with the natural environment in all stages of its life from construction through to destruction and reincarnation. This design paradigm considers the built environment in a holistic viewpoint taking into consideration the environment, local culture, available resources and the availability of materials.

### 2.3. Case studies of successful ecological design projects

Some European countries are currently leading the way on ecological design. In Germany and Holland ecological design is fast becoming the preferred way to construct. The success of these countries can be partially attributed to some of the governments' initiatives and programmes to promote ecological design in the countries concerned. "The national Dutch government provides financial subsidies, has sponsored national pilot demonstration projects, and has orchestrated agreements with the building industry that set sustainable building targets. The government has recently established a national centre for sustainable building and the incorporation of sustainable building practices is now typical for all the new national building sites. Development occurs here through agreements between the central government and regional authorities, which now commonly include provisions dealing with sustainable building" (Beatley, 2000:307). An important trend in these European countries is to incorporate ecological design when renovating or restoring a built environment. "These projects typically involve greening initiatives (green walls, roof gardens, tree planting, and the replacement of pavement with greener alternatives), rainwater collection systems with rainwater treated through a vertical biological filter and used for toilet flushing, and the use of environmental building materials, and solar energy systems" (Beatley, 2000:304).



Europe has many exciting case studies where large scale structures have been built using ecological design principles. Some examples include the Demont Fort University Queens building in Leicester, the SAS building in Stockholm and the ING headquarters in Amsterdam as well as many other housing projects. The ING building has received some considerable attention globally. "It is a large building, some 50, 000 square meters, housing 2,400 employees, designed in a distinctive S-shape, accentuated by a series of ten slanting towers. The building has a strong organic look with natural colours and shapes, a building that seems to grow from the ground up. The entire building is designed along a main corridor or mainstreet, along which major functions and activities, including canteens, theatres and meeting rooms are located. An emphasis in the building is given to energy conservation, which is accomplished in several significant ways. The building is angled toward the sun and emphasizes daylighting throughout. No workspace is more

than 23 feet away from a window, and windows are fully operable. The interior spaces are mostly painted in light colours, and the atrium towers contain extensive 'sun paintings' and metal sculptures that help to further bounce sunlight into the interior of the building. There is considerable vegetation along the mainstreet, including hanging plants that drape luxuriously from the upper floors of the atria. Water flow forms are used extensively, with some handrails transformed into gurgling brooks. Water from these flow forms comes from a rainwater collection system. Other energy features include double-glazed windows, a highly-efficient electric generator, an energy retrieval wheel and other heat recovery systems. Again, there is a heavy emphasis on daylighting and a heavy reliance on task lighting" (Beatley, 2000:302-303). The bank has also been built in a high pedestrian zone and near a shopping area, a few blocks from a major metro centre and train stop. Furthermore management has reported a marked decrease in absenteeism and a large increase the productivity of the employees.

"The urban regenerative project at Fredensgade in Kolding is one of the most spectacular ecological urban renewal projects for several reasons. Comprising about 140 flats, the blocks of four and five storey buildings were creatively renewed and renovated, incorporating a number of ecological features. Two older buildings were demolished, with two new buildings constructed (with one made entirely from recycled building materials). Most of the interior courtyard is off limits to cars. By far the most impressive aspect of the Fredensgate project is the glass pyramid greenhouse and wastewater treatment facility, which is known as the 'bioworks' situated in the centre of the interior courtyard. Rainwater is also collected in a below-ground cistern, purified in a pond, and then pumped to the flats for toilet flushing machines. Some of the units have added solar water heaters, and many have installed passive solar winter gardens and glass rooms. Additional insulation, energy efficient glass, water-saving fixtures and toilets, and extensive recycling and composting facilities were also added. Extensive use was made of recycled brick and other materials. There is at least one section of the rooftop that has been converted into a glass solar terrace. A series of photovoltaic panels in the interior provides most of the power to run the pumps and motors in the bioworks" (Beatley, 2000:305).

## 2.4. The South African context

The construction, architectural, engineering, building supply and other building related industries in South Africa are flourishing. The aforesaid can be attributed to the current state of the South African economy. Interest rates are down, the rand is fairly strong against the major currencies, inflation rates are down compared to previous years and the economy is growing albeit at a small percentage. More citizens are investing in home ownership. Commercial developments are also increasing. The rise of the black middle-income group is also creating demand for property. All of the aforesaid bodes well for economic development. Yet we fail to consider the strain being placed on the natural resources that are used in the construction and maintenance of these residential and commercial buildings, notwithstanding the pressure on the already over burdened sewage systems, electric grid and water supply.

Developers, government, individuals and all other stakeholders could curb the ecological footprint of the built environment by adopting ecological design principles. However ecological design or green architecture principles are not being implemented on a large scale in South Africa as yet. According to Irurah (2005) universities that offer architectural studies do not have systematic and comprehensive design coverage in their current curriculum. The national government has not included the ecological design paradigm in their current housing policies as per Swilling (2005) and Goven and Rendall (2005). The housing department is concentrating their efforts on the social aspect of development, choosing to ignore the benefits of ecological design to the environment and the poor simultaneously. It is the opinion of the researcher that the long term consequences of unsustainable design currently adopted by the housing department will eventually lead to social problems as result of the layout designs i.e. match box houses in a square layout without any consideration for communal activities and shared services, lack of green areas, sewerage breakdown due to under capacity, respiratory disease due to excessive coal burning in winter etc. Efficiencies in water and electricity attributed to ecological design principles can become a major benefit for both government and the

poor in a country where disposable incomes are low and state subsidies on basic services are high.

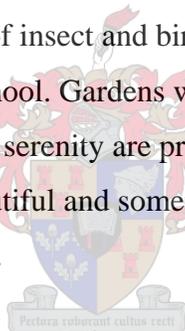
There are a few case studies where eco-design has been implemented in the design and construction of the building as a priority (see appendix three). These include the Lynedoch development in Stellenbosch, the BP headquarters in Cape Town and the Sustainable Energy Association's building in Cape Town to mention a few. These buildings have been constructed using eco-design principles by the relevant owners as an attempt to lessen their respective ecological footprints and to try to set precedents from which other projects can learn. The process is at most times frustrating due to lack of support, availability of alternate building technologies and products. The end result however is often very rewarding. Furthermore projects in different parts of the country are being established by visionary people. These projects are raising awareness and are creating platforms for dialogue between various stakeholders.

We already have a governing body regulating the construction of buildings to some degree. The National Home Builders Registration Council (NHBRC) could start the process by initiating the dialogue for sustainable building. Financial institutions could also promote sustainable building by offering discount on bonds (which would be covered by government) for green projects. "A unique system of green funds is also maintained in the Netherlands and is a major source of private funding for a variety of ecological projects and investments. The funds are operated by private banks, but the projects are certified and approved by national government. The main financial incentive behind the program is that interest income for those investing in green funds are tax free" (Beatley, 2000:309). The lesson learnt from the European experiences cited in Beatley (2000:309) is the power of government to take leadership and successfully drive sustainable building which is not the case in South Africa.

## **2.5. Principles Adopted**

Using the principles of ecological design and prioritizing around a spiritual base the project team has agreed to adopt the following principles:

- Recognize, build and design around the limits of the available natural resources. In the same light the project team must embrace technologies that would be least disruptive to mother earth.
- A healthy indoor environment for both teachers and students by using natural paints and building materials and by banning the use of any toxic materials.
- Adoption of passive thermal design methodologies in an attempt to maintain optimum levels of comfort within the classrooms without the use of artificial heating or cooling systems.
- Reduce the ecological footprint of the school through efficiencies in electricity and water consumption.
- Ensure that the buildings will be organic by integrating art, natural materials, sunlight, green plants, water, energy efficiency and low noise levels into the building design.
- Promote the re-introduction of insect and bird species by planting indigenous gardens in and around the school. Gardens will create environments where meditation, introspection and serenity are prevalent.
- Ensure that the school is beautiful and something that the Sri Sathya Sai Organisation can be proud of.



## **2.6. The link between Sustainability and Spirituality**

Humanity is currently facing a crisis that has been escalating over the past few centuries. Moral degradation and humankind's consequential behaviour has created challenges that continue to create imbalances on the planet. Global warming, poverty, wars, deforestation are indicators that something is drastically wrong in the way we choose to operate on a global level. "Living systems theory advocates that nature is a complex of self organizing systems" (Macy and Young-Brown, 2001:107). In nature waste from one system is food for another exchanging matter and energy. Biomimicry principles advocate the need for all human activities to mimick nature. "Unsustainable living habits, unequal distribution of income, goods and services, unsustainable production methods and consumption patterns must all be changed for the greater good of both humanity and mother earth" (Govindasamy, 2005b:9).

There is an urgent need for a shared vision or a set of common human values in order to lay the foundation for a brighter future. World peace, eradication of poverty, equal access to basic human rights and basic needs can be achieved if human beings start to value and respect all forms of life irrespective of their status. In small steps towards sustainability we must find better ways in meeting or needs. We need to change the mindset that found ways to derive fuel from oil, electricity from coal and nuclear power and plastics from polypropylene. “Each system from atom to galaxy is a whole. That means that it is not reducible to its components. Its distinctive nature and capacities derive from the interactive relationships between its parts. This play is synergistic, generating emergent properties and new possibilities which are not predictable from the character of the separate parts,” (Macy and Young-Brown, 2001:107).

There is an opportunity to embrace ecologically responsible behaviour in all dimensions of socio-economic life. The need to instill values and traditions that rebuild morals and human values whilst supporting Earth’s human and ecological communities is apparent. Human beings must imbibe and nurture spiritual wisdom and traditional or indigenous knowledge systems so that all people from all cultures embrace stewardship in order to protect both the environment and humanity at large (see appendix three). “Design should follow and not oppose the laws of nature” (Edwards, 2000:6).

“Living systems sees problems with both the environment and society and how they interrelate with each other. Transformation within these interrelations is needed if the crisis is to be avoided. Deep ecologists on the other hand are concerned primarily with the environment. Not really concerned about human needs and equality. Living systems looks at both social and environmental justice as they feel that humans live within the environment and cannot live without it” (Govindasamy, 2005b:11).

Integrating nature and her cycles into spiritual practices are inherent in many cultures and act as a reminder that we as individuals were part of a greater system, part of a community and one with nature. From a Hindu perspective there are many rituals that thank mother earth for rain, for providing food and harvest. Many ancient texts show how our ancestors tried their best to live in harmony with nature, maintaining her intricate

balances. Humans slowly lost our respect and love for nature as we started large scale agricultural practices, the industrial revolution and mass consumption. Our entire way of life is about survival of the fittest, highly competitive, self-interest before the common good of all and the continued abuse of the natural environment. “What is destroying our world is the persistent notion that we are independent of it, aloof from other species and immune to what we do to them,” Johanna Macy cited in (Young-Brown, 2002). We have forgotten our cultural heritages and love for mother earth.

We consider ourselves superior to nature, ecosystems and any systems. We are in total disharmony with all other species on the planet. We only see the monetary value of nature as a provider of natural resources in our production processes for our ever expanding markets. “Through our selfish actions we have created distortions in the larger systems negatively affecting the sphere of life. As human beings we have been given the power to make choices to discriminate between right and wrong. We have the power to filter and select between options unlike other species that operate on instinct. We have over time abused this strength that sets us apart from all other species in the world. Our choices are based on self-interest, greed, power, lust and jealousy” (Govindasamy, 2005b:11). “Because we do not understand that we are each a subsystem within the larger systems of humanity and nature, we have constantly made choices as if our self-interest was separate from the welfare of the whole,” (Young-Brown, 2002). Self-interest and greed has become an acceptable norm in society.

Over the last two hundred years the global population particularly the northern countries have moved forward on the premise of economic prosperity and greed alone. We are now left with a world where the majority of the worlds population are poor and a very few have large amounts of wealth at their disposal. New philosophical thought in Europe during the 1700’s brought about ideas like utilitarianism (Edney, 2002). “In the new philosophy there is no conspicuous concern with sympathy, compassion, honesty, courage....It accepts that humans are fundamentally selfish and egoistic and they don’t care about society as a whole,” (Edney, 2002). This philosophical thought was further enhanced by Adam Smith in that he proclaimed that selfishness and society go together.

He proclaimed that through his selfish behavior man will look for efficiency in order to improve his ways and means of making money. He will therefore invent better ways of doing things for personal gain. If everybody does this the entire community will improve as a result of all these individual actions. “And all this could be achieved without the values of justice, because justice, like the preceding list of noble values, is not a natural quality. It requires rules, and utilitarianism is fundamentally to be rule-free....Old morality withered, except where it became an instrument of economic progress,” (Edney, 2002). This is how vices such as greed, lust, jealousy and envy became main stream thought, encouraged and embraced all in the name of self-improvement on the economic scale.

## **2.7. The Sri Sathya Sai Organisation**

“This is the bases of the Human Values programme that was given to the world by a great teacher Sri Sathya Sai Baba (see appendix six). The programme advocates the re-introduction of the five basic values into every action that we undertake. Love, Non-Violence, Truth, Peace, Right Action are the five basic human values with 83 sub-values attached. The premise of the concept is that by cleansing the mind man frees himself of anger, greed, lust and jealousy and starts to act unselfishly, taking up selfless service to those less fortunate, the sick, the elderly, the environment, the orphans, the nearly extinct Siberian Tiger etc. The Sri Sathya Sai Organisation under the guidance of Sri Sathya Sai Baba has many centres of spiritual practices around the world. Each centre is a place where members can deepen their spiritual discipline and knowledge. The main aim of the organisation is selfless service as mentioned above” (Govindasamy, 2005b:13).

“Mankind is happiest when man is in harmony with himself, his fellowmen and Mother Nature. This can happen only when Man installs God in his heart, discovering his divine origin and divine destiny and develops true selfless love,” (Sri Sathya Sai Baba, 1968).

### **2.7.1. Focus Areas**

#### **2.7.1.1. Health Care**

Public health care in many countries are in a state of dismay. Private health care has become a big business. The poor are often marginalized and left with sub-standard and in

many cases no basic health care. The health care projects undertaken by the trust are guided by the following principles taken from (Sri Sathya Sai Organisation, 2005a):

- **Medicine for all:** Medical aid should be the right of every individual, regardless of caste, creed, nationality, or colour.
- **Medicine free from the stigma of commercialisation:** The act of healing should be restored to its pristine sanctity, which can be done only when it ceases to be a commodity bought and sold in the market.
- **Human values in medical care:** The human agents of the delivery system of health care, be they health administrators, doctors, nurses, or technicians, should be perfectly "human" in thought, word, and deed. They should demonstrate the five human values; Truth, Righteousness, Peace, Love, and Nonviolence, in every act of theirs.
- **Spiritual well being as a medical concept:** Present day medicine stops at laying down health practices and policies to provide physical, mental, and psychological health of the individual. It makes little or no attempt at strengthening the spirit of a person, the divine force in them that energizes their physical, mental, and psychological systems. Modern medicine has lost its inherent and intrinsic proximity to spirituality. Until that element is restored, medicine or health care could never be holistic.

At a primary health care level the organisation undertakes regular medical camps in rural villages, old age homes and orphanages where various ailments are treated. The organisation considers blood donation an act of selfless service. The donor is selflessly giving liquid love to someone he or she may never meet. In lieu of the aforesaid the organisation arranges many blood donor clinics on a regular basis. At secondary health care level the organisation has two hospitals one in Puttaparthi which was established in 1956 and another in Whitefield. Both these hospitals offer their services free of charge to the poor. To date the hospital is able to manage a thousand patients at a time.

The various departments in the general hospitals are: general medicine, pediatrics, general surgery, orthopedic surgery, plastic surgery, urology, ENT surgery, ophthalmology, Sri Sathya Sai Eye Bank, obstetrics, and gynecology.

The hospital in Puttaparthi as well as the hospital in Whitefield is equipped with specialized units and these hospitals offer medical care that is free of charge. These hospitals are equipped to offer care that is in keeping with care offered by up to date facilities. The service rendered by the staff i.e. doctors and nurses is done totally on a selfless basis. Professors, world renowned specialists, nursing staff and various other medical staff from all over the world render their services free of charge to the hospital as a token of love to Sri Sathya Sai Baba. Infact many regard this as an absolute privilege to work in these institutions. The aim of these facilities is to cater for the much needed medical care for the lower economic end of the community.

“The chain of health care is completed by the Super Speciality Hospital which serves as the tertiary end of the chain. The Super Speciality Hospitals is the tertiary link in the chain of health care (refer to appendix six). Leading doctors specialising in the fields of Cardiology, Urology, Nephrology and Ophthalmology etc volunteer as service to humanity and out of the love for Sai Baba. The Super-Speciality hospital acts as a nucleus for the extension of primary health care at village levels in the surrounding areas. Sri Sathya Sai General Hospital at Prashanthi Nilayam (refer to appendix six) and Sri Sathya Sai Hospital at Whitefield, Bangalore extend the secondary health care and finally the Super-Speciality Hospital acts as the tertiary link in the chain of total health care” (Govindasamy, 2005a:25).

#### **2.7.1.2. Education**

The future on the planet rests with the leaders of tomorrow. If the current paradigm of an unsustainable and unequal world is to change then our educational institutions is where the fostering of human values and new moral and righteous leaders can be bread and nurtured. “Universities in particular have a role in developing in their students so-called dynamic qualities that allow them to critique, construct and act with a high degree of

autonomy and self determination, if not in their personal lives then at least in their professional lives. At the same time, universities should develop in their students the competencies which will enable them to cope with uncertainty, poorly defined situations and conflicting or at least diverging norms, values, interests and reality constructions” (Wals & Jickling, 2002).

The organisation has schooling from what we know as grade 00 through to postgraduate studies. All of the institutions provide high quality education totally free of charge. “Guidelines for Sai institutes have been drawn by the central trust. The institutions are run by the central council within the countries concerned. The difference between these Sai institutes and conventional institutes is that the emphasis on character building is equal to that of academic perfection. The concept of human values is the underlying commonality of all institutions, human values is therefore integrated into all aspects of education. The beneficiaries on the receiving end of this type of education are usually underprivileged and therefore are not charged to attend these institutions .Another integral part of this particular type of education is the unity of thought, word and deed and also the fostering of good character through turning the mind towards God or conscience” (Govindasamy, 2005a:22). “The uniqueness of the Institute lies in the academic environment being suffused with pure Love, and the students being moulded in a spirit of sacrifice and service to the community” (Sri Sathya Sai Organisation, 2005a).

Graduates from the Sai institutions have started the ‘Human Values Revolution’ in many areas of industry, government, science and research. They have become beacons of light slowly effecting change to a more sustainable and righteous world. “They are soldiers of human values so to speak, effecting change to a more sustainable, just and spiritual world. They are not motivated by greed, lust, anger and jealousy rather they have the human values of love, peace, truth, right action and non-violence as their strategic objectives” (Govindasamy, 2005a:23).

### **2.7.1.3. Poverty Relief**

Poor communities benefit from sustainable projects launched by the Sri Sathya Sai Trust. The aim of many of these projects is the provision of shelter, food and clothing. The

organisation can be seen as the cell and the Central Trust can be regarded as the nucleus. Therefore the policy guidelines governing service activities carried out nationally as well as globally are written up by the Trust. Service activities aimed at the welfare of the needy and the poor, carried out by the trust is a global concept. Devotees globally launch and sustain projects that are a means of selfless service. These projects are aimed at the upliftment of the poverty stricken parts of the community. . “In other words, poverty cannot be eliminated without largely scrapping the present global economy, radical change in our settlements, systems, values and culture, and without dramatic simplification of the lifestyles of those who live in rich countries” (Trainer, 2002: 66). The writer proposes that “human values” is the answer to this problem.

Sri Sathya Sai Organisations are carrying out charitable activities meant for the welfare of the needy. Some of the activities undertaken are:

- Polio, blood donation, eye screening camps etc.
- Visits to hospitals, leprosy homes, orthopedic centres, maternity homes with food, clothes, etc.
- Distribution of clothes, food to the poor.
- Rehabilitation programmes for orphans, delinquents, etc.
- Village upliftment programmes.
- Giving educational scholarships to the disabled.
- Various services to people in times of earthquake, floods, etc.
- Providing various facilities to people in times of earthquake, floods, etc.

The construction and renovation of community halls, schools and temples in the village of Prashanthi Nilayam is another aspect of the projects run by the trust. Medical personal and patients from around the world are offered accommodation in buildings erected by the Trust. Performing artists as well as academics lecturing at the various educational institutes are also accommodated in these buildings. The Trust is also responsible for making the special arrangements for international and national visitors who have come for the specific reason which is to imbibe the moral, ethical, cultural, and human values espoused by Bhagawan Sri Sathya Sai Baba on a continuous basis.

#### **2.7.1.4. Sri Sathya Sai Drinking Water Supply Project**

One of the problem areas which India as a country experiences is that of fresh drinking water. There are large aspects of the community as a whole that do not have access to safe water. It is through the Sri Sathya Sai Water Supply Project which is under the guidance of Sri Sathya Sai Baba that a lot of communities are now provided with potable water. This project can be seen as a model for other districts in the State and country to mimic.

It was during 1995-1997 that the Sri Sathya Sai Water Supply Project for Anantpur was undertaken. It is this area that has been one of the most frequently affected by drought. It is in this state the available ground water has particularly high fluoride content. The uniqueness of this project is three fold in that it is the first of its kind in the country of this magnitude, it is entirely funded by the Charitable Trust and it was completed in record time.

The project started in 1994. It brought water to 700 villages to the Indian state of Andhra Pradesh (where Prashanthi Nilayam is situated). The project cost \$63 million and was funded by the Central Trust without any solicitation. Tables 3 below and tables 4 and 5 on the next page highlight the various aspects of the project:

**Table 3: Project highlights of the Sri Sathya Sai Water Project**

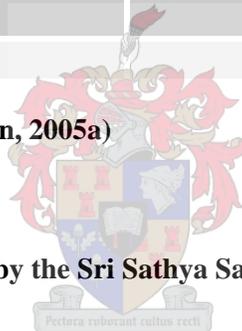
<b>Number of villages covered</b>	<b>750</b>
Population covered	900, 000
Design population	1,250,000
Project cost	US\$63 million

**Source: (Sri Sathya Sai Organisation, 2005a)**

**Table 4: Construction highlights of the Sri Sathya Sai Water Project**

<b>Main trunk lines</b>	<b>750km</b>
Branch lines	1550km
Overhead service reservoirs (40,000-300,000 litre capacity)	268
Ground-level service reservoirs (20,000-60,000 litre capacity)	125
Ground-level balancing reservoirs (100,000-1,000,000 litre capacity)	21
Booster stations	40
Summer storage tanks (60 acres)	4
Summer storage tanks (32 acres)	3
Infiltration wells	13
Bore wells	250

Source: (Sri Sathya Sai Organisation, 2005a)

**Table 5: Details of villages covered by the Sri Sathya Sai Water Project**

<b>Villages covered with borewells as source</b>	<b>274 villages</b>
Villages covered by 14 comprehensive protected water supply schemes and infiltration wells and filter points	98 villages
Villages (including Anantapur municipality) covered by 7 summer storage tanks ranging from 30 to 100 acres	98 villages
Comprehensive scheme with water treatment plants using water from Pennar Ahobilam Balancing reservoir as source	115 villages
Comprehensive scheme with infiltration well in the bed of Chitravathi Balancing Reservoir at Parnapali as source	165 villages

Source: (Sri Sathya Sai Organisation, 2005a)

“The Sri Sathya Sai Organisation has just completed similar projects in Madras and has started another in Bombay” (Govindasamy, 2005a).

Satterwaithe (2003) talks about the United Nations Millennium Goals listed below:

- Achieving universal primary education by 2015;
- Reducing infant and child mortality by two-thirds between 1990 and 2015;
- Reducing maternal mortality by three-quarters between 1990 and 2015;
- Halving the number of people without safe drinking water, adequate incomes and food intakes by 2015, as compared to 1990;
- Significantly improving the lives of at least 100 million “slum” dwellers by 2020 (this includes increasing the proportion of people with improved sanitation and access to secure tenure);
- Halting and beginning to reverse the spread of Aids, malaria and other major diseases; and
- Promoting gender equality and empowering women.

The Sri Sathya Sai Organisation under the divine guidance of Sai Baba continues to work successfully towards achieving these goals.

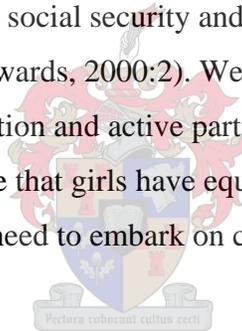
A spiritual aspirant reduces their desire for material possessions as they progress on the path of self-realization. As the aspirant lessens the load, her or his life becomes simpler and more sustainable thereby reducing his/her ecological footprint. The spiritual aspirant could belong to any religion for that matter because the goal and basis of all religions are the same, leading mankind to spiritual liberation through spiritual practice in one form or the other, “Simple Living and Higher Thinking” (Sri Sathya Sai Baba, 1968).

## **2.8. New Paradigms**

A successful way to effect change is by nurturing the minds and character of children to develop new thought patterns and paradigms. We need to implement learning methodology into all areas of education, both formal and informal, that instill skills and values required for a sustainable way of life. Integration of sustainable development,

environmental stewardship and human values into the curriculum is of vital importance. We must also embrace the importance of moral and spiritual education for sustainable living, based on the five human values of love, peace, truth, non-violence and right conduct, thereby encouraging unity in diversity and world peace. This model has been adopted by the Sri Sathya Sai Education Institutions on a global basis. Other forms of teaching such as the Montessorri, Auroville (see appendix three) and Waldorf systems have also been successful in working towards achieving the same goals. “The end of Education is Character,” (Sri Sathya Sai Baba, 1968).

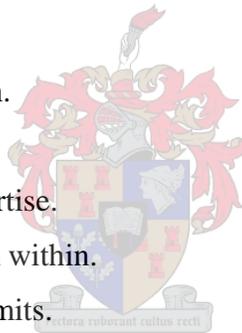
It is equally important to uplift the disadvantaged or poverty-stricken. Service to mankind is service to god. Basic human needs such as clean water, shelter, food and sanitation are just some of the basic needs that billions of people live without on a daily basis. “We need to empower every human being with the education and resources to secure a sustainable livelihood, and provide social security and safety nets for those who are unable to support themselves” (Edwards, 2000:2). We also need to secure the rights of women and strengthen their protection and active participation in all aspects of society. In Africa especially we need to ensure that girls have equal access to education, health care and career opportunities. We also need to embark on campaigns to end all forms of violence against women and girls.



Ecological design promotes evolving connections between spiritual and material consciousness. Everyone has a part to play in the design process. In building the desired structure people heal themselves. One of the main objectives of a Sai devotee is to first become the change you want to see. Two guiding principles of Sri Sathya Sai Baba are “Love All Serve All” and “Help Ever Hurt Never” (Sri Sathya Sai, 1968). This expanding vision includes all beings on earth including trees, animals, plants, ecosystems and the biosphere at large. “Taoist philosophy reveals that the order, harmony of nature and healthy human life lies in nature” (Zhang, 2004:1). Ecological design creates innovative solutions that link nature, culture and technology to reiterate the needs of human society within the balance of nature. The life force running through all beings on earth is common. It regulates natural processes and maintains balance in the universe.

The goal of spiritual aspirant is to find solutions to life through inner meditation or introspection. “In nature there is a spiritual approach to living which is believed to be the answer to the burning issues of today. What is the basis of a stable, unified, enduring and healthy social order? The order, harmony of nature and human life could only flourish in accord with nature, supplying a free and easy approach to life” (Zhang, 2004:2). Design should be sustainable through the integration of living systems. By engaging in processes that regenerate rather than deplete, we become more alive. Making natural cycles and processes more visible allow the designed environment to be brought back to life. Nature is the ultimate designer or “Master Architect” as described in the following Biomimicry principles cited in Edwards (2000:2):

- Nature runs on sunlight.
- Nature uses only the energy it needs.
- Nature fits form to function.
- Nature recycles everything.
- Nature rewards cooperation.
- Nature banks on diversity.
- Nature demands local expertise.
- Nature curbs excesses from within.
- Nature taps the power of limits.



Ecological design uses nature’s processes as a basis of design. Van der Ryn and Cowan (1996:21) conceptualizes ecological design around three strategies: conservation, regeneration and stewardship. They explain that conservation stretches or minimizes the use of resources with technologies such as recycling, insulation, appliance efficiencies. Restoration is the repair of degraded natural systems whereas stewardship entails protecting and nurturing our environment. Ecological design embraces all three concepts. “Conservation involves spending natural capital more slowly, and regeneration is the expansion of natural capital, then stewardship is the wisdom to live on renewable interest rather than eating into natural capital” (Van der Ryn and Cowan, 1996:22). Ecological design principles are non-generic. It involves adopting design to the soils, climate, vegetation and weather patterns of the area. This requirement in itself leads humans to

rekindle their relationship with nature, to listen and take heed to her cycles and patterns. “Ecological design is a way of integrating human purpose with nature’s own flows, cycles and patterns” (Van der Ryn and Cowan, 1996:24).

## **2.9. The Link between Spirituality and Eco-Design Informing the Design Concept – Introduction to Vastushastra**

### **2.9.1. Introduction**

Vastu Architecture is a very complex system of knowledge that stems from ancient India. Vastushastra is a building system that designs and builds for the spiritual and material benefit of mankind. Many have tried to study and understand the dynamics of this knowledge system but have not been successful. The few that hold the keys to this knowledge have had their lineage dated back thousands of years to that of ancient builders and have now set up institutes to spread the knowledge and fundamentals of this very beneficial system of construction. One such master is Dr Ganapathi Sthapati (Sthapati being the Sanskrit name for builder). The aforementioned mahatma (great soul) is a leading authority on Vastushastra and has designed the high school in question. Vastushastra was chosen as the guiding light and main force behind the construction of the high school as a result of Sri Sathya Sai Baba commissioning many of the educational and health institutes of the organisation in India under Vastu principles. Being devotees of Sri Sathya Sai Baba we adhere strictly to his guidance and actions. We took the lead from our divine master and commissioned the construction of the high school under Vastu principles.

The author will now try to provide a brief introduction to this knowledge. According to Dr Sthapati (2005), architecture based on Vastu Science and Technology is the supreme achievement of mathematics and when applied on the design of structures and sculptures, it creates a rhythm in spatial form resulting in physically appealing and spiritually alluring creations on earth. “Vastushastra has codes, guidelines and rules which link art, astronomy, astrology, ancient healing systems, biology, chemistry, physics and yoga in order to understand the minutest influence of the sun, the moon, the stars, the planets, and the geomagnetic radiation on living organisms and human life in order to build dwellings that are in harmony with nature, the cosmos, natural forces and energy

fields and balanced enough to create a harmonious environment for the proper functioning of the human body and mind. While modern architecture specializes in bodily comforts of a dweller and functional effectiveness of a structure, Vastushastra aims at ensuring the health, happiness, prosperity, and well-being of a human being occupying the dwelling, and endows him with a sustained peace and tranquility of mind” (Sahasrabudhe & Mahatme, 1999:1).

Vastushastra uses the physical world and the abstract world to build beneficial buildings. The physical world covers issues such as building materials, people involved in the construction process from the architect to the builder, equipment, budget, land etc. Under the abstract world (issues that cannot be seen but can be felt and experienced) covers the eight directions, effects of five elements, geomagnetic fields, frequency of sound waves and light waves, religious practices and traditions and the science of astrology and influence of planets are covered (refer to appendix one).

“The science of Vastushastra is indeed very very difficult to comprehend, since unlike the material science of today which is rooted in material substances and based on laboratory tests etc., the science of Vastushastra has its roots in the Vast Space surrounding and filling the whole universe and tested by the science of sound and resonance. It is this space that dwells in all living beings including man. This science, in a nutshell, is a science of the Cosmic Space which goes into experience, vibration and turns into spatial forms of what is experienced – that is the universe and its objects” (Sthapati, 2005, III).

### **2.9.2. Helix, Golden Ration and Vastushastra**

“In the natural forms, asymmetry of energy always implies evolution of creative life. Vastushastra principles reflect the essence of asymmetry. In Vastushastra, analysis of asymmetry begins with the study of geomagnetic axis. Since geomagnetic flux lines are unidirectional (North-South), the asymmetric effects are evident in other directions. Because the earth’s rotational axis is inclined by 22.5 degrees to its plane of revolution around the sun, all the earthly forms are exposed to asymmetry. Asymmetry is also seen in gravitational effect which is a function of interacting masses and distances in-between.

The entire nature flows out of asymmetry and all the energy forms, current flows, and their actions are asymmetric in nature. The key to creative utilization of this asymmetry lies in nature itself. Helix is the most common naturally available antidote to anomalies and destructive effects resulting from energy imbalances”, (Sahasrabudhe & Mahatme, 1999:9). In nature every organism is shaped for purpose and a definite cause. Shapes play an important role and are determined by conditions and circumstances within the various ecosystems.

“Yogashastra refers to the nabhi (navel) as a kanda (bulbous root) and considers it to be the source point of all the nadis (channels of energy). The manifestation of energy through the nadis is akin to the growth of spiraling helix with multiple openings. In nature, uniformity is evident in formation or construction of dwellings suitable for a particular species and serving a limited purpose of safety against destructive natural forces. The honeycomb formations of the bees, the conical nests of the termites, the ant-hills, the elaborately woven nest of the weaver bird, all these shapes are in harmony with nature. The Homo Sapiens, gifted with the power of thinking and the ability to imitate nature, learn from nature and project their creativity through construction of material objects” (Sahasrabudhe & Mahatme, 1999:9).



History has proven that if mankind incorporates and works with nature mimicking her cycles and principles then success and harmony are assured. A structure built with Vastu principles attains a stable helical form. “Considering the directional aspects of geomagnetic field and temperature gradients, it can be inferred that the North-East zone is marked by low temperatures and stable geomagnetic flux lines while the South-West direction represents a zone of maximum temperatures and anomalous magnetic field lines. The flow of energy in the terrestrial atmosphere is influenced by the sun’s daily sojourn in the sky, West to East rotation of the earth relative to the sun and the earth’s magnetic field. Gravitational waves (yet to be detected in terrestrial laboratories) may also affect the dynamics of energy flow. Helix, a naturally evolved shape, embodies the path of least resistance and balanced interaction encompassing the energy currents of terrestrial, solar and cosmic origin”, (Sahasrabudhe & Mahatme, 1999:10).

### **2.9.3. Orientation**

“The basic source of energy of the whole world is stored at North and South poles. It flows uninterruptedly from North pole to South pole in the form of magnetic waves”, (Jhajharia, 1996:17). It is therefore imperative that the northern side of the building be lower than the southern part of the building in order to hinder the flow of magnetic waves (refer to appendix one).

The sun provides us with energy. Heat and light from the sun is crucial for life to exist on the planet. It is a common fact that the sun rises in the East and sets in the West. In Vastushastra building, the relation to the sun is very important (refer to appendix one).

“Besides the sun, while oscillating between the Tropics of Cancer and Capricorn, passes through all the twelve signs of the Zodiac. This oscillation of the Sun not only causes seasons and changes but also affects us. The directions of East and West are important as far as obtaining the energy from the Sun is concerned. The importance of the directions of the North and South lies in the flow of magnetic waves which flow from North Pole to South Pole. These waves affect us and are as beneficial to us as are the Sun rays”, (Jhajharia, 1996:23).

“The corners in which North and East, East and South and West and west and North meet are known in Sanskrit as ‘Ishan’, ‘Agneya’, ‘Nairitya’ and ‘Vayavya Konas’ respectively. At last it is also necessary to make mention about ‘Panch Mahabhut’ {Five-basic elements}. These are earth, water, light, air and space”, (Jhajharia, 1996:24). These are also found in the cosmos and from them the living organisms have been created. For a healthy life it is necessary to attune our lifestyle according to them and to understand the mysteries of these (refer to appendix one).

### **2.9.4. The Significance of Four Directions and Sub-Directions**

Along with earth, water, air, fire and space the question of directions and sub-directions is also related to the Vastushastra. The idea of deriving benefits from the sunrays coming from the East and the magnetic waves entering from the North is implied in determining the directions of various parts of the building (see appendix one). The building should be constructed as not to create any hindrance in the flow of these rays and waves. The basic

rule of Vastu Shastra, therefore, is to keep the North and North-East parts at lower levels (refer to appendix one).

Along with it, the second rule is that the eastern part should be lower than the western part. The basis for this rule is that the sun rises in the east and the rays from the rising sun are most beneficial. These rays should enter the building without any barrier (refer to appendix one). As the parts, both in the North and East should be lower so the North-East part should also be kept at a low level. Besides this, the residence of god is supposed to be in the North-East. Therefore the place of worship should be constructed in the north-eastern part of the building.

The magnetic axis and the geometric axis of a Vastu play an important role in attaining good qualities and virtues in a Vastu (see appendix one). Unless these axes are parallel and co-linear, the body movements inside the Vastu result in friction and high impedance to micro-magnetic fields of human body cells on account of oblique crossing of magnetic force lines through the medium (see appendix one). In such cases where geometric axis of a plot is not parallel and collinear with the geometric axes of the house with the magnetic axis, giving a dynamic balance to the house. The building should be constructed in the South West Zone so that ample open space is obtained in the North-East zone.

#### **2.9.5. Basic Principles of Vastushastra**

- **The Earth.** Site selection is very important in Vastushastra. The plot should have fertile soil and sufficient water supply. The slope or gradient of the plot should be inclined towards the East or North-East. The plot should be ideally square or rectangular in shape {see appendix one}; squaring the plot or the erection of Vastu fences can remedy irregular shaped plots. “According to the Vastushastra, the eastward inclination of the land provides us with the life-carrying rays of the rising sun. The land should be higher on the South-West side to receive maximum benefits of the rays of the rising sun and to allow the building to receive free flow of magnetic waves from the north”, (Jhajharia, 1996:27).

- **Water.** The North-East direction is always auspicious and most suitable for the domestic flow of water such as swimming pools, boreholes and drainage systems for sewerage.
- **Fire.** The kitchen, fire place and geysers etc should be placed only in this direction as the direction of the element of fire is South-East. “Alternatively these could be placed in the North-West, because it is at 180 degrees to the South-East”, (Jhajharia, 1996:29).
- **Air.** The air should enter the building from the North-East. All the openings and media for air entry such as doors, windows, ventilators coolers, air-conditioners, verandahs, balconies should be in this direction.
- **Space Sky or Open Space.** Traditionally every house in India used to have an open space in the centre of the house. It provided the dwellers not only the open sky but also sunlight and cross-ventilation of air so that the inhabitants got the effect of terrestrial-energies uninterruptedly.

### 2.9.6. The Importance of Colours in Vastu

In Vastushastra colours also play a significant role as the different colours remit different types of energy. The table below shows the directions and related colours:

**Table 6: Directions and related colours**

<i>Direction</i>	<i>Colour</i>
<i>North</i>	Orange
<i>North-East</i>	Yellow
<i>East</i>	Light Green
<i>South-East</i>	Blue
<i>South</i>	Dark Blue
<i>South-West</i>	Violet
<i>West</i>	Dark Green
<i>North-West</i>	Red

Source: (Jhajharia, 1996:93)

### **2.9.7. Planning Construction According to Vastushastra**

In order to reap the optimum benefits of Vastushastra here are some of the **very basic rules and guidelines** taken from (Jhajharia, 1996; Sahasrabudhe & Mahatme, 1999; Sthapati, 2005 and Puri, 2002):

- The plot should be sloping either to the North, East or North-East direction.
- Water supply such as boreholes should be ideally located in the North or North-East direction.
- Geometric axis of the Vastu should be aligned to match with the geomagnetic axis of the plot (see appendix one)
- The North-South axis should be longer than the East-West axis (refer to appendix one).
- The North East section of the plot should be kept as an opens space and majority of the construction should occur in the South-West area of the plot.
- Storage rooms should be located in the South-West corner of the property.
- Excavation should commence from the North-East side and move in a clockwise direction towards the South-East side and then onto the South-West direction.
- Activities like providing a footing for the structure and ground-filling must begin in the South-West.
- Soil should be fertile. If need be corrective measures must be undertaken to enrich the soil.
- The South side walls should not have any door or window openings. The wall in this direction should be either an 18 inch (45cm) thick construction or a double wall with cavity in-between.
- The North, North-East and East side of the buildings should be as open as possible with maximum number of doors, windows, ventilators and balconies.
- In the same house, differential levels for internal rooms are not advisable.
- Basements and cellars should be avoided.
- Roofs slanting towards the South and the West directions are not advisable.
- If possible, an additional room or a floor should be constructed on the South-West side.
- Medicinal plants and trees should be planted on the South border.

- The North and East sides should be provided with open spaces for free air circulation.
- The North, North-East and East side walls should be painted with bright glossy colours, while the painting scheme for the West and South side walls could use dull, matt-finish type colours.
- Toilets should be located in the South and the West.

Vastushastra has been imparted to mankind through the great Rishis in their infinite wisdom to enlighten mankind for the benefit of all life on the planet. This knowledge has been laid down in the ancient texts of India called the Vedas. Vedic knowledge has already benefited many in the form of Ayurveda (health systems), various forms of Yoga as well as various forms and techniques of meditation which is just a small iota of the amount of knowledge enshrined in these ancient knowledge systems. Vedic knowledge is an avenue to assist mankind out of the current status quo of unsustainable living, poverty, wars, environmental crisis, economic meltdown, fear and violence.

In nature waste from one system is food for another. All species maintain an ecologic balance. Individual organisms undertake activities in a selfless manner that eventually benefits the entire ecosystem. Implementing this terminology will inform every part of the process from design through to the eventual operation and maintenance of the school; examples include passive heating and cooling, biological waste treatment, solar heating and permaculture. The next chapter provides the conceptual design framework of the project. The chapter will look at a master plan of what ecological design technologies will be considered.

## Chapter Three – Context

The Sri Sathya Sai Organisation in South Africa's current focus is on education. The organisation has already built five primary schools and a high school in Newcastle. The subject of this project proposal is the construction of the second high school in Gauteng.

### 3.1. The Project

The project centers on the construction of a high school with all supporting buildings and residences for students and teachers (the current focus of this project is phase one, which is the high school itself). Phase two would concentrate on the construction of a multi-purpose hall whilst phase three would see all stakeholders boldly embark on the construction of residences for students. The organisation has already established a primary school five kilometers from the proposed site, in the suburb of Lenasia South. Majority of the learners are from the surrounding informal settlements. Students from poverty stricken homes are often chosen to benefit from the education provided by the Sai schools. The original intention was to continue building classrooms at the current school for the needs of the students as they progress to secondary levels. However the board of management of the Sri Sathya Sai School in Lenasia South has decided that new facilities would be required for school due to space constraints.

The Sai Schools in South Africa are registered as independent schools. They operate under the guidelines of the Central Trust in Prashanthi Nilayam, India. The style of teaching and the outcomes expected will be discussed in chapter four. Funds required for the operations and maintenance of the school is raised from within the membership of the organisation. Fundraising outside the organisation is prohibited.

### 3.2. The Site

The site for the proposed high school is on a smallholding at Plot 68, Uniaville, South of Johannesburg (see appendix four). The area is on the border of Lenasia South on the one side and five kilometers to the border of Vlakfontein on the other. The closest service road to the site is the K54 which is approximately five hundred meters from the site. This

allows for easy access to public transport for the children. Buses and taxis have scheduled routes passing the area throughout the day. The property is currently zoned for residential and/or agricultural use. The property has been donated to the organisation by a member of the organisation. The size of the plot is approximately 5 acres with existing dwellings (refer to appendix four). These dwellings include a residential house comprising of three bedrooms, two bathrooms, kitchen, lounge and dining room. Other structures include two lecture rooms (that was used for tutor support programmes), additional toilet and bathroom facilities, a pump house for the borehole pump, maid quarters and a large garage able to fit up to four medium sized vehicles. The rest of the property is vacant land (refer to appendix four). It is envisaged that the current dwelling will be transformed into the administration block.

### **3.3. Climate and Topography of the Region**

The climate of the area is mild and moderate and practically wind free (relatively so in summer), not too hot or humid in summer and clear and crisp in winter. Summer runs from October to March whilst very cold conditions are only experienced in the six weeks between mid July and end of August. Rainy season is in summer characterized by harsh storms accompanied by lightening, thunder and occasionally hailstorms. They do not last long though and are often followed by warm sunshine. The land on the site is extensively flat with the breadth of the property facing north (refer to appendix four). A portion of the land surrounding the current dwellings has been landscaped whilst bulk of the vacant land where the new school will be built is filled with Backenveld up to 2 meters in some areas. The surrounding area has a good supply of clay soil which will be used in the brick manufacturing process.

### **3.4. Vaastu of the land**

The proposed site meets 90 to 95 percent of the Vaastu requirements for construction.

- The plot is sloping to the North-East direction.
- Geometric axis of the Vastu should be aligned to match with the geomagnetic axis of the plot (see appendix one).
- The North-South axis is longer than the East-West axis.

- The North East section of the plot is open and will be kept open even after construction.
- Storage rooms will be located in the South-West corner of the property.
- The soil on the plot is fertile.
- The South side walls will be thick and heavy with no openings. It is suggested that the south side wall be a double wall.
- The North, North-East and East side of the buildings will be as open as possible with maximum number of doors, windows, ventilators and balconies.
- There are no basements and cellars planned for the building.
- Roofs slanting towards the South and the West directions are not planned.
- Medicinal plants and trees will be planted on the South border.
- Toilets will be located in the South and the West quadrants of the building.

### **3.5. Challenges of the Site**

There are very few challenges regarding the land. One of the challenges revolves around underground sewerage. The area where the plot is located is a smallholding community. Most of the plots in the area use septic tanks or pit latrines. To cater for the large volume on account of the school the project team needed to decipher whether council would consider piped sewerage. The initial meetings with council resulted in the project having to fork out R500 000 for additional infrastructure for end of pipe sewerage. This solution was not only expensive but opposed the underlying principles of ecological design. Needless to say the solution was closed loop sanitation (discussed in chapter six) where all the water and nutrients will be recycled back into the school. Negotiations are underway at present for council to accept the closed loop system.

The second challenge is the location of the borehole on the plot. Vastu principles dictate that the supply such as boreholes should be ideally located in the North or North-East direction. The borehole pump and borehole is in the South West quadrant of the plot. This will now entail a shifting of the borehole and pump house to the North East quadrant of the plot. The expense incurred may seem unnecessary but in relation to Vastu this can drastically impede the energy of the building and project.

### 3.6 Design requirements

We are designing a school for 400 students - there will be 25 students per class in 10m x 10m classrooms. The school will be for boys and girls - there will be 16 classrooms (8 boys and 8 girls).

#### Classroom requirements:

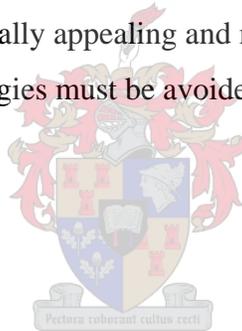
Each classroom must have storage facilities at the back of the classroom for bags, stationery etc.

#### Other rooms:

- We require 4 storerooms for storing text books, sports equipment, other equipment etc.
- We require a multipurpose hall for indoor sports activities, cultural activities, prize giving, examinations, assembly.
- **Toilet facilities** are required for boys and girls.
- **Toilet facilities** are required for staff.
- We need **laboratory** rooms for chemistry, biology and physics. A minimum of two would be needed.
- A **music room** is needed.
- **Locker rooms and shower facilities** are needed, one for girls and one for boys.
- **Multi-media resource centre** is needed.
- **Two meditation/prayer rooms** are needed (one for boys and one for girls)
- **The administration block** will be built from the existing house. The administration block must include the principles office, an administration office, teachers' lounge, teachers' ablution facilities, a sick room, a storage facility and a copying room.

The design must create an environment where students, parents, teachers and the community at large live simpler and more spiritual lives. The school must be aesthetically appealing and must be easy and cost effective to maintain. Costly building technologies must be avoided due to budgetary constraints.

The classrooms must be large enough to cater for approximately 30 students per class (100 square meters per classroom). Each student will be allocated a work station such as those used by architectural students at universities. This creates a personal space for the students where they can base their learning experiences from. The classrooms must be well ventilated and sufficiently lit with natural light. A resource centre that will store books, periodicals, computers and other audio visual equipment which must be in close proximity to the administration block. High levels of security must be incorporated into the design of the resource centre considering the types of equipment that will be installed in the room. This room must have sufficient plug points due to high demand for energy as a result of the equipment. The administration block will comprise the principal's office, administration office, teachers' lounge, teachers' ablution facilities, a sick room, a storage facility and a copying room. The design must create an environment where students, parents, teachers and the community at large live simpler and more spiritual lives. The school must be aesthetically appealing and must be easy and cost effective to maintain. Costly building technologies must be avoided due to budgetary constraints.



## Chapter Four – Resource Context

The Sri Sathya Sai Organisation is an international spirituality-based organisation whose main focus is upliftment of morals, values and spirituality. The organisation lends its name from Sri Sathya Sai Baba, an avatar residing in India (refer to appendix six). Swami as he is fondly referred to by his devotees advocates the need for humanity to re-imbibe the five human values that has become so rare in our modern society; they are love, peace, truth, non-violence and right conduct. These human values are applicable to all ethnicities, races, religions, cultures and nationalities. Members of the organisation are encouraged to embark on community upliftment projects as part of their personal transformation. Putting into practice the teachings of one's religion through the physical manifestation of a service project has proven to be the best form of spiritual practice an aspirant can subject himself/herself to.

Many of the Sai devotees have formed Sri Sathya Sai Service organisations in their respective countries. There are currently more than 12000 centres in 137 countries. One of the fundamental teachings of Sai Baba is the desire to serve the less fortunate and poverty stricken. “The crucial sociological concern is the social bond; the ties of gratitude, affection, social debt, obligation, reciprocity, etc. which ensure that a society involves far more than the pursuit of individual interests. The social bond also includes commitments to intrinsic values and standards, especially to do with justice. No society, let alone a good society, can exist unless there is a considerable level of concern for the welfare of the other and for the public good. Indeed it is hardly plausible that there could be a society in which there are only individuals who are concerned solely with their private welfare and advantage” (Trainer, 2002: 61). Sai Baba often states in his many discourses that “Service to Man is Service to God” (Sri Sathya Sai Baba, 1968).

Devotees do not embark on fundraising outside the organisation. The organisation sustains its projects through the selfless donations from members within the organisation who find spiritual joy in the upliftment of their fellow human beings guided by the teaching of Sri Sathya Sai Baba, “The hands that serve are holier than the lips that pray”

(Sri Sathya Sai Baba, 1968). Devotees of Sri Sathya Sai in many countries have formed large corporations and contribute 85% of their profits to the organisation in order to sustain, grow and embark on new projects. Two such global corporations are the Sundaram Group and the TATA Corporation. These companies are run as trusts and ultimately have the upliftment of mankind as the underlying reason for making profit.

#### **4.1. Financial Resources**

The first rough estimate for the construction of the school, pending a final quantity surveying report, estimates the cost of the first phase of the building to be around R10 million. A third of this amount has already been sponsored by a businessman belonging to the organisation. The balance of the funds required for the organisation will come from within the congregation. A plan has been devised to get one thousand families donating R278 per month specifically for this project over a period of thirty six months. In this way the funds needed for the project can be raised successfully. There are already three hundred and fifty families that have confirmed their commitment. Benchmarking from previous projects the project team is confident to that the sponsorship from 1000 families can be achieved in the very near future.

The funds raised will be deposited into the Sri Sathya Sai Central Trust of South Africa's account. Money will then be allocated to the project according to budgets and timelines. The trust is registered as a spiritual based organisation. As a result, monthly, quarterly and yearly financial statements must be submitted and audited not only by a Trust nominated auditor but an independent auditor as well. In line with the spiritual teachings of Sri Sathya Sai Baba every cent must be accounted for. The Board of Management of the School (doubling up as the project team) has a finance sub-committee that ensures that the school complies with all financial regulations as well as maintaining all the checks and balances.

#### **4.2. Human Resources**

As mentioned earlier service to humanity is considered one of the best forms of worship a spiritual aspirant can undertake. In light of the aforesaid it is never difficult to round up a

team of experts to run a project like the one proposed. Many members of the organisation are skilled in various technologies such as medicine, business, government, legal, financial, building and construction, consulting etc. These devotees are very keen to assist and render their time to projects undertaken by the organisation. The hospitals and universities in India have many devotees complementing full time staff. To undertake a construction of this magnitude one would need the following skilled team:

- Vastu architect
- Natural builder
- Bricklayers
- Plumbers
- Structural Engineer
- Master Electrician
- Labourers

#### **4.2.1. Vastu architect**

Dr Ganapathi Stapathi is a world renowned master in Vastushastra. He is the foremost authority on this ancient science. Through divine intervention and the commitment and selfless love of Martin Gluckman from the International Vedic Society the project team was able to commission this guru to design the school. Dr Stapathi has charged a bare minimum fee for his masterpiece (plans attached).

#### **4.2.2. Natural Builder**

Luke Boshier has been commissioned as the builder for the school. His technical skills in natural building methods coupled with his passion to empower communities towards self-sustainable living are unprecedented. He has graciously undertaken to accept a substantial decrease in remuneration. He feels privileged and blessed that he can play a large part in the construction of the school. He is the driving force behind the chosen alternative technologies (see chapter six) and has the necessary skill, network of specialists and building experience to make the school an ecological design success. Luke will relocate for an entire year to Johannesburg from Cape Town. He will be housed on site at one of the existing buildings. Luke is also important to maintain the momentum and energy of the community building aspect of the project as it is this aspect that will ultimately determine the success of the project.

#### **4.2.3. Bricklayers and Labourers**

As mentioned before students that attend the Sai schools come from very poor backgrounds. The parents of many of the students are unemployed. The project team used the construction of the school as an opportunity to empower, skill and provide employment to some of the parents that showed interest. A group of twelve parents have mobilized themselves to become the backbone of the project. The process will begin with the group undergoing training in compressed earth brick manufacturing (see chapter six on Hydraform). The next three months will see the parents together with teams of devotees manufacturer 180 000 bricks. A remuneration package (for the parents) has been negotiated and agreed upon. The parents will be further skilled to lay bricks and assist in the basic building.

#### **4.2.4. Structural Engineer**

The structural engineer in question, Mr. Tony Smith has been involved with one of the project team members in many development projects and has graciously agreed to donate his expertise and time to this project as his way of paying back and helping communities empower themselves. He has already had several meetings with Luke and the some of the more experienced (skilled in building, construction and property development) devotees. He has agreed to draw up the Quantity Surveyor report, see to the geotechnical aspect of the project as well as sign off on the structural engineering aspect according to building regulations.

#### **4.2.5. Electrician, Plumber, other Builders and Carpenters**

The board of management of the school has devotees that are master electricians, industrial plumbers that own construction companies and carpentry businesses. All their time and skill will be donated free to the project.

Furthermore the school will adopt the same methodology that the organisation has used to build all of its schools around the world. The devotees themselves will help physically in building the school, pouring their love, devotion and energy into the project wherever possible.

### 4.3. Materials

Currently the main focus of the project is to manufacture 180 000 bricks before the end of January. The chosen method of brick manufacturing is a manual press machine that makes compressed earth bricks from clay and 7% cement as a stabilizer (see chapter six under Hydraform brick). The sand has been sourced from a nearby smallholding. The owner was looking to move the sand in order to undertake some building work. Total volume of sand needed to manufacture the 180 000 bricks is 400 to 500 truck loads. A member on the project team has a grader, tractor and loading bin that has a hydraulic lift mechanism that enables the sand to be dumped with minimal effort. The only cost incurred for moving 500 truck loads of sand over a distance of less than 750 meters is the cost of diesel and the two workers handling the grader and the tractor. A rough estimate pegs the saving from attaining the sand in the aforementioned manner at approximately R600 000.00. This in the opinion of the project team is only by the grace of the divine. The mortar mix that will be used to build will be exactly the same as the mix used to manufacture the bricks. Here again the saving of cement comes into play. The health and passive thermal properties are further extended.

The colour of the soil is a typical clay colour which makes a beautiful deep red, earth colour brick which speaks mountains on the energy, love and ecological aspects of the brick. Furthermore the colour of the brick is so beautiful that the decision to plaster both the internal and exterior walls has been abandoned.

## Chapter Five – Ecological Design Conceptual Framework

The project team has proposed the use of ecological design for the school at two separate presentations, first to the board of management of the school in Gauteng and then again at a national forum to the central council in Kwa-Zulu Natal. The concept of constructing using ecological design principles has been accepted and the project team will now implement these technologies into the preliminary design proposal. The principles adopted will be chosen on the basis of their advantages over conventional techniques based on the following requirements

- Improved occupant comfort
- Energy savings
- Improved environmental conditions
- Improved system and equipment function
- Improved building operation and maintenance

The below mentioned table provides a comparison between ecological design and conventional design considering the various issues one would take into consideration when planning a project such as the high school in question.

**Table 7: Conventional and Ecological Design compared**

<i>Issue</i>	<i>Conventional Design</i>	<i>Eco-logical Design</i>
<i>Materials Use</i>	Usually non-renewable and destructive, relying on fossil fuels or nuclear power; the design consumes natural capital  High quality materials are used clumsily and resulting toxic and low quality materials are discarded in soil, air and water	Renewable whenever feasible, solar wind, small-scale hydro, or biomass, the design lives of solar power  Restorative materials cycles in which waste for one process becomes food for the next, designed in reuse, recycling, flexibility, ease of repair and durability

<i>Issue</i>	<i>Conventional Design</i>	<i>Eco-logical Design</i>
<i>Pollution</i>	Copious and endemic	Minimized: scale and composition of wastes conform to the ability of the ecosystems to absorb them
<i>Toxic substances</i>	Common and destructive, ranging from pesticides to poisons	Use extremely sparingly in very special circumstances
<i>Ecological accounting</i>	Limited to compliance with mandatory requirements like environmental impact reports	Sophisticated and built in; covers wide range of ecological impacts over the entire life cycle of the project, from extraction of materials to final receiving of components
<i>Ecology and economics</i>	Short run view	Long run view
<i>Design Criteria</i>	Economics, custom and convenience	Human and ecosystem health, ecological economics
<i>Sensitivity to ecological content</i>	Standard templates are replicated all over the planet with little regard to culture or place; skyscrapers look the same for New York to Cairo	Responds to bioregion; the design is integrated with local soils, vegetation materials, culture, climate, topography, the solutions grow from the place
<i>Sensitivity to cultural context</i>	Tends to build a homogenous global culture; destroys local commons	Respects and nurtures traditional knowledge of place and local materials and technologies fosters commons
<i>Biological cultural, and economic diversity</i>	Destroys biodiversity	Maintains biodiversity and the locally adapted cultures

<i>Issue</i>	<i>Conventional Design</i>	<i>Eco-logical Design</i>
<i>Knowledge base</i>	Narrow disciplinary focus	and economies that support it. Integrates multiple design disciplines and wide range of sciences; comprehensive
<i>Spatial scales</i>	Tends to work to one scale at time	Integrates design across multiple scales, reflecting the influence of larger scales on smaller scales and smaller on larger
<i>Whole systems</i>	Divides systems along boundaries that do not reflect the underlying natural processes	Works with whole systems, produces designs that provide the greatest possible degree of internal integrity and coherence
<i>Role of nature</i>	Design must be imposed on nature to provide control and predictability and meet narrowly defined human needs	Includes nature as a partner whenever possible, substitutes nature's own design intelligence for a heavy reliance on materials and energy
<i>Underlying metaphors</i>	Machine, product, part	Cell, organism, ecosystem
<i>Level of participation</i>	Reliance on jargon and experts who are unwilling to communicate with public, limits community involvement in critical design decisions.	A commitment to clear discussion and debate; everyone is empowered to join in the design process
<i>Type of learning</i>	Nature and Technology are hidden, the design does not teach use over time	Nature and technology are made visible, the design draws us closer to the

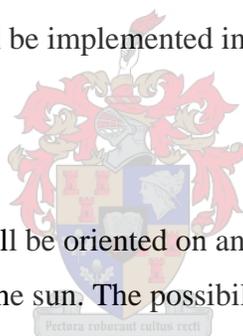
<i>Issue</i>	<i>Conventional Design</i>	<i>Eco-logical Design</i>
		systems that ultimately sustains us.

**Source: (Birkeland, 2002)**

The aforementioned table gives a clear indication that ecological design is an obvious and logical choice for social, economic and environmental reasons. “Sustainable architecture is not anti-technology; it simply calls for wiser design which uses technology to augment the energy-efficiency of buildings instead of depending on technology alone. Green architecture, sustainable design, whatever the name, the new generation of architects must relearn and revive some of these age old lessons and adapt them to our modern world” (Hsin, 1996).

### **5.1. Strategies for school design**

The following broad strategies will be implemented in the school design and construction.



#### **5.1.1. Orientation**

The longer side of the buildings will be oriented on an east-west axis in order to maximize the heat and light from the sun. The possibility of overhangs will be considered in order to maximize the sunlight during winter and to minimize the extreme heat in summer. This can also be achieved through the strategic use of trees, shrubs and other indigenous plants.

#### **5.1.2. Thermal mass**

In order to maintain efficient cooling in summer and heating in winter without much aid from heaters and airconditioners it is important to look at the thermal mass of the building. Efficient thermal transfer is obtained when the mass of the exterior wall and roof is great. Storing solar heat gain in the daytime and using this heat during evening hours can be achieved by utilizing high thermal mass construction and materials. Colour

also plays an important role in maintaining comfortable room temperatures. Reflective colours would be used in very hot climates whilst darker colours which absorb heat would be used in colder climates. The dark red of the exterior coupled with the light colours of the interior walls is most efficient for the Johannesburg climate. The lighter colours of the interior assist with decreasing the need for artificial light during the day.

### **5.1.3. Windows**

Windows are poor insulators resulting in too much heat gain in summer and too much heat loss in winter. The purpose of the building is a school; therefore windows become an important necessity. It will become vitally important to look at special insulated glass such as Smartglass or other types such as double glazing in order to affect energy efficient strategies.

### **5.1.4. Building Materials**

Building materials will be chosen according to initial costs, toxicity, quality and life expectancy and possibility for being recycled and/or reused. The aforementioned will not be an easy task as there will be various factors to consider when embarking of the selection process for materials. For example, wooden frames may come from a sustainable source but would require continual maintenance and possible replacement every few years whereas aluminum frames, although containing a high embodied energy count, will offer a lifetime of service at no additional cost for repair or replacement.

### **5.1.5. Toxicity of materials**

Materials that emit toxic fumes must be avoided. Natural or more environmentally friendly materials must be used together with sufficient ventilation strategies. Formaldehyde-based glues, chlorofluorocarbons, resins, lead and oil-based paints, and volatile organic compounds (VOCs) used in adhesives are just some of the many chemicals which will be avoided.

### **5.1.6. Natural materials will be used where possible.**

Natural materials such as stone, lumber, and earth are generally less energy-intensive to produce, have lower toxicity levels, and contribute less pollution to the environment.

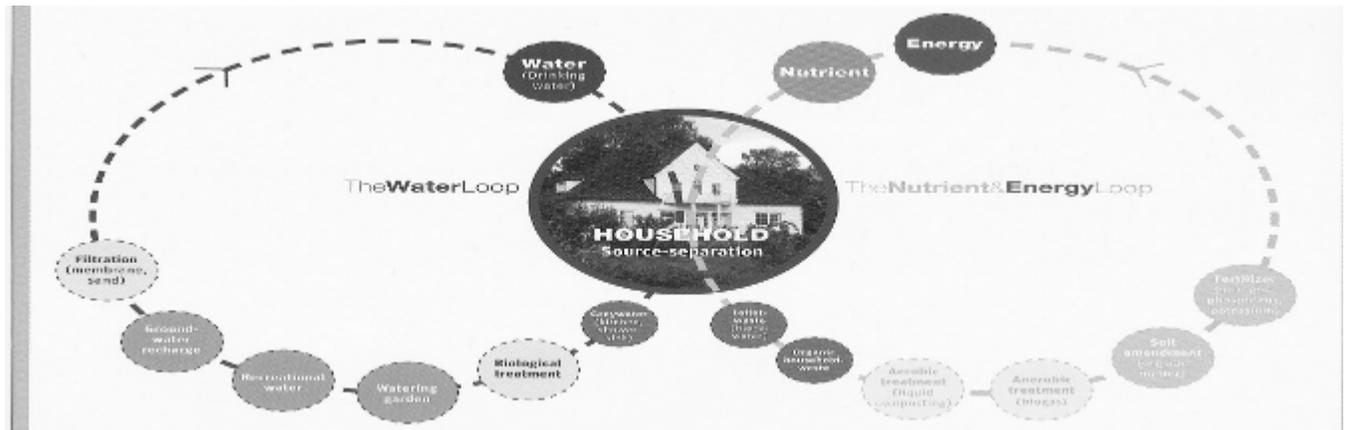
### 5.1.7. Water

The project team would like to achieve the following:

- Reduce water usage through the use of conservation practices and raising awareness within the school environment.
- Install technologies that would reduce water consumption; the largest consumption of water would be through sanitation and irrigation needs
- Use on-site sources of water drawn from the borehole
- Grow indigenous gardens
- Use low-flow systems in all new toilets, showers and faucets and look into alternative methods of on-site water sanitation systems
- Recycle, reuse and reclaim water onsite from grey and black water
- Rainwater collection from the roof of the school. [The annual rainfall figures for Johannesburg indicate an approximate figure of 750mm per annum (Joburg City Metropolitan, 2007).]

In this regard the project team will adopt a closed-loop sewerage system where all the nutrients, water and waste is recycled back into the school for toilet flushing and irrigation purposes thereby reducing the education centre's water needs (refer to figure 1). The project team is currently researching a biodigester system which enables users to recycle both black and grey water successfully and produce by-products of fertilizer and methanol gas. The Biodigester system is an ecological sanitation solution. Ecological sanitation is based on three principles according to Moosa (2005) - pollution is prevented rather than being controlled after it occurs; sanitizing the urine and faeces; and using the products for agricultural purposes. Ecological sanitation co-operates with nature.

**Figure 1: Dynamics of a closed loop ecological sanitation system**



Source: (Moosa, 2005)

### 5.1.8. Energy

Regarding reducing the energy needs of the school and becoming more sustainable the project team would like to embark on the following:

- Fit buildings with energy efficient devices which include CFL's.
- Purchase the most energy efficient computers, kitchen appliances and other electric powered appliances the school may need.
- Using solar powered geysers for water heating.
- Use biogas from close loop sanitation for cooking needs.
- Passive heating and cooling has already been discussed.
- Maintain close contact with parties involved in renewable energy to be the first to implement solar or similar technology to completely run the school when this becomes affordable.

### 5.1.9. Waste

The school will embark on sustainable waste management which will entail the following:

- Recycling of any paper, plastic, aluminum and other metals and glass items that may be in the school grounds.

- Compost all vegetable and fruit peels and scraps.
- Recycling of black and grey water has already been discussed.

The education centre will be free of toxins through the use of natural paints (such as Envirotouch from Cape Town, producing interior and exterior waterborne natural resin based wall finishes) and adhesives and the use of compressed earth brick, heating and cooling technologies will rely on natural processes as far as possible, energy and water consumption will be reduced through various technologies, all organic wastes will be composted, recycling of paper, plastic, aluminum and glass will be undertaken and the green areas around the education centre will be replanted with indigenous species of plants, trees and shrubs to attract the birds and insects indigenous to the area. This education centre will serve as a prototype for the construction of other buildings by the project team, it may well serve as an inspiration for people within the organisation to retrofit or build using ecological design principles.



## Chapter Six – Detailed Interventions

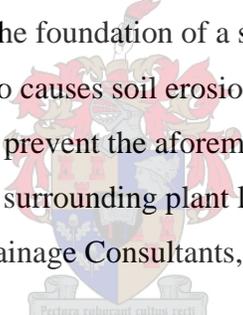
This chapter will concentrate on the detailed interventions chosen in the construction of phase one (high school) of the education centre.

### 6.1. Vastu Design

The design requirements have been sent to Dr Sthapati and two months later the final plans were sent back to South Africa (see plans attached). Using all of the principles of Vastushastra down to minute detail which includes the size of the doors and windows Dr Sthapati has designed the main school building, a shrine to honour Sri Sathya Sai Baba and a multi-purpose hall which will be included in phase two of the project.

### 6.2. Exterior Drainage

Water that does not drain into the soil becomes surface and sub-surface water which could have detrimental impacts to the foundation of a structure as well as the surrounding plant life. Surface water run-off also causes soil erosion. It is therefore important to have a well-designed drainage system to prevent the aforementioned problems from negatively impacting on a construction and its surrounding plant life. Some common drainage problems are cited below (NDS Drainage Consultants, 2006).



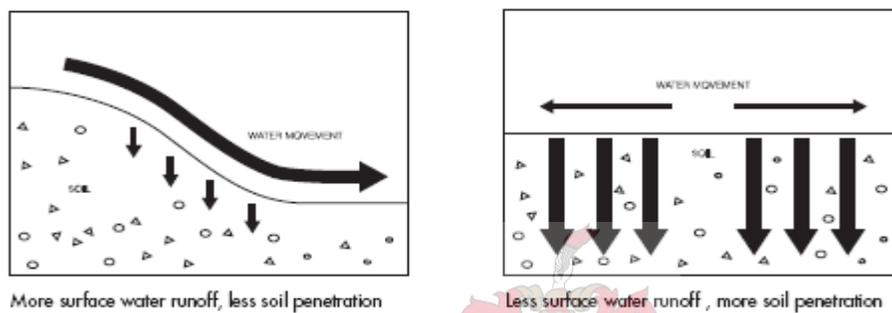
**Table 8: Common Drainage Problems and Solutions**

<b>Common Drainage Problems and Solutions</b>	
<b>Problems</b>	<b>Solutions</b>
Down spouts from gutters empty near foundations	← → Tie down spouts into a drainage system
Water seeping through foundation walls	← → Surface and subsurface drainage system
Standing water in low spots of yard	← → Surface drains
Standing water in contoured landscape	← → Surface drains
Driveway slopes into garage	← → Install channel drain in front of garage
Patio slopes towards building	← → Install channel drain next to building
Retaining walls	← → Weep holes, french drains, and surface drains
Soggy flat turf areas	← → French drains

**Source: (NDS Drainage Consultants, 2006)**

As mentioned earlier the land of the proposed construction gently slopes to the North, which is ideal for Vastushastra but could create problems around drainage and irrigation. Although the gradient of the slope is gentle which would mean more absorption and less surface run off as can be seen from the diagrams below (figure 2), the project team has decided to take a very conservative and risk averse view of putting in a drainage system.

**Figure 2: Influence of the slope of Land on drainage**



Influence of slope

**Source: (NDS Drainage Consultants, 2006)**

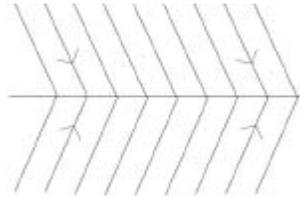
Luke Boshier has designed a sub-surface drainage system (refer to figure 3 on the next page) using the below mentioned parameters:

1. He first analyzed the topography, checking where the water is coming onto the site.
2. He also checked the topography for surface run-off and percolation and possible means of disposal, which was a man-made dam or lake at the North-East corner of the property (again ideal for Vastushastra).

“The major components of a subsurface drainage system are mains, submains, laterals and drainage outlets. The laterals collect the free water from the soil and carry it to the submains and mains. These in turn, conduct the water to the drainage outlet. The spacing of drainage lines depend on the texture of the soil to be drained. Sandy soils permit more

rapid movement of water than do heavy clay soils, therefore lines may be spaced farther apart and deeper in sandy soils than in clay soils” (NDS Drainage Consultants, 2006).

**Figure 3: Fishbone designed drainage system**



**Source: (NDS Drainage Consultants, 2006)**

The above mentioned wishbone design will be adopted. The council for Geosciences and a qualified structural engineer will be consulted with Luke Boshier for final design and layout.

### **6.3. Brick**

Hydraform bricks are dry-stacked hydraulically-compressed earth bricks with a seven percent cement stabilizer (figure 4 on next page). Compressed earth bricks have been used for centuries in the construction of various dwellings. Because it is a material close at hand, underfoot actually, the cost of producing the material and transporting it is minimal. The manufacturing cost of producing one brick is R0.95. The advantages of unbaked earth walls can be attributed to the following as per (Henry Fagan & Partners, 2005) cited in Jobanputra (2005: appendix 3:5):

- Walls can more easily accommodate movements without cracking.
- Potential cost savings. The manufacturing cost of producing one brick is R0.95. One Hydraform brick is equivalent to two and a half normal sized bricks. A good quality brick can cost as much as R1.80 per brick.
- Bricks and walls can be built using labour and materials.
- Fireproof and insect resistant.
- Longevity and low maintenance.
- Better air quality inside the room, by moderating the air moisture content.
- Unbaked earth walls provide better insulation than most other walls.

- Heat sink effect, absorbing heat during the day and heating the inside air at night.
- Using earth walls does not contribute to the pollution of the environment caused by the firing of clay bricks.
- Built on-site reducing the energy of industrial manufacturing and transportation.
- Non toxic.

**Figure 4: Manual hand press and finished compress block**



**Source: (Hydraform, 2006)**

The Hydraform brick is an authorized building material by the National Home Builders Registration Council (NHBRC). The board of management has opted to purchase four manual presses from Hydraform (figure 4 above). This will enable the volunteers to manufacture 1600 bricks per day. Project team members have secured sand from nearby construction sites. Water is available on site from a borehole. The only cost involved is the cement which is mixed into each batch on a seven to one ratio. The manufacturing cost of producing one brick is R0.95.

The technology fulfills all of the design requirements of the users as it has zero levels of toxicity, contributing to the improvement or maintenance of a good level of air quality inside the classrooms. The need for artificial heating in winter and artificial cooling in summer will be greatly reduced or even eliminated due to the inherent design of the buildings, north orientation of the buildings and the thermal properties of the brick. This will reduce maintenance costs and reduce energy bills. The spiritual energy resonating in

the walls will benefit the teachers and students. The spiritual energy will manifest during the manufacturing process when members of the organisation offering their selfless love in making bricks for the construction of the school. The earth bricks represent an extension of the surrounding earth moulding itself to embrace an institution that is nurturing the future leaders of tomorrow.

#### 6.4. Energy

The approach for the education centre as far as energy consumption is concerned is that passive and renewable technologies will be used as far as possible in mitigation of fossil fuel resource depletion and greenhouse gas emission.

**Table 9: Environmental impacts of electricity consumption in SA**

<b>Resource consumption per kWh of electricity</b>		
Coal	0.5	Kg
Water	1.26	Litre
<b>Emissions per kWh of electricity</b>		
Ash produced	0.14	Kg
Ash emitted into atmosphere	$0.31 \times 10^{-3}$	Kg
SO <sub>2</sub>	$7.91 \times 10^{-3}$	Kg
NO <sub>x</sub>	$3.61 \times 10^{-3}$	Kg
CO <sub>2</sub>	$0.89 \times 10^{-3}$	Kg

**Source: Eskom Annual Report in Morris (2002: 4)**

The technologies that the project team has agreed upon are:

- Solar vacuum tubes powered geysers systems as shown in appendix two will be used to generate hot water. Vacuum tubes placed on the roof draws solar power from the sun thus providing the energy to heat the water for household use (refer to appendix two). With the abundant sunshine in the area it is logical to draw energy from the sun (refer to appendix two). This provides another medium where the teachers and students are linking themselves to nature and spirituality. They will become more aware of the sun's patterns, developing a relationship with the sun due the dependence of the energy source to provide power for the geysers. The relationship with the sun is further enhanced by the orientation of the buildings which will face north allowing the full benefit of the winter sun to be enjoyed whilst reducing the harmful effects of the summer sun by angling overhangs at the correct geometric dimensions creating a sift for the heat and harmful ultraviolet rays (refer to appendix two). North orientation will also allow users to benefit from natural light during the day thereby reducing the need for artificial light (refer to appendix two).
- Gas for cooking or solar powered cookers. This is not the perfect solution but is cleaner technology than electricity. The project team does not envisage that a large amount of cooking will be done on the premises. Gas will be drawn from the biodigester which will be discussed under Sanitation.
- Ceiling insulation, double glazed windows coupled with the thermal properties of the Hydraform brick will assist in maintaining a moderate temperature throughout the year thereby maximizing comfort for the students and teachers (refer to appendix two).
- To further reduce the school's need for coal driven electricity the project team has suggested that sufficient window space be incorporated into the design of the buildings. Windows will allow sufficient natural light into the classrooms during the day in order to eliminate the need for artificial lighting (refer to appendix two and plans attached). The use of blinds (refer to appendix two) and/or overhangs (refer to appendix two) will allow users to control the amount of sunlight coming into the classrooms (see appendix two). Natural light also promotes feelings of

well-being and happiness. Painting the interior of the classrooms with light colours using natural paint will also promote concentration (especially light yellow) and further enhance the positive effect of the natural light (refer to appendix two). The low hanging fruit or quick fixes which are very easy to implement is the use of energy saving light bulbs and lamps and energy efficient appliances. “Although lighting is not necessarily a high power demand, it can account for significant energy consumption if lights are operated for extended periods of time” (Morris, 2002: 18).

Another manner in which energy can be saved in the actual construction process is the purchasing or recycled materials rather than sourcing new materials. “This saves the energy and landfill space embodied in construction materials, which are responsible for 40 percent of all material flows that mainly end up as waste whose disposal are typically 2-5 percent of constructions budgets” (Hawken, Lovins & Hunter, 1999:100). Window panes, doors, furniture items, light fittings are just some of the items that can be purchased from suppliers of pre-used building materials. The project team will set up a procurement function that will undertake intensive research to ascertain the availability, quality and feasibility of various pre-used materials during the entire project cycle.

## **6.5. Biogas Technology: Delivering Ecological Sanitation and Renewable Energy**

### **6.5.1. Introduction**

“Biogas is a low cost form of energy derived from renewable resources: animal dung, human waste and other organic materials. In China, India and Nepal, biogas has been used widely as a source of energy and waste treatment, and as liquid fertiliser for soil enhancement, since the 1950’s. Biogas digestion is a renewable energy technology that ensures a distributed energy production where the energy is produced at the point of consumption or demand. A biogas digester – in which the biogas is produced – also provides an ideal on-site water-borne sanitation system, as well as an integrated organic kitchen and garden waste recycling opportunity” (Boshier, 2006).

### **6.5.2. Biogas: An overview**

As per the writer's discussion with Luke Boshier (2006) the Biogas digesters are airtight containers in which water, organic wastes, animal wastes and/or faeces are acted upon by anaerobic bacteria i.e. those bacteria that thrive in the absence of oxygen. Biogas is formed by bacterial action on the organic matter, with three primary sets of bacteria being involved in the biological breakdown. The final stage of this process is the production of methane and carbon dioxide, which make up 2/3 and 1/3 of the total gas produced, respectively. Small amounts of nitrogen, hydrogen and hydrogen sulphide also occur. One m<sup>3</sup> of biogas will provide a cooking time of at least 2 hours, or 1.5 kWh electrical output. The second useful product is digested slurry with between 60 and 70% reduction of the five-day biochemical oxygen demand (BOD5) compared with the raw materials. The reduction in BOD5 is a measure of how far the biological breakdown of the solids has progressed. Regarding pathogen destruction, there is a vast literature describing the generally observed elimination of around 99% of pathogens arriving in the biogas digester. By coupling the biogas digester to an ecological aerobic process in the form of a wetland and polishing pond virtually 100% of the pathogens are removed to achieve a suitable water quality containing less than 30mg/litre COD.

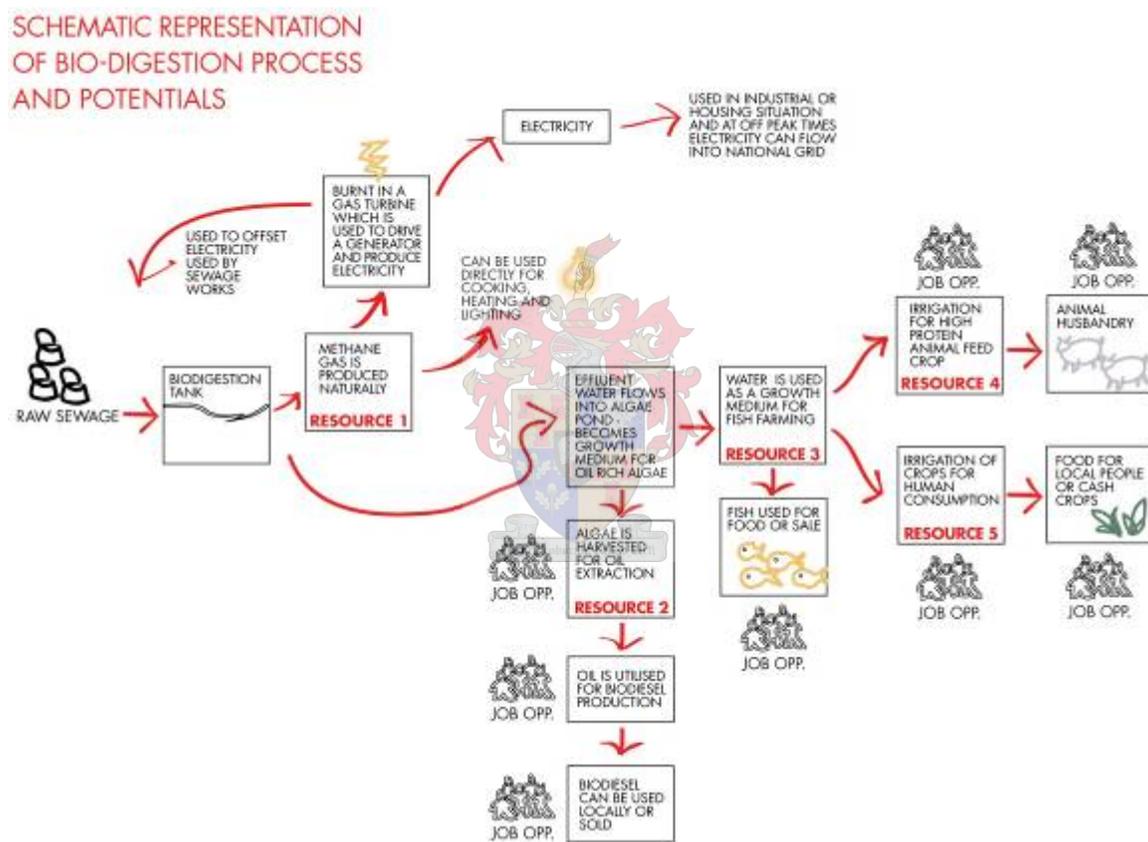
### **6.5.3. Advantages of biogas technology**

Biogas can make an important contribution to the protection and improvement of natural resources and environment:

- Slurry, a residue from the process, is a high-grade fertilizer that can replace expensive mineral fertilizers, in particular nitrogen (refer to figure 5).
- The technology is ideal for effective and productive management of effluent wastes.
- The technology provides an efficient wet sanitary system - that enhances effective waste product disposal.
- It provides an integrated system for waste treatment, energy and fertiliser production (refer to figure 5).
- Use of biogas technology improves the standard of living and can directly contribute to economic and social development of a country (refer to figure 5).

- Biogas systems result in halving of waste solid collection volumes and frequency and landfill disposal costs.
- A biogas digester can be locally produced or built, and locally operated.
- The technology has the potential to permanently employ many thousands of people should its potential be reached in the country.

**Figure 5: Schematic Representation of Bio-Digestion Process and Potentials**



**Source: (Boshier, 2006)**

The school will install a brick and mortar type system. Using the organic waste from the food gardens, soup kitchens and feeding schemes the digester would supply enough gas for the cooking needs of the school and meet some of the heating needs during winter or possibly run a generator for applications in other areas of energy need. The school's

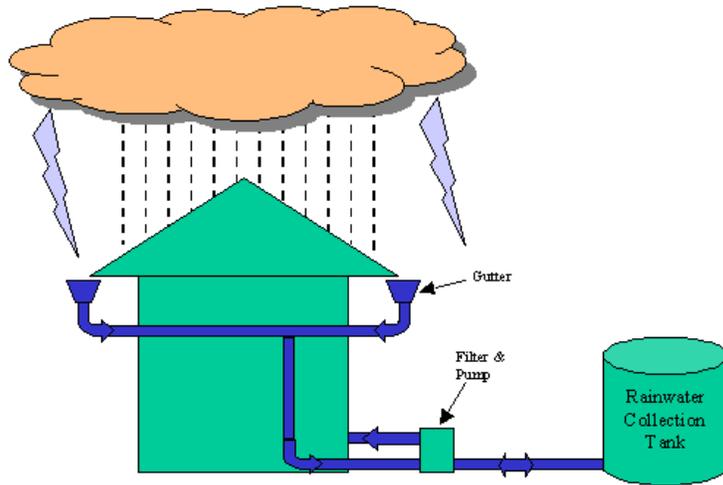
toilets and other black and grey water sources will all feed into the digester. The water discharged is *partially treated*. It can be used for irrigation but it is not free of smell. To remove the smelling components requires an aerobic post treatment. This is best done with a horizontally operating root treatment system. Thus the remaining nutrients in the overflow produce biomass, which can be charged into the digester again. After this second treatment step the water is free of smell. The preconditions for long-term good operation are the good execution of the construction work with absolute gas tightness of the digester and the piping system, and regular feeding of organic matter (unfortunately unavoidable). Another output being the sludge will be used as fertilizer on the school grounds and food gardens. The board is hoping to receive full return on investment in four years from the savings in water consumption, electricity, and other conventional fuel usage.

#### **6.6. Rainwater Harvesting**

The water on the property for the proposed education centre is drawn from a borehole. The construction of the school on the property has placed larger demands on water supply. The need to supplement the water supply is evident. Rain water harvesting can be used to supplement the education centre's water needs. The basic fundamentals of a rainwater harvest system is seen in figure 6 on the next page where rainwater is collected through a system of gutters, directed towards a storage tank through a system of pipes, purified through a filtering process and eventually stored for later use. The project team would have to look at various issues in order to decide on the best system for the education centre. These issues as per the Intermediate Development Group (2005:8) include:

- Local rainfall data and weather patterns.
- Size of roof which is the collection area.
- User numbers and consumption rates.
- Whether the system will supplement or replace existing water supply.

**Figure 6: Rainwater Harvest system at work**



Rainwater Collection Overview

**Source: (Lakota Water Company, 2005)**

Due to the levels of pollution that is sometimes prevalent in rainwater some treatment would be necessary should the water be used for drinking and cooking purposes. Also the roof surfaces may contain harmful bacteria, animal droppings, twigs and leaves and it will be important to ensure that the first flush water be diverted away from the storage tank.

### **6.7 Cost Estimate of Phase One**

A work in progress cost estimate has been provided on the next two pages.

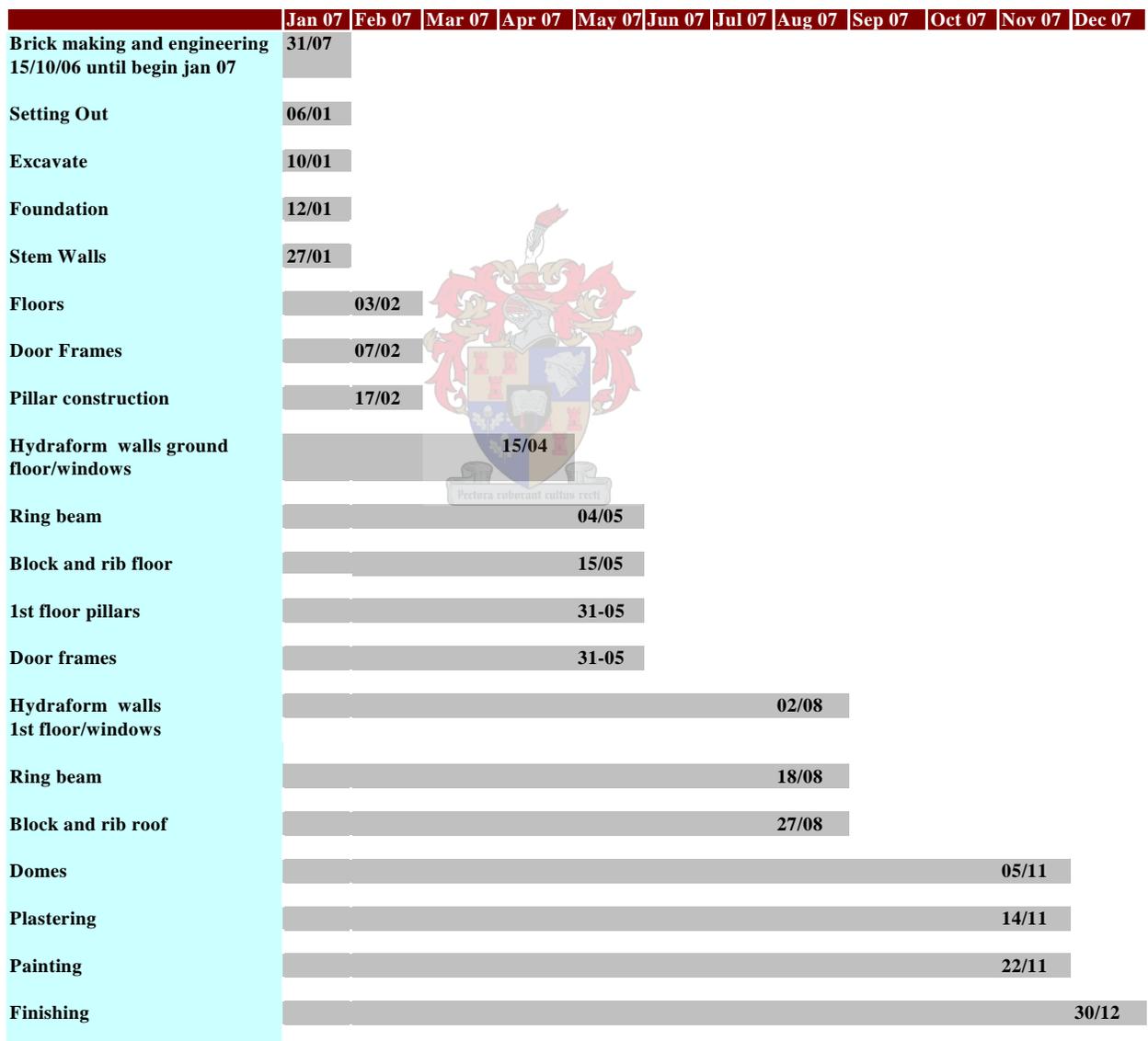
ITEM	Unit	Rate	Labour	Time	Quantity	Price	Notes
Storage	month	0	1	0	1	0	
Toilet	week	0	1	0	1	0	
Clear Site	each					0	
Set Out	each					0	
Excavate footings	hrs	250		24		6000	Assume 24hrs JCB hire, cut/fill balance, 1m deepaverage
Concrete footings 900x350	m3	730	1	1	223.65	163264.5	
Foundation brickwork	m	1	1	1	18500	18500	
Backfill	m					0	
DPC School	m2	8.333333	1	1	300	2500	R250 per roll
DPC Patio	m2					0	included above
Concrete floor 15 Mpa school	m3	730	1	1	220	160600	110 slab on compacted sand
Concrete floor 15 Mpa patio	m3	730	1	1	25	18250	50 slab on compacted slab
Concrete footings internal walls	m2					0	included above
Screed school	m2	250	1	1	480	3000	
Screed patio	m2					0	included above
Brickgrip		0	1	1	0	0	
Building sand	m3	750	1	1	1000	125000	allow 1000 cubic metres
Door + frames exterior		2500	1	1	36	90000	
Door + frame exterior special		3000	1	1	0	0	
Door + frames interior		1000	1	1	0	0	
Patio Doors					0	15000	
En-suite doors	no	2000	1	1	0	0	
External Gate	no				0	3000	
Brickwork external	m2	1	1	1	225000	225000	
Brickwork gables	m2	1	1	1	5000	5000	
Brickwork internal	m2	1.33	1	1	0	0	
Ringbeam	m	1120	1	1	56	62720	
Concrete lintels 1.8m						0	
Plastering external		50	1	1	0	0	
Plastering internal (additional)		8	1	1	6000	48000	cement only, painting below
Rib & Block floor		300			2000	600000	
Balcony railings						30000	confirm pricing - budget allowance
Drive way		0			0	1000	
Cement		3000			50	150000	extra over plaster, for brickwork
<b>Roof</b>							
echo floor/roof	m2	300	1	1	2000	600000	
Rafters						0	
Purlins						0	
S/S tie bar						0	
Insulation		0	0	0	0	0	
Stoep roof front						0	
Stoep roof back						0	
Fascia boards						0	confirm
Gutters and downpipes						32000	
Pergolas						0	
<b>Internal Finishes</b>							
Rhino ceiling		0	0	0	0	0	
Cornices		0	0	0	0	0	
Wooden floor		0	0	0	0	0	
Staircase						10000	confirm pricing
Curtain tracks/blinds						3500	
Ballustrading						175000	
post and pillar						0	
<b>Windows</b>							
1500 x 2500		3200	1	1	164	524800	
600x 1750		0	1	1	2	0	
1100x1650		0	1	1	6	0	
900x1200		0	1	1	10	0	
2.1x 1.8 (patio)			1	1	4	0	
glazing						25000	confirm pricing - budget allowance

garage door					0	
<b>Plumbing</b>						
Bath		1	1	0		
Toilet	450	1	1	12	5400	wall mounted
Basin -	0	1	1	1	0	confirm pricing - budget allowance
		1	1	2	0	
		1	1	1	0	
Shower	1800	1	1	8	14400	alum glass cubicle plus rose
Kitchen sink - prep	0	1	1	1	0	
Kitchen sink (double)	0	1	1	1	0	
Internal taps - basins	0	1	1	8	0	
Internal taps - kitchen	0	1	1	2	0	
External taps	0	1	1	1	0	
Geyser	3500			2	7000	tubes
Mains 25mm	220	1	1	103	3776.66667	R220/6m length. Allow extra for hot
Sewer to boundary					1000	
sewer bends & inspection					500	
Grey H2O					0	
Manholes					1000	
Gulley					500	
<b>Floor and Wall covering</b>						
<b>Electrical</b>						
DB installation					5000	
Cabling to boundary					15000	
Meter installation					2500	
Single plugs					0	
Double plugs					8000	
Light points					25000	
Light switches					7000	
Geyser points					0	
Stove point					0	
Telephone point					0	
TV point					0	
light fittings					0	confirm pricing
<b>Carpentry</b>						
<b>Painting</b>						
External walls					3500	
Roof					25000	
Fascia boards					0	
Stoop woodwork					0	
Doors					5000	
Internal walls					0	
Ceilings					12000	
Skirtings					0	
bioldgestion					400000	
drainage					75000	
contingancy					0	
VAT @ 14%					0	included above - check individ prices
Labour costs					3200000	
Supervision costs	220000				220000	
Travelling & Subsistence costs					50000	
Landscaping						
Contingency					1000000	
engineering fees and geoscience	280000				280000	
<b>Fees</b>						
Water meter					2500	
Electricity Meter					3500	
Municipal fees	0			0	32000	
					8501711.2	

## 6.8. Project time line for phase one

From November through to the January the main focus of the project will be to manufacture 180 000 bricks for the actual construction of the project. It is envisaged that construction begin early in February 2007 the latest. Below is the latest time line (subject to change).

**Figure 7: Project Time Line for Phase One**



## 6.9. Benefits of Chosen Interventions

Using the principles of ecological design and prioritizing around a spiritual base the design of the school will address many of the issues listed by {Swilling (2006) in Govindasamy, 2006c:44} so that equity, urban growth and sustainability is sufficiently addressed:

**Water:** Use of low-flow systems in all toilets, showers and faucets and onsite water sanitation systems that recycle water. Rain water harvesting will be used to supplement the education centre's water needs. Recycling of all grey water will be undertaken. It is estimated that the school will reduce their water usage by 40 to 60 percent within the first year and a further 15 percent as more innovative techniques are tested and implemented.

**Sanitation:** The school will use a closed loop sewerage system where all the nutrients and water used in flushing is recycled back into the school for toilet flushing and irrigation purposes. Reduction rates in water usage have been mentioned in the previous point. A biodigester will be used to create biogas that can be used for cooking purposes and the resultant fertilizer can be used in the gardens. The biodigester will also provide cooking gas for the school thereby eliminating the need for LPG or electricity.

**Land and space:** Designed with nature in mind, ecological design principles have been promoted.

**Transport:** Building hostels on the premises will result in less traveling for students.

**Energy:** Passive and renewable technologies will be used such as solar powered geysers, photovoltaics for artificial lighting, CFLs, procurement of energy efficient equipment only. Solar powered pump for the borehole. It is estimated that energy savings from efficient lighting can decrease the lighting load in both ambient and task lighting by 71 percent resulting in a return of between 50 to 80 percent of the initial investment over a period of two years. Correct orientation, thermal insulation and thermal mass from the brick will reduce the need for active heating and cooling by at least 40%.

**Food:** Permaculture principles will be adopted within the school grounds.

**Solid waste:** recycling of all solid waste, adopting a zero waste policy will eliminate waste leaving the site.

**Building materials and design:** The buildings will face north allowing the full benefit of the winter sun to be enjoyed whilst reducing the harmful effects of the summer sun by angling overhangs at the correct geometric dimensions creating a sift for the heat and harmful ultraviolet rays. North orientation will also allow users to benefit from natural light during the day, reducing the need for artificial light. Ceiling insulation and double glazed windows will assist with passive heating and cooling. It is estimated that energy efficient windows can decrease heating costs by up to 40 percent and decrease cooling costs by 32%. Main building source will be compressed unfired brick. Zero toxicity, high thermal properties, no inherent energy, fireproof and insect resistant, manufactured on-site by the community. Energy costs from the aforementioned will be reduced by between 45 to 70 percent.

**Air pollution and CO2 emissions:** the Hydraform brick and use of natural paints and adhesives, using biogas for cooking and recycling black and grey water all drastically reduce CO2 emissions.

**Health:** an in-house clinic will be set up where doctors from within the organisation will undertake monthly medical camps to administer high quality and free medical care to learners and their families.

**Biodiversity and recreational space:** large areas of green and indigenous gardens planted along Permaculture principles with areas for meditation and reflection. The parking area and areas of high traffic will be paved using natural compressed stone and not concrete.

**Child-centred development and learning:** the entire project is centred around the development and nurturing of our future leaders. Human values which include love for the ecosphere makes up 50% of the curriculum.

## Chapter Seven - Conclusion

### 1.1. Research Problem

This report presented the draft project proposal for the design and construction of a high school for the Sri Sathya Sai Organisation using ecological design principles and Vastu architecture.

The report aimed to accomplish the key objectives of the project which were:

### 1.2. Key Objectives of the Project

- Be a worth instrument of Sri Sathya Sai Baba and his teachings.
- Build a school using Ecological design principles to reduce the ecological footprint of the school. Research available technologies and ascertain the practicality of implementing those technologies.
- Build a school using Vastushastra so that the school can heal the community, students and teachers.
- Provide the most conducive environment possible to nurture the future leaders of this country, benefiting them on a spiritual, mental and physical level.

The research, writing and presentation of the document provided a reference and framework towards the realization of the project. This report unpacked the subject of sustainable development in relation to the built environment and highlighted the need for ecological design. Thinking along ecological design principles where the structure is considered an ecosystem is still a very new and strange concept to many people. In the past human structures were part of the local ecosystems where they were constructed, whereas today's modern buildings distant human beings from nature and the surrounding ecosystems. Humanity's link with the earth and the spiritual community is being broken by the ruthless western society based on money and greed.

The report appraised various technologies that could be incorporated into the project and went further to choose those interventions that were deemed best in reaching the objectives of the project and the Sri Sathya Sai Organisation.

The report looked at the state of the world at present in relation to the socio-economic and environmental challenges facing humanity. The research looked at the issues from both an international and national perspective using Europe as a case study for proactive governments taking the leadership role to promote. The report cited the challenges facing local government in trying to achieve sustainable development goals.

The subject of spirituality and sustainability was discussed suggesting that unless human beings return to living their lives along spiritual means (whatever their disposition might be) the world will continue to deteriorate and the goals of a sustainable world will not be met. On the other hand the writer suggests that using spirituality the big challenge of a sustainable world which many believe to be too much of an impossible Utopian dream can be achieved. A very interesting building science linked or integral to ecological design but not really well known is Vastushastra or Vastu architecture. The report highlighted the principles and fundamentals of this ancient science and suggests that this science which links spirituality and sustainability is the missing link many in the built environment science have been searching for.

The Sri Sathya Sai Organisation was also researched and discussed. This was undertaken to provide the reader with the rationale of why the project was commissioned and how the school would be built, maintained and supported (other than economically). Linking spiritual growth to serving humanity selflessly was the message brought forward by the report.

The technical aspects of the report discussed the various technologies presented and discussed. Taking the attributes of the site and other resources into consideration the report suggested various technologies that could be practically and successfully applied to the construction of the project. The underlying intention of the chosen interventions was to reduce the ecological footprint of the school.

This project proposed the construction of an entire education centre along ecological design principles. The decision to build in an ecological manner was not a difficult one to commit to considering the spiritual background of the organisation. People within the organisation consider themselves family and this bode well for ecological design's community building and building with your hands concepts. However the path was and still is frustrating (at most times) as many solutions to questions around the concept design, technologies to be employed and benefits thereof are not readily available. The research and discovery is rewarding though as people reconnect with themselves and nature. The design principles compel people to take cognizance of their natural surrounding, weather patterns, vegetation, climate, topography which in itself rekindles a relationship between people and their environment.

Government's mandate to improve the social and economic welfare of the citizens of South Africa can be better achieved using alternate models like those presented in this proposal. Involving people at the grassroots level, empowering communities to embrace alternate technologies and build for themselves community centres, schools and even houses will in the opinion of the writer create more holistic and successful development models than those currently used, where government officials with their team of consultants drive a top down approach.

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## Appendices

### Appendix One

#### 1.1. The plant earth and Vastushastra

The earth has three different and distinct motions:

1. The earth spins like a top (rotation and precession).
2. The earth travels around the sun (orbital motion).
3. The earth moves through the Milky Way along with other planets of the solar system, around the centre of the universe.

The earth spins around its axis, an imaginary line connecting the North and South Poles. Because of this spinning motion, the sun appears to be moving from the East to the West. The earth tilts by about 23.5 degrees with respect to orbital plane. This tilt and the earth's motion around the sun cause changes in the seasons.

The spin of the earth may be changed by three distinct physical processes:

1. Redistribution of matter on and within the earth (or, in the language of physics, a change in the axial moment of inertia of the earth),
2. An exchange of rotational energy between the earth and the moon (and the sun)
3. An exchange of rotational energy between the solid and fluid parts of the earth.

All these processes act in various combinations to produce observable effects, including the changes in the length of day.

The sun and the earth are bound by mutually interacting force. This force of attraction known as gravitation, acts on all bodies in the universe. The force of gravity varies from place to place on the earth. It is stronger at the poles than at the equator, stronger at the sea levels than at mountain tops. The force of gravitation is of prime importance in the Vastushastra.

We also have to consider the force of magnetism. The magnetism of the earth is similar to the one that is obtained when electricity flows through a coil of wire. The earth's magnetic force is particularly evident in the magnetosphere, a region that is shaped like a doughnut which acts on charged particles like protons and electrons trying to enter the earth's atmosphere from outer space. The magnetic field of the earth is weak, but it provides a shield against cosmic rays. The source of the magnetic field is supposed to be large loops of electric current within the earth. The current is generated by a 'self-exciting type dynamo' resulting from circulation of molten rock in the earth's outer core. Because of the close proximity between the magnetic axis and the rotational axis of the earth, some scientists believe that the 'dynamo' draws its energy from the earth's rotation.

Let us now examine whether we can correlate the motion of the earth, the forces of electromagnetism and gravitation and their macroscopic and microscopic effects on human beings and human dwellings.

1. The three motions of the earth lead to interdependent and dynamic interaction between the various active forces.
2. Gravitation and geomagnetism are the two forces which have direct influence on the animate and inanimate objects on this earth. Gravitation is the force of attraction and repulsion. Some physicists are trying to introduce a short range force of repulsion in mathematics of gravitation force equations in Einstein's theory in relativity to achieve asymmetry of the type evident in Maxwell's equations on electromagnetism.
3. Force of gravitation is represented by exchange of massless particles called gravitons. This concept is similar to exchange of massless photons in electromagnetism and in general, exchange of 'bosons' associated with various energy-field equations in quantum mechanics.
4. Magnetic force lines emanate from the magnetic North pole and terminate in the South pole (these are imaginary lines along the magnetic field).

5. Inclination of the earth at 23.5 degrees to the horizontal, a strong wind from the East to the West and the spin of the earth create a stress concentration in the South-West direction. This direction is also subjected to shock-wave front when the solar wind is stopped by the earth's magnetosphere or the magnetic shield. Thus the South-West is the most unstable zone.
6. The North-East (directionally opposite to the South-West) remains in a comparatively stable state as regards the solar wind and electromagnetic fluctuations.
7. Elementary cosmic particles enter the earth's magnetic field and travel along the geomagnetic force lines to gather at the polar regions of the earth. The primary charged cosmic particles and the secondary radiation particles create stress concentration at the South and South-West directions. Cosmic rays consist mainly of low energy protons and electrons apart from secondary 'shower' of interaction and resonance particles which may include leptons, hadrons, and massless exchange particles generated when the primary charged particles collide with atmospheric atoms and molecules. Elementary cosmic particles get entangled in distorted networks of force lines in the South and South-West sectors and start resonating at dislocated nodal points, giving rise to hazardous radiations which build up in geometric progression. This creates chaotic energy fields in the South and South-West directions.
8. The earth's magnetic field is represented in terms of lines of force diverging from one pole and converging on the other. A charged particle inducted into this field perpendicular to a line of force goes around it in a circle / with a radius directly proportional to the particle's mass and velocity and inversely proportional to the strength of the magnetic field. Protons are massive compared to electrons and travel in larger circles and in the opposite direction to the electrons. All particles go into closely spaced circles near the geomagnetic poles where the magnetic field is stronger as indicated by the converging lines of force. Two-dimensional circles are turned into three-dimensional spirals or helices when particles possess a component of velocity parallel to the line of force in addition to the

perpendicular component. A charged particle starting at the geomagnetic equator spirals poleward around its private line of force, tightening the spiral as it travels. On the reverse trip, it loosens the spiral. Sometimes the earth's converging field acts like a magnetic mirror that reflects particles from pole to pole, especially for high energy protons with velocity parallel to the magnetic line of force substantial relative to the total velocity. The radiation effects of the high energy particles are particularly severe in the Western direction. The other important particle in motion is the East-to-West drift of protons and West-to-East drift of electrons that is added to the North-South spirals. This longitudinal drift is caused by the fact that the strength of the earth's magnetic field varies with height and pushes the spiraling/oscillating particles eastward or westward depending upon their electrical charge.

9. High temperatures or abnormal variations in temperatures create distortion in the force lines of magnetic flux, creating a chaos in the energy field.
10. Transverse of the sun along the East-South-West path creates temperature variations, disturbing the symmetry of magnetic force lines in the South-West region. Once again, a typical imbalance in energy fields is evident in the South and South-West zones, the danger zones in Vastushastra.
11. The sunlight is primarily a visible part of the broad electro-magnetic spectrum and is represented as oscillating electromagnetic field, with energy transfer mediated by massless exchange particles called 'photons'. When a sunbeam strikes any water surface, the light gets polarized in transverse direction. Polarization results in uniform amplitude, harmonic vibrations and a beautifully ordered wave pattern.
12. Apart from the daylight radiation, we also have to consider the night-time cosmic radiation. The night sky is filled with waves of electromagnetic radiation. Characteristic infrared and ultraviolet waves are emitted by constellations and are reflected by our own sun to the surface of the moon and back to the earth. The radiating light consists of low intensity hues of red, green, near-infrared, and near ultraviolet. The human eye is restricted to the narrow visible portion of the

- electromagnetic spectrum. Though not visible to the ordinary human eye, these night radiations do have a definite effect on our lives and on nature around us.
13. Some biophysicists have reported that DNA, the molecule bearing the hereditary information, acts as a laser that has a very particular geometrical structure and properties that allow the molecule to absorb electromagnetic radiation of low energy (infrared region) and emit that radiation, at a shorter wavelength high energy ultraviolet light, which in turn runs the metabolic processes of the cell.
  14. The blurred light in the predawn sky, is characterized by ultraviolet light (close to the visible portion of the spectrum). The flooding of UV light usually occurs at least an hour before trace of dawn. This ultraviolet radiation also known as black light, disturbs the night adaptation of the human eye and thus induces the sensation of darkening. But, this light is considered beneficial to nature and the man in yugic practice. Some Vedic rites are, in fact, performed at predawn hours. It must be noted that Yogashastra and Vastushastra consider the predawn energy field as rejuvenator for the entire nervous system.

It is essential to note that all the above points pertaining to the earth's rotation, gravity, geomagnetism, electromagnetic radiation (visible light, ultraviolet light, infrared light, etc.), solar wind, temperature differentials were thoroughly examined by the seers codifying Vastushastra principles, to arrive at definite solutions for human dwellings in tune with cosmic environment.

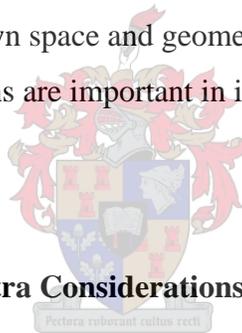
## **1.2. Conservation Laws in Physics and Vastu Principles**

Gravitational interactions can be interpreted in terms of space geometry as implied in Einstein's theory of relativity. On microscopic level, some of the conservation laws also have geometrical origin. These laws include parameters like energy, momentum, angular momentum, centre of mass, reflection of space axes and reflection of time.

1. The law of conservation of energy is applicable to all elementary particle interactions, and its physical origin can be traced to the concept of homogeneity of time.

2. The law of conservation of momentum holds good in all particle interactions, and owes its physical origin to the concept of homogeneity of space.
3. The law of conservation of angular momentum is followed in all the elementary particle interactions and is valid because of isotropy of space.
4. The centre of mass remains unchanged because of equivalence of inertial reference frames.
5. The law of reflection of space axes originates in the concept of ambidextrous symmetry of space and is conserved in most of the particle interactions.
6. The law of reflection of time is conserved in almost all the elementary particle interactions due to the observed symmetry with respect to the change in the sign of time.

Since any 'Vastu' must have its own space and geometry, the above conservation laws along with gravitational interactions are important in interpreting Vastushastra in terms of modern science.



### **1.3. Cosmic Rays and Vastushastra Considerations**

The term 'cosmic rays' applies to high energy stable microparticles, protons, alpha particles, etc., with energies from 10 MeV to 100,000 MeV and higher that fill the cosmic space. The cosmic rays have to penetrate a thick layer of the earth's atmosphere and undergo complex chain of transmutations before reaching the earth. As such, the radiation reaching the earth (secondary cosmic radiation) is vastly different from the one existing in the outer space (primary cosmic radiation). In the vicinity of the earth, the primary cosmic radiation consists of galaxial cosmic radiation by unidentified remote stellar objects and of solar cosmic radiation.

The cosmic radiation in the region of the solar systems remains isotropic and constant in time. The particles in primary cosmic rays consist of:

- protons, deuterons and tritons;

- alpha particles, nuclei of helium and their isotopes;
- light nuclei like lithium, beryllium and boron;
- medium nuclei like carbon, oxygen, nitrogen, fluorine;
- heavy nuclei;
- very heavy nuclei.

In the primary cosmic rays, there is an abundance of protons, alpha-particles and light nuclei compared to other groups. Electron flux constitutes 1.5 per cent of the total flux of cosmic particles with their positrons contributing a negligible 0.3 per cent.

The earth's magnetic field prevents particles with relatively small energies from entering the atmosphere. For example, the minimum momentum a proton must have to enter the atmosphere at the equator is 15 GeV per second, while at the magnetic pole the same particle can enter the atmosphere with a minimum momentum. In general, the intensity of primary cosmic radiation depends on the geomagnetic latitude (latitude effect). The earth's magnetic field also prohibits certain directions of entrance of particles into the atmosphere. Positively charged particles cannot enter the atmosphere at certain angles (Stermers's forbidden cone) to the horizon. It is experimentally found that the intensity of cosmic radiation depends on the orientation of the detector with respect to the points of the compass (azimuthal effect). This effect is also known as the 'East-West Asymmetry Effect'. Without going into the mathematics of the process, we can say that it provides the proof that primary cosmic radiation consists of positively charged particles and that maximum flux of particles enters the atmosphere from the 'West' direction.

It is really amazing that Vastushastra also terms the West as one of the evil directions along with the South and the South-West. Vastushastra prescribes certain procedures for avoiding ill effects of deficiencies in the West direction. A deeper analysis of these particles indicate a definite methodology to offer protection against radiation from the West direction.

#### 1.4. Dynamic Balance and Geometric Symmetry

According to the ancient Indian philosophy and theology, the square embodies the perfect, fundamental form. Both the construction of the altars and the architecture of temples are based on the square as the starting point. All other shapes play a secondary role. The circle, for example, represents a state of flux, the expanding energy from its centre evolving its shape, ultimately culminating in the square. The square on the other hand, symbolizes order, stability and the final state of evolving life. It is perfection beyond life and death. It is also postulated that the essence of the square is retained by any mandala as long as the area is kept unaltered.

Vastushastra systematically codified these ideas so that the entire human race could utilize practically the knowledge contained therein without actually having to measure and study the minute effects of cosmic forces at work.

As discussed in relation to concepts of nabhi and brahmasthal in this book, nature displays intricate patterns with perfect order and symmetry in various animate and inanimate objects. In both, organic and inorganic systems, forces acting from within, often in combination with environmental factors decide the different classes of regular shapes these systems will evolve into. Curves and surfaces, conceived and studied purely from a mathematical interest, find their expression in a variety of exquisite natural specimens. Growth of a crystal is mediated by evolving a helix to form beautiful symmetrical geometrical shapes. Organic growth by accumulation of matter as in the case of horns, tusks, and shells follow the equiangular or logarithmic spiral pattern. Here the requirement imposed by nature is that, each successive increment of growth be self-similar to its predecessor in shape and relative positioning except that it is a magnified version of the latter. And the mathematical curve, logarithmic spiral, is the most suitable form for this purpose.

Formation of geometric structures in nature, in general follows extremisation principles, i.e., minimization or maximization of certain factors in natural processes. Some examples which can easily be verified are:

- Law of reflection of light – light ray taking the shortest path in its passage between two points,
- Fermat's principle pointing towards minimization of time of passage of light between two points located in two different media,
- Honeycomb structure with its hexagonal symmetry in all planes to evolve into a configuration requiring least quantity of material for construction,
- Soap bubbles taking shape to minimize the work done against the force of surface tension, or to evolve into surfaces of minimal area with specified boundaries, and
- Geodesic structure having a curve along which the distance between two neighbouring points is the least.

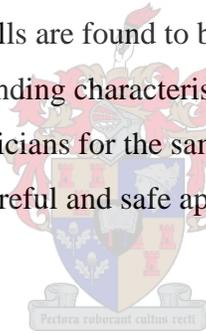
All of the above principles, in one way or the other, are reflected in the science of Vastu. Shapes like pentagon, octagon, and circle do represent a geometric symmetry, but not a dynamic symmetry or dynamic balance. On the basis of orientation of North-South magnetic axis, these figures do not represent balanced shapes. As against this, squares and rectangles match their axes with geo-magnetic axis. Hence, one can definitely say that squares and rectangles represent dynamically balanced figures and shapes. As explained in adjoining figures, force-lines of gravitation and magnetism do not form any zigzag or cross patterns in squares and rectangles. The flow of elementary particles through such figures will hardly intersect the network of force-lines. This will lead to a healthy, good and salubrious cosmic environment.

There is logic in preference for the square shape in Vastushastra. In essence, a square does justice to the virtues and qualities of all the eight directions. The square embodies the Prithvi tatva (earth element) which in turn symbolizes shabda (speech), sparsh (touch), roop (shape), rasa (taste), and gandha (smell), the entities catalysts of worldly pleasures. Vastushastra provides the owner of an abode not only peace and tranquility of mind, but looks after his bodily comforts also.

Rectangles with the minor axis along the East-West direction and major axis along the North-South will have the least lateral perimeter exposure to the sun, resulting in cooler and shadow sections, whereas in the reverse case where the minor axis is along the North-South direction, a very large perimeter gets exposed to the sun which is objectionable in Vastushastra.

Any excessively high temperature characteristics create disturbance in magnetic force lines, imparting them with random zigzag pathways leading to cosmic hazards. This is the reason why the audumber family trees which are known for heavy absorption of water and soil, are recommended for the South direction which normally is a high temperature zone.

In old structures, the South side walls are found to be thick and wide, and their joints filled with lead plates. It has outstanding characteristics to resist radiation effects. Lead is also used in aprons for X-ray technicians for the same reason. Indeed, the ancient construction techniques reflect a careful and safe approach brought about by deep thinking.



Extracted from Sahasrabudhe & Mahatme (1999).

## Appendix Two

### 2.1. Passive Solar Design Introduction

Solar energy is a radiant heat source that causes natural processes upon which all life depends. Some of the natural processes can be managed through building design in a manner that helps heat and cool the building. The basic natural processes that are used in passive solar energy are the thermal energy flows associated with radiation, conduction, and natural convection. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. Additionally, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a home.

Passive solar energy means that mechanical means are not employed to utilize solar energy.

#### 2.1.1 Passive solar systems rules of thumb:

- The building should be elongated on an east-west axis.
- The building's north face should receive sunlight between the hours of 9:00 A.M. and 3:00 P.M. (sun time) during the heating season.
- Interior spaces requiring the most light and heating and cooling should be along the north face of the building. Less used spaces should be located on the south.
- An open floor plan optimizes passive system operation.
- Use shading to prevent summer sun entering the interior.

### 2.2 Passive Solar Heating

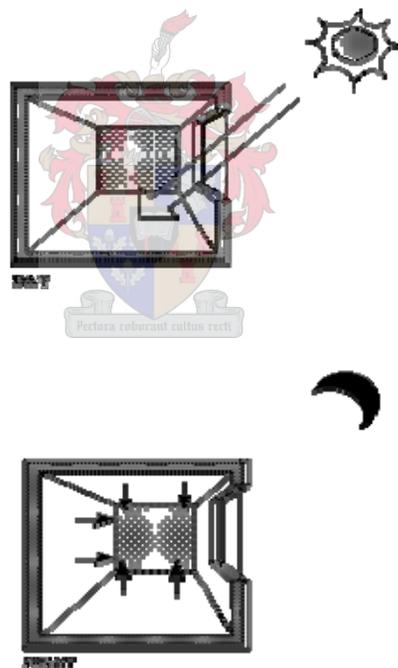
2.2.1. Two primary elements of passive solar heating are required:

- North facing glass
- Thermal mass to absorb, store, and distribute heat

There are three approaches to passive systems - direct gain, indirect gain, and isolated gain. The goal of all passive solar heating systems is to capture the sun's heat within the building's elements and release that heat during periods when the sun is not shining. At the same time that the building's elements (or materials) is absorbing heat for later use, solar heat is available for keeping the space comfortable (not overheated).

### 2.2.2. Direct Gain

In this system, the actual living space is a solar collector, heat absorber and distribution system. North facing glass admits solar energy into the house where it strikes directly and indirectly thermal mass materials in the house such as masonry floors and walls. The direct gain system will utilize 60 - 75% of the sun's energy striking the windows.



**Figure 1**

**Thermal mass in the interior absorbs the sunlight and radiates the heat at night**

In a direct gain system, the thermal mass floors and walls are functional parts of the house. It is also possible to use water containers inside the house to store heat. However, it is more difficult to integrate water storage containers in the design of the house.

The thermal mass will temper the intensity of the heat during the day by absorbing the heat. At night, the thermal mass radiates heat into the living space.

### **2.2.1 Direct gain system rules of thumb**

- A heat load analysis of the house should be conducted.
- Do not exceed 6 inches of thickness in thermal mass materials.
- Do not cover thermal mass floors with wall to wall carpeting; keep as bare as functionally and aesthetically possible.
- Use a medium dark color for masonry floors; use light colors for other lightweight walls; thermal mass walls can be any color.
- For every square foot of north glass, use 70Kg of masonry or 10 litres of water for thermal mass.
- Fill the cavities of any concrete block used as thermal storage with concrete.
- Use thermal mass at less thickness throughout the living space rather than a concentrated area of thicker mass.
- The surface area of mass exposed to direct sunlight should be 9 times the area of the glazing.

Sun tempering is the use of direct gain without added thermal mass. For most homes, multiply the house m<sup>2</sup> by 0.08 to determine the amount of north facing glass for sun tempering.

### **2.3 Indirect Gain**

In an indirect gain system, thermal mass is located between the sun and the living space. The thermal mass absorbs the sunlight that strikes it and transfers it to the living space by

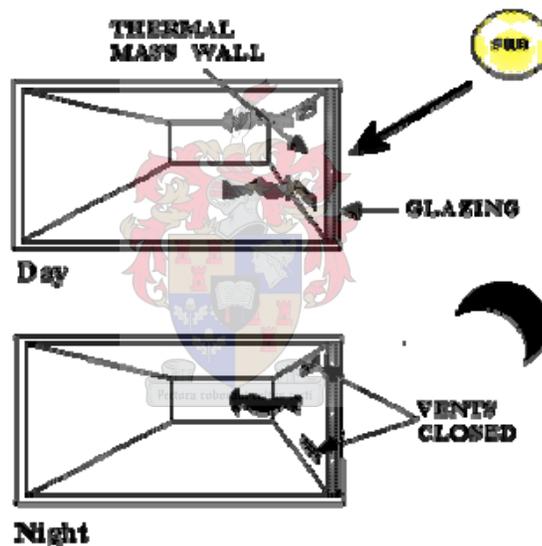
conduction. The indirect gain system will utilize 30 - 45% of the sun's energy striking the glass adjoining the thermal mass.

There are two types of indirect gain systems:

- Thermal storage wall systems (Trombe Walls)
- Roof pond systems

### 2.3.1 Thermal storage wall systems

The thermal mass is located immediately behind north-facing glass in this system.



**Figure 2: Thermal Mass Wall or Trombe Wall Day and Night Operation**

Operable vents at the top and bottom of a thermal storage wall permit heat to convect from between the wall and the glass into the living space. When the vents are closed at night radiant heat from the wall heats the living space.

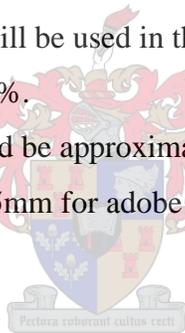
### 2.3.2 Roof pond systems

Six to twelve inches of water are contained on a flat roof. This system is best for cooling in low humidity climates but can be modified to work in high humidity climates. Water is

usually stored in large plastic or fiberglass containers covered by glazing and the space below is warmed by radiant heat from the warm water above. These require somewhat elaborate drainage systems, movable insulation to cover and uncover the water at appropriate times, and a structural system to support up to 65 kg/m<sup>2</sup> dead load.

### 2.3.3 Indirect gain system rules of thumb for thermal storage walls

- The exterior of the mass wall (toward the sun) should be a dark color.
- Use a minimum space of 100mm between the thermal mass wall and the glass.
- Vents used in a thermal mass wall must be closed at night.
- A well insulated home (7-9 BTU/day-sq. m.-degree C) will require approximately 0.20 square meter of thermal mass wall per square meter of floor area or 0.15 square meter of water wall.
- If movable night insulation will be used in the thermal wall system, reduce the thermal mass wall area by 15%.
- Thermal wall thickness should be approximately 240-300 mm for brick, 360-425mm for concrete, 175-225mm for adobe or other earth material and at least 125mm for water.



### 2.4 Isolated Gain

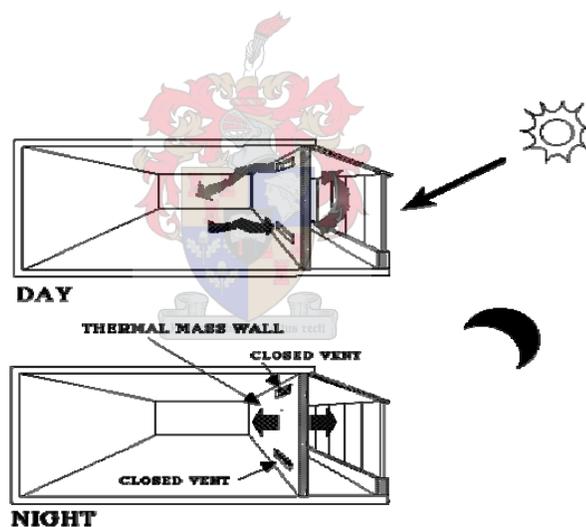
An isolated gain system has its integral parts separate from the main living area of a house. Examples are a sunroom and a convective loop through an air collector to a storage system in the house. The ability to isolate the system from the primary living areas is the point of distinction for this type of system.

The isolated gain system will utilize 15 - 30% of the sunlight striking the glazing toward heating the adjoining living areas. Solar energy is also retained in the sunroom itself.

Sunrooms (or solar greenhouses) employ a combination of direct gain and indirect gain system features. Sunlight entering the sunroom is retained in the thermal mass and air of the room. Sunlight is brought into the house by means of conduction through a shared

mass wall in the rear of the sunroom, or by vents that permit the air between the sunroom and living space to be exchanged by convection.

The use of a north facing air collector to naturally convect air into a storage area is a variation on the active solar system air collector. These are passive collectors. Convective air collectors are located lower than the storage area so that the heated air generated in the collector naturally rises into the storage area and is replaced by return air from the lower cooler section of the storage area. Heat can be released from the storage area either by opening vents that access the storage by mechanical means (fans), or by conduction if the storage is built into the house.



**Figure 3: Day and Night Operation of a Sunroom Isolated Gain System**

The sunroom has some advantages as an isolated gain approach in that it can provide additional usable space to the house and plants can be grown in it quite effectively.

The convective air collector by comparison becomes more complex in trying to achieve additional functions from the system. This is a drawback in this area where space heating is less of a concern than in colder regions where the system would be used longer. It is best to use a system that provides more than one function if the system is not an integral

part of the building. The sunroom approach will be emphasized in this information since it can provide multiple functions.

### **2.4.1 Sunrooms**

Sunrooms can feature sloped and/or overhead glass, but is not recommended for the Austin area. A sunroom will function adequately without overhead or sloped glazing. Due to long hot summers in this area, it is important to use adequate ventilation to let the heat out. Sloped or overhead glazing is also a maintenance concern. Due to the intensity of weather conditions for glazing facing the full .i.ventilation: passive design and brunt of the sun and rain, seals between the gazing panels need to be of extremely high material and installation quality.

A thermal wall on the back of the sunroom against the living space will function like the indirect gain thermal mass wall. With a thermal wall in the sunroom, the extra heat during the day can be brought into the living space via high and low vents like in the indirect gain thermal wall.

More elaborate uses of the heated air generated in the sunspace can be designed into this system, such as transferring the hot air into thermal mass located in another part of the house.

### **2.4.2 Isolated Gain rules of thumb for sunrooms**

- Use a dark color for the thermal wall in a sunspace.
- The thickness of the thermal wall should be 175-225mm for adobe or earth materials, 240-300mm for brick, 360-425mm for (dense) concrete.
- Withdraw excess heat in the sunroom (if not used for warm weather plants) until the room reaches 25 degrees and put the excess heat into thermal mass materials in other parts of the house.
- For a sunroom with a masonry thermal wall, use 0.30 m<sup>2</sup> of north glazing for each m<sup>2</sup> of living space floor area. If a water wall is used between the sunroom

and living space instead of masonry, use 0.20 m<sup>2</sup> of north facing glass for each m<sup>2</sup> of living area.

- Have a ventilation system for summer months.
- If overhead glass is used in a sunroom, use heat reflecting glass and or shading systems in the overhead areas.

### **Solar vacuum tubes**

Solar Vacuum Glass Tubes (SVGT) absorb solar energy, converting it into heat for use in water and air heating. SVGT are also referred to as evacuated tubes, as the space between the two glass layers is evacuated to form a vacuum. SVGT have already been used for years in Germany, Canada, China and the UK and getting more and more popular in South Africa. There are several types of solar tubes in use in the solar industry. The Solarwysse's SK-TF uses the most common "twin-glass tube" also known as the "Sydney Tube". This type of tube is chosen for its reliability, performance and low manufacturing cost.



Each solar tube consists of two glass tubes made from extremely strong borosilicate ("Pyrex") glass. The outer tube is transparent allowing light rays to pass through with minimal reflection. The inner tube is coated with two separate layers of special selective coating (Al-N/Al) which features excellent solar radiation absorption and minimal reflection properties.

The top of the two tubes are fused together and the air contained in the space between the two layers of glass is pumped out while exposing the tube to high temperatures. This "evacuation" of the gasses forms a vacuum, which is an important factor in the performance of the solar tubes.

Why a vacuum? As you would know if you have used a glass lined thermos flask, a vacuum is an excellent insulator. This is important because once the solar tube absorbs the radiation from the sun and converts it to heat, we don't want to lose it!! The vacuum helps to achieve this. The insulation properties are so good that while the inside of the tube may be 150°C, the outer tube is cold to touch. This means that solar tube water heaters can perform well even in cold weather when flat plate collectors perform poorly due to heat loss (during high Delta-T conditions).

In order to maintain the vacuum between the two glass layers, a barium getter is used (the same as in television tubes). During manufacture of the solar tube this getter is exposed to high temperatures which causes the bottom of the evacuated tube to be coated with a pure layer of barium. This barium layer actively absorbs any CO, CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>O and H<sub>2</sub> out-gassed from the solar tube during storage and operation, thus helping to maintaining the vacuum. The barium layer also provides a clear visual indicator of the vacuum status. The silver coloured barium layer will turn white if the vacuum is ever lost. This makes it easy to determine whether or not a tube is in good condition.

Extracted from Boshier (2006).

## Appendix Three

### Auroville – A Case Study

#### The Mother



#### Early years

Mirra Alfassa (Paris 21.2.1878 - Pondicherry 17.11.73) was born as the second child of an Egyptian mother and a Turkish father, a few months after her parents had settled in France. An extraordinarily gifted child, who became an accomplished painter and musician, she had many inner experiences from early childhood on. In her twenties she studied occultism in Algeria with Max Theon and his English wife Alma, who was a highly developed medium. After her return to Paris, the Mother worked with several different groups of spiritual seekers

#### Meeting Sri Aurobindo

She first heard of Sri Aurobindo from her friend Alexandra David-Neel, who had visited him in Pondicherry in 1912; and in 1914, along with her second husband Paul Richard, she was able to travel to Pondicherry and meet him in person. There, she immediately

recognised him as a mentor she had encountered in earlier visions, and knew that her future work was at his side. Although she had to leave India after the outbreak of the First World War, first returning to France, and then accompanying Richard to an official post in Japan, in April 1920 she returned to join Sri Aurobindo in Pondicherry and never left again. Sri Aurobindo recognised in her an embodiment of the dynamic expressive aspect of evolutionary, creative Force, in India traditionally known and approached as the 'Supreme Mother'.

### **Sri Aurobindo Ashram and Auroville**

It was the Mother, as Sri Aurobindo's 'Shakti', who organised the growing group of followers around him into the Sri Aurobindo Ashram from November 1926 onwards, and who in 1952, after his passing in 1950, created the Sri Aurobindo International Centre of Education to fulfill his wish to provide a new kind of education for Indian youth. In 1968 she founded the international township project of Auroville as a yet wider field for practical attempts to implement Sri Aurobindo's vision of new forms of individual and collective life, preparing the way towards a brighter future for the whole earth.

### **Consciousness beyond Mind**

Both Sri Aurobindo and The Mother worked all their lives for the manifestation of a mode of consciousness beyond mind, which Sri Aurobindo named "Supermind" or "The Supramental". The full expression of this consciousness on earth would result not only in a new species, as far beyond Man as humanity is beyond the animals, but also in a modification of the whole terrestrial creation, even more complete than the change brought about by the entrance on the world scene of the human race.

Between humanity and the fully Supramental species there would have to be one or several transitional steps, represented by transitional beings, born in the human way, but able to contact and express the higher consciousness. These transitional beings would prepare the way for the advent of the Supramental Race by establishing suitable conditions.

## **Brief Overview of Auroville**

### **What is Auroville?**

Auroville is a universal township in the making for a population of up to 50,000 people from around the world.

### **How did Auroville begin?**

The concept of Auroville - an ideal township devoted to an experiment in human unity - came to the Mother as early as the 1930s. In the mid 1960s the Sri Aurobindo Society in Pondicherry proposed to Her that such a township should be started. She gave her blessings. The concept was then put before the Govt. of India, who gave their backing and took it to the General Assembly of UNESCO. In 1966 UNESCO passed a unanimous resolution commending it as a project of importance to the future of humanity, thereby giving their full encouragement.



### **Why Auroville?**

The purpose of Auroville is to realise human unity – in diversity. Today Auroville is recognised as the first and only internationally endorsed ongoing experiment in human unity and transformation of consciousness, also concerned with - and practically researching into - sustainable living and the future cultural, environmental, social and spiritual needs of mankind.

### **When did Auroville start?**

On 28th February 1968 some 5,000 people assembled near the banyan tree at the centre of the future township for an inauguration ceremony attended by representatives of 124 nations, including all the States of India. The representatives brought with them some soil from their homeland, to be mixed in a white marble- clad, lotus-shaped urn, now sited at the focal point of the Amphitheatre. At the same time the Mother gave Auroville its 4-point Charter.

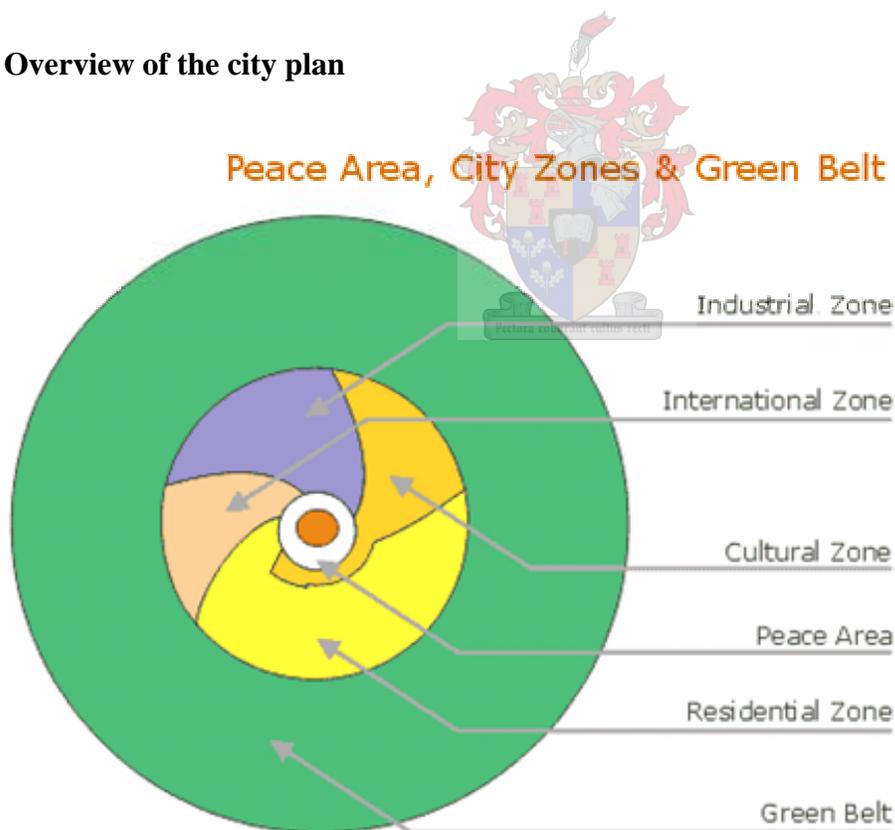
## Where is Auroville?

Auroville is located in south India, mostly in the State of Tamil Nadu (some parts are in the State of Pondicherry), a few kilometres inland from the Coromandel Coast, approx 160 kms south of Chennai (previously Madras) and 10 kms north of the town of Pondicherry.

## Who are the Aurovilians?

They come from some 35 nations, from all age groups (from infancy to over eighty, averaging around 30), from all social classes, backgrounds and cultures, representing humanity as a whole. The population of the township is constantly growing, but currently stands at around 1,700 people, of whom approx one-third are Indian.

## Overview of the city plan



## **Peace Area**

At the centre of the township lies the Peace Area, comprising the Matrimandir and its gardens, the amphitheatre with the Urn of Human Unity that contains the soil of 121 nations and 23 Indian states, and a lake to help create an atmosphere of calm and serenity and to serve as a groundwater recharge area.

## **Industrial Zone**

A 109-hectare area to the north of the Peace Area, the Industrial Zone, a zone for "green" industries, is focused on Auroville's efforts towards a self-supporting township. It will contain small and medium-scale industries, training centres, arts and crafts, and the city's administration.

## **Residential Zone**

The largest of the four city zones, comprising of 189 hectares, the Residential Zone is bordered by parks on the north, south and west. Main access to the zone will be through the crown road with further traffic distribution via five radial roads that divide the zone into sectors of increasing densities. This zone wants to provide a well-adjusted habitat between individual and collective living. 55% of the area will be green and only 45% built surface, thereby creating an urban density balanced by nature.

## **International Zone**

The International Zone, a zone of 74 hectares to the west of the Peace Area, will host national and cultural pavilions, grouped by continents. Its central focus is to create a living demonstration of human unity in diversity through the expression of the genius and contribution of each nation to humanity

## **Cultural Zone**

Planned on a 93-hectare area, situated to the east of the Peace Area, the Cultural Zone will be a site for applied research in education and artistic expression. Facilities for cultural, educational, art and sports activities will be located in this zone.

## **Green Belt**

The city area with a radius of 1.25 km. will be surrounded by a Green Belt of 1.25 km width. As a zone for organic farms, dairies, orchards, forests, and wildlife areas, this belt will act as a barrier against urban encroachment, provide a variety of habitats for wildlife, and serve as a source for food, timber, medicines etc. and as a place for recreation.

Presently an area of 405 hectares, the Green Belt - though incomplete - stands as an example of successful transformation of wasteland into a vibrant eco-system. Its further planned extension with an additional 800 hectares will make it into a remarkable demonstration site for soil and water conservation, ground water recharge, and environmental restoration. As lungs for the entire township, it will complete the healing process that Auroville started several decades ago.

Pectora cuberant cultus recti



Auroville wants to be the first realisation of human unity based on the teaching of Sri Aurobindo, where men of all countries would be at home. As the world is rapidly changing and groping for new paradigms to re-model itself, so Auroville stands poised at the start of a new millennium, ready to enter a new phase of its development and growth, and aware of a new flowering of the faith in humanity's future that it represents.

### **Projects: Arts & Culture**

Over the past decade, Auroville has developed a multifarious cultural scene that is quite remarkable for a population of just over 1,500 people.

Many outstanding music performers, both from within India and abroad, perform regularly in Auroville. Eminent musicians such as Zakir Hussain, Shiv Kumar Sharma, Pandit Jasraj and Marcus Stockhausen have been giving concerts. Live performances by Auroville residents of western and eastern classical music, as well as of jazz and popular music, and blends of Indian and western music occur frequently. Music education is given for a variety of western and eastern instruments, such as vocals, violin, piano, flute, guitar, tabla and harmonium. Also, an adult's and a children's choir is regularly rehearsing and giving performances.



Numerous artists resident in Auroville have studied in art institutions all over the world. They are exhibiting their works in Auroville as well as in India and in major galleries in Europe. The preferred media are oil, acrylic and watercolors, pastels, pencil and chalk. For sculpture and bas relief works a variety of materials such as terra-cotta, ceramics, plaster, wood, metal, marble and granite are being used.

Auroville is an affiliate member of RES ARTIS, an international network which promotes residential exchange programmes for artists world-wide to do research, work with other artists, and to strengthen international ties and understanding of the diverse cultural heritages that invigorate the human society.

### **Projects: Educational Research**

Auroville's Charter speaks about Auroville as "a place of unending education", thus introducing the concept of a life-long process of development towards a person balanced in body, mind and spirit.

Auroville's educational research endeavours to nurture the child's potential to its highest possible level, and is based on a child-centered approach. A free choice system, allowing the student to increasingly choose his/her own subjects for study, is gradually being introduced, in particular in the more advanced courses. Also, sports and physical education are strongly emphasized for a balanced and healthy growth of the children. Artistic training is an intrinsic part of Auroville's system of education, which encourages the child to develop his/her artistic faculties and sense of beauty.

At present, there are crèches, kindergartens, primary schools and one high school in Auroville, next to 4 day schools and over 15 part-time evening schools for the children of the nearby villages. About 1000 children from the neighbouring villages and from Auroville are benefiting from Auroville's educational programme.

Education in Auroville is administered under the umbrella of the Sri Aurobindo International Institute for Educational Research (SAIIER), an organisation established in 1984 to focus on Auroville's multi-faceted educational and cultural activities for both children and adults.

### **Projects: Environmental Regeneration**

Auroville has gained national and international acclaim for its wasteland reclamation and reforestation work. More than 2,500 acres of near barren and visibly dying land have been transformed into a lush green area. Comprehensive contour bunding and the building of small check dams for soil and water conservation have significantly enhanced the life-support potential of the whole area. Over 2 million forest trees, hedge trees, fruit, and fuel wood trees have been planted.

The Auroville Centre for Ecological Land Use and Rural Development, "Palmyra", has been carrying out soil and water conservation, and reforestation programmes over the last decade on almost 3,000 acres of village land with a total of more than 1.2 million trees having been planted. Palmyra also offers training programmes for farmers, NGOs, and government officers in the field of ecological and sustainable land use.

### **Projects: Handicrafts and Small-Scale Industries**

There are more than 100 commercial units, both large and small, operated by Auroville at present. Their activities are diverse and include handicrafts (such as ready-made garments for adults and children, candle and incense products, embroidery, crochet, quilts, hand painted silk, beadwork, jewellery, postcards, leather work, pottery, paper lampshades, woodwork, etc.), printing and graphic design, food processing, electronics and engineering, computer software, windmill manufacturing, and construction and architectural services.

In terms of its own maintenance, Auroville wishes to become increasingly self-sufficient. Auroville's commercial units have an important role to play in achieving this objective. Besides generating funds to assist the community in maintaining its basic services and infrastructure, the units provide employment and training for the local villagers, enabling them to improve their standard of living and acquire valuable skills. At present, about 5,000 villagers are employed in Auroville.

### **Projects: Health & Healing**

Many systems of primary health care are in use in Auroville, including allopathy, homeopathy, acupuncture, chiropody, podology, massage, chromato-therapy, and others.

The Auroville Health Centre, recognised as a Mini Health Centre by the Tamil Nadu State Government, is equipped with basic medical facilities and staffed by an international team. It serves the Auroville community as well as about 200 patients daily from the villages at its headquarters in Kuilapalayam and its sub-centres. A team of 30 local women trained as village health workers serve in 17 villages, giving first aid, home

cures and basic health education. The Auroville Health Centre also runs a dental care unit, a children's home for pediatric treatment, a medical lab, a pharmacy and a small medicinal plant garden, and offers several preventive health programmes to village women and children.

Under the aegis of The Indian Foundation for Revitalization of Local Health Traditions (FRLHT), Auroville hosts one of the 15 Medicinal Plants Conservation Parks which are being set up in the three South-Indian states of Kerala, Karnataka and Tamil Nadu. The aim of these centres is to revive the local health traditions and the ancient medical systems of India as described in the Ayurveda and its Tamil equivalent, the Siddha. For this purpose, Auroville has established an ethno-medicinal forest area to conserve medicinal plant diversity, an outreach nursery focusing on medicinal plant propagation and distribution, and a Bio-Resources Centre dedicated to education, training and research in the use of locally available medicinal plants in primary health care.

In 1997, a new healing centre complex, "Quiet", near the beach was inaugurated to focus on providing alternative healing therapies. An international homeopathic seminar, led by world-renowned homeopaths from India and UK, marked the beginning of a new chapter in Auroville's endeavour to combine new therapies with conventional health care.

### **Projects: Innovative Building Technologies**

Auroville has gained a considerable knowledge and expertise in the field of innovative, appropriate and cost-effective building technologies, especially earth construction and ferro-cement.

Earth construction uses compressed earth blocks, made with a manual press from local earth mixed with 3-5% cement. The blocks are usually produced on the building site, without polluting the environment or depleting the forests, as no kiln firing is required.

Ferro-cement is a thin cement mortar laid over reinforcing wire mesh, thus employing steel and cement in a highly efficient and cost-effective manner. It is cheap, strong, versatile and long lasting, and the basic techniques are easily acquired, making this

building technology readily accessible to the neighbouring villagers. Ferro-cement doors, roofing channels, water tanks, biogas systems, latrines and other building components are being manufactured in Auroville.

The Auroville Building Centre, which is part of a national network of more than 500 building centres all over India initiated by the Housing and Urban Development Corporation of India (HUDCO), provides regular training programmes for masons, master masons, site supervisors, contractors, engineers, and architects. It also offers consultancy, designs buildings and supervises construction sites using these appropriate, cost-effective building technologies. In 1995 and in 1996, the Auroville Building Centre received via HUDCO the yearly Outstanding Performance Award from the Ministry of Urban Development and Poverty Alleviation for its activities in this field.

### **Projects: Organic Farming**

The development of an ecologically sound agriculture, which excludes the use of pesticides and detrimental chemicals, and the application of agro-forestry techniques are being actively pursued in Auroville. Efforts are being made with the surrounding village farmers to reverse the process of growing cash crops using chemical inputs in the form of fertilisers and poisonous pesticides such as DDT. Alternative biodegradable pesticides are being developed and marketed as part of an overall attempt to re-introduce sustainable agricultural practices throughout the bioregion.

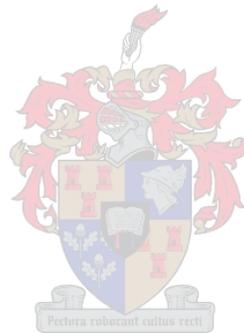
Training programmes are regularly organised for farmers from the surrounding area. On the national level, Auroville has participated in many Indian conferences on organic farming, and hosted in April 1995 an All-India seminar on organic farming under the name "ARISE: Agricultural Renewal in India for a Sustainable Environment".

### **Projects: Renewable Energy**

Concerned with the ecological implications of energy consumption, Aurovilians have been experimenting with the use of renewable energy sources from the beginning. The major forms of renewable energy utilised in Auroville are solar, wind and biomass. At

present, more than 1,200 photovoltaic (PV) panels are in use for electricity and water supply. Some 30 windmills of various designs are in operation for pumping water, and specially designed ferro-cement biogas systems process animal and vegetable waste to produce methane gas and organic fertilisers. Today, Auroville has become a major testing ground for renewable energy sources in India.

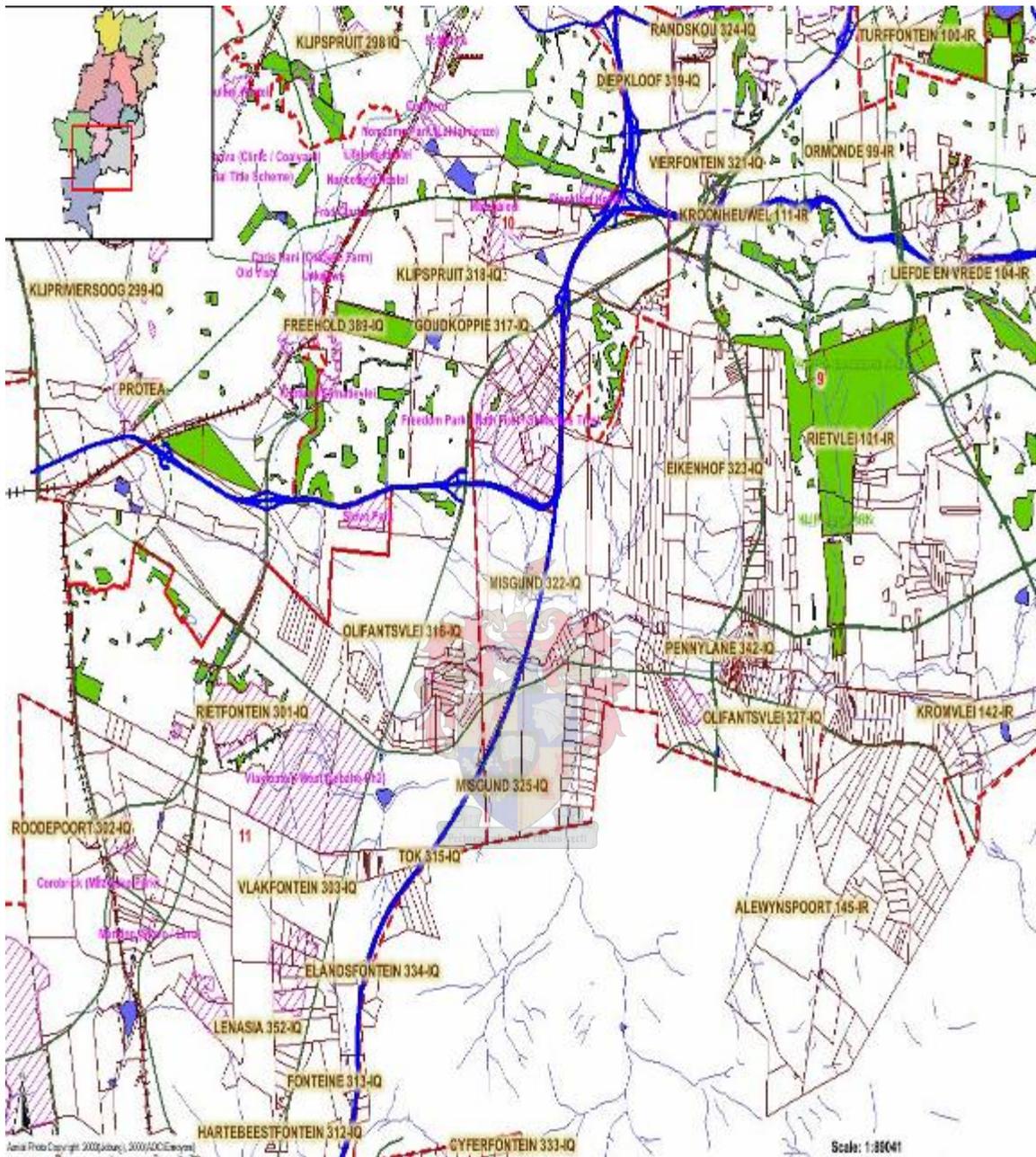
Extracted from [www.auroville.org](http://www.auroville.org)







Source: (Joburg City Metropolitan, 2005a)



Source: (Joburg City Metropolitan, 2005a)

## **Appendix Five**

### **Biogas installations in Southern Africa**

#### **5.1. Private Homesteads & Developments**

##### **5.1.1. Lynedoch Ecovillage, Stellenbosch**

An 11 m<sup>3</sup> (11,000 litres) digester was installed in the Lynedoch Ecovillage housing development, outside Stellenbosch in the Western Cape. The digester replaced the planned installation of three septic tanks serving three of the forty houses, with the gas line being piped back to the houses. In order to meet the cooking energy needs of the three families, the digester is loaded with waste organic (kitchen and garden) scraps from the broader community, as well as cow manure sourced locally.

##### **5.1.2. Stanford Valley Farm, Stanford**

The farm has installed an ecological sanitation system, comprising a 10 cubic metre with aerobic post-treatment (comprising a constructed wetland and polishing pond) for this rural conference centre.

##### **5.1.3. Ecocity biogas digester at Ivory Park Ecovillage**

Installed a 25 cubic metre with aerobic post-treatment using a constructed wetland to provide sanitation for 29 households (116 people). The project was been approved by the local council based on the pre-feasibility study.

#### **5.2 Rural Digesters**

##### **5.2.1. eThekweni small holding**

A digester with a volume of 10 m<sup>3</sup> (10,000 litres) was commissioned in November 2000, at a household outside of Durban. This digester takes input from a toilet and dung from 3 cows that are kraaled overnight. The digester generates in the region of 3 m<sup>3</sup> of biogas

each day, enough to cook for the family of eight. Of particular interest is the integration of the digester within the household, since all food and water wastes (viz. grey water) are directed through the biogas plant. The levelised lifecycle cost of this system is equal to the cost of LP gas, without taking either externalities or biogas benefits into account – or the inconvenience of accessing and transporting LP gas in outlying areas.

### **5.2.2. Dundee Department of Agriculture, Research Farm**

A 16 m<sup>3</sup> (16,000 litres) digester on a research farm belonging to the KwaZulu-Natal Department of Agriculture, near the town of Dundee. The digester receives directly the washings from the dairy where eleven cows are milked daily, and around 2,400 litres of water used. The treated liquids overflow directly from the digester into a fishpond that is being used to raise barbel, or catfish. The biogas is used in the kitchen to prepare maas, jams, and to boil water.

### **5.2.3. Cape Nature Conservation: sewerage upgrade at Groot Winterhoek**

This was the first biogas digester installation in South Africa to be procured by public tender (number S53/04 dated 17 August 2004, issued by the Western Cape Department of Transport and Public Works). The specifications were prepared by AGAMA Energy, who also acted as the lead consultant to the primary contractor. The biogas digester is sized to treat the waste from a peak of 56 people using 65 litres of water/day, and to provide aerobic post-treatment of digester overflow using a constructed wetland or reed-bed to be situated below the digester overflow for gravity feeding. Gas is piped to the communal kitchen from the digester.

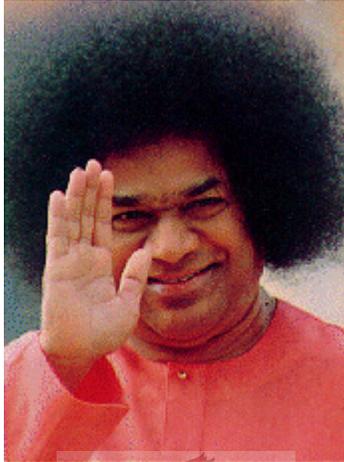
### **5.2.4. Remote Lesotho smallholdings**

Over sixty families with smallholdings located in the remote mountainous regions have voluntarily replaced their conventional septic tanks with biogas digesters to avoid the high cost of hiring the truck to pump out the septic tanks. These smallholdings make use of the nutrient rich effluent to provide substantial savings on fertilizer costs.

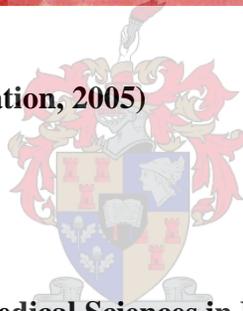
Extracted from Boshier (2006).

## Appendix Six

### Picture of Sri Sathya Sai Baba



Source: (Sri Sathya Sai Organisation, 2005)



Sathya Sai Institute of Higher Medical Sciences in Prashanthi Nilyam





**Source: (Sri Sathya Sai Organisation, 2005)**

**Sathya Sai Institute of Higher Medical Sciences in Whitefield, Brindavin**



**Source: (Sri Sathya Sai Organisation, 2005)**