Towards Building a Sustainable University Campus
Vinod Gupta, Space Design Consultants

Introduction

Building a University Campus at Neemrana right at the edge of Thar desert was a huge challenge in the beginning. With extreme desert climate, dusty winds, highly eroded landscape, no water supply, no sewerage system and no infrastructure to support, the 100 acre site sits next to a hillock on the foothills of Aravali midway between Delhi and Jaipur. The design brief was to have a university with world class facilities offering undergraduate, postgraduate and research programmes in different disciplines.

In the initial stages, we were concerned about how students and teachers would commute to the University. If they commute from Delhi/ Gurgaon or Jaipur (the nearest cities), wouldn't the energy costs be too high? What residential population the barren land would be able be support? Where water would come from for the large number of students that a self sustaining university would require to enroll? What kind of built environment would suit the harsh climate of the site? What would be a sustainable way of building in the desert?

Green is everyone's favourite colour these days. From fashion to buildings to furniture, green is the latest trend in the market. Green buildings are forerunners in this movement with several rating systems that evaluate reductions in natural resource consumption. These ratings deal with individual buildings or groups of buildings and not with a whole campus or a settlement. They do not take into account the macro site planning issues and other issues external to the site. For a large site, without applying the resource conserving approach at the macro level, sustainability would not be achieved at all. Green building norms can hardly correct the problems created by bad planning. In any case, some of these norms are not sensitive to a warm climate and the Indian ethos.

The questions that we asked lay outside the framework of green building norms and even the environmental impact assessment norms. The mandatory EIA clearance required us to use water and energy efficiently, preserve natural features of land, treat and reuse waste water, provide solar water heating, use recycled building materials, manage solid waste etc. While all that is manageable, the campus design in Neemrana was an opportunity to explore the possibilities of building sustainably in the difficult terrain of Rajasthan. The issue was not just green buildings but a whole environment friendly campus. The initial phase of the project is complete and the first batch of students was admitted in September 2009.

Site:

The 100 acre site is located midway on the Delhi - Jaipur highway in district Alwar, Rajasthan. The long site lies between the highway and a hilly outcrop of the Aravali, the oldest fold mountain range in the world. The sandy site had been deeply eroded by the runoff from the hill gushing through it year after year. It is a barren land with a sparse cover of few native trees. The climate is typical for the desert with daytime summer temperatures reaching to about 43°C accompanied by hot dusty winds. Because of the leveling of land in the neighbourhood, the general dust level in the atmosphere is high.

Highly eroded site with deep ravines

During monsoons, the humidity is high at about 85%. The temperature in winters drops to about 5°C. There is no municipal water supply or sewerage system in place. Rain and ground water are the two sources of water. The area lying between the site and the hill is barren land where no construction is permitted. The hill offers spectacular views all around.

Objective:

- To use available resources to create a comfortable, healthy and interactive educational campus.
- To address off site and on site environmental issues and develop a prototype for future developments in the region.
- To apply the concept of environmental and economic sustainability as the major determinants for design.

This paper highlights some of the issues dealt with during the design process and the solutions adopted for each of them. These issues were – population density; water, energy and waste management; transportation, site intervention and micro-climate modification; construction materials and technology; project phasing. These concerns are addressed first at the site planning level and then at the individual building level.

Density

India's resources of arable land are small (1.3 sq km for 1000 persons versus world average of 1.9 sq km) [2]. We are at a time when urban development is accelerating and it is putting pressure on agricultural land. Forests are being cleared up for agriculture

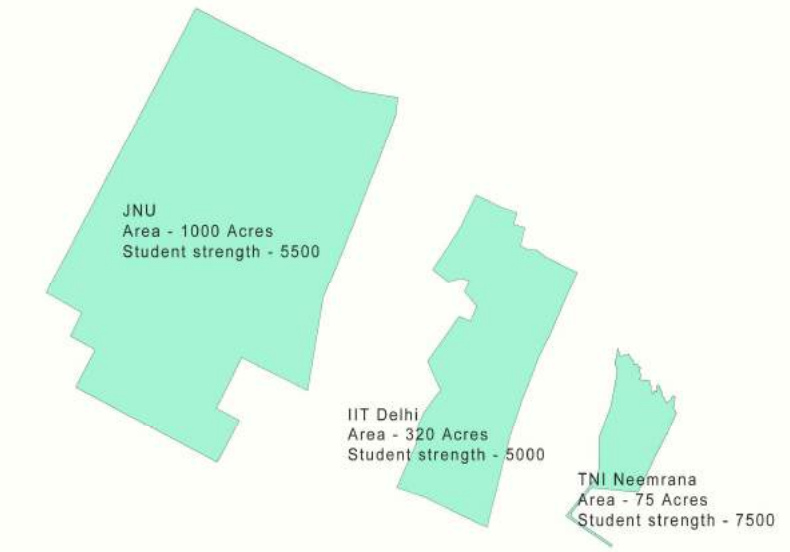
and agricultural land sacrificed for development. The Western model of low density developments is being followed in India as well. Apart from taking away agricultural land, low density developments are typically associated with larger transportation, infrastructural costs and consequent carbon emissions as well.

NIIT University campus has been designed like a traditional Indian desert city, a compact dense development which will support a larger population on a small area of land.

Comparison of densities in Chandigarh and Jaipur. Walled city of Jaipur is almost 6 times as dense as Chandigarh.

It is planned to house 7500 students (5000 resident students) and 500 staff families on an area of 75 acres which makes it 6 times as dense as IIT Delhi and 18 times as dense as JNU Delhi. This is still less than the difference in densities of the modern city of Chandigarh and the traditional city of Jaipur.

The high density allows it to be a walking campus where distances are short. The tight site layout responds in a much better way to the harsh desert climate and allows the resources to be utilized more efficiently with less developed area. Tight knitting of open and built spaces helps in creating shaded spaces for active campus life.



Comparison of densities of Jawaharlal University, Indian Institute of Technology, Delhi and NIIT University, Neemrana.

Water

Neemrana lies in Alwar District that is considered to be an area with overexploited underground water table. Considering the paucity of water, available rain water in the site and its surroundings has been taken as the basis of determining the carrying capacity of the site. The hydrological survey showed that rainwater from the hills comes to the site through surface drainage channels and through sub-soil flows. The site lies over an underground bowl that will provide a sustainable source of water. Existing water courses on the site have been maintained for rain water harvesting. During the dry season these spaces will be used for outdoor activities.

Rajasthan has a tradition of conserving water and using it very carefully. Traditional settlements in Rajasthan have magnificent water structures like man made lakes, step-wells and ponds to collect rainwater for use throughout the year. NIIT University will promote water conservation amongst the resident population, treat and reuse its waste water and thus draw no more than the annual rainfall recharge. Water saving thermal-conditioning system and toilet fixtures are being used. Treated water from STP will be utilized for flushing toilets and for irrigation reducing the requirement of fresh water to about half.

The bio-technology department of the University has already started a project of greening the hillside beyond the site boundary. Native plant species that require little water have been planted. It is a move away from a resource consuming ‘beautiful landscape’ to a more contextual landscape that the site can support.

Bund created to impound rainwater from the hill

Transport

Neemrana is 100 km from Gurgaon and about 130 kms from Delhi and Jaipur. The residential campus will discourage students and teachers to drive to the campus on a daily basis. Day scholars would be admitted only in the last phase when the surrounding area will have acquired substantial residential development.

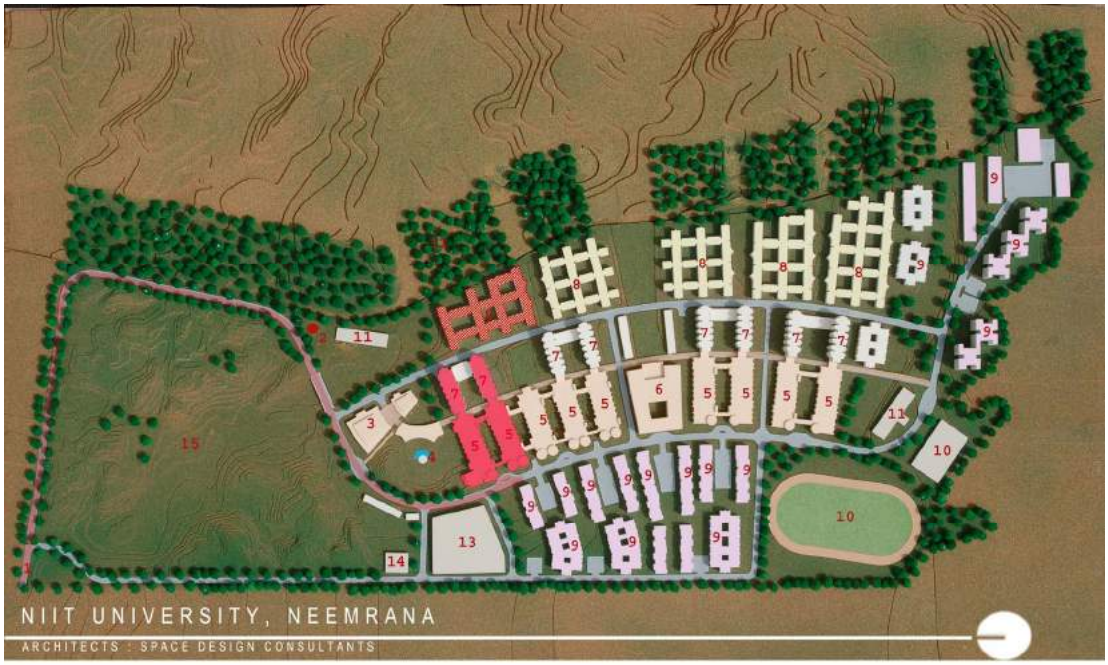
To reduce the need for transport, Neemrana campus would be a 'walking' campus keeping cars and motorcycles out of it. Visitors will park their vehicles in a common parking facility near the entrance and will walk thereafter. Most facilities in the campus are located within a short 5 minute walk. A shaded and rain protected "pedestrian spine" links all the major buildings. This spine runs along the length of the campus and is conceived as an activity hub connecting all student residential and social areas to the academic parts of the campus. With all student activity areas and cafeterias being located on the spine, it will become a 24 hour activity zone. The design of the spine as well its interconnectedness allows for walking comfortably and safely in the heat of Neemrana. In addition, the University will run a bus service that will connect the campus to the public transport system that is available in the vicinity. Ownership of private vehicles will be discouraged actively. Only emergency and public service vehicles will have access to internal roads of the campus.

Site Intervention

The site is badly scarred by the rainwater flowing through it. The environmental management plan for the site includes stopping illegal extraction and mining of stone

from the hill, greening the hillside with tree plantation, making check dams to harvest rainwater and stop soil erosion. Natural depressions within the site are being developed into amphitheatres and sports arena. Overall site levels have been maintained to minimize cut and fill.

University skyline



LEGEND

1- ENTRANCE	6- LRC	11- GUEST HOUSE
2- MOEBIUS RING	7- P.G.HOSTEL	12- PLANTATION ALONG HILL
3- CULTURAL CENTRE	8- U.G.HOSTEL	13- PARKING
4- BOWL	9- STAFF HOUSING	14- SERVICES
5- ACADEMIC BLOCK	10- SPORTS	15- FUTURE EXPANSION

The total built up area on the site would be 300,000 sqm which would be built over a period of 10 years. To avoid the appearance of a construction site during the continuous development phase, the University will start from a small initial nucleus of academic and residential buildings that will grow in a linear fashion. This approach facilitates continuous expansion with least disturbance to the buildings and landscape already in use. It also permits one to develop only as much land as required, minimizing infrastructural development costs. University campuses are rarely

developed with phasing in mind and it is common to see different functions segregated by large open spaces.

View on entering the Campus

Building Design

The design of individual buildings in the campus takes further the concept of sustainability. The architectural traditions of Rajasthan and the contemporary thinking about climate sensitive and resource conserving design have been used. All buildings are oriented in North-South direction with minimal exposure on the west side to avoid heat gains. Use of glass on the exterior is restrained and shaded from sun. Buildings are insulated from outside and detailed to avoid thermal bridges. They are designed to be comfortably cool and dust free without conventional air-conditioning. The buildings will be built with high percentage of recycled materials.

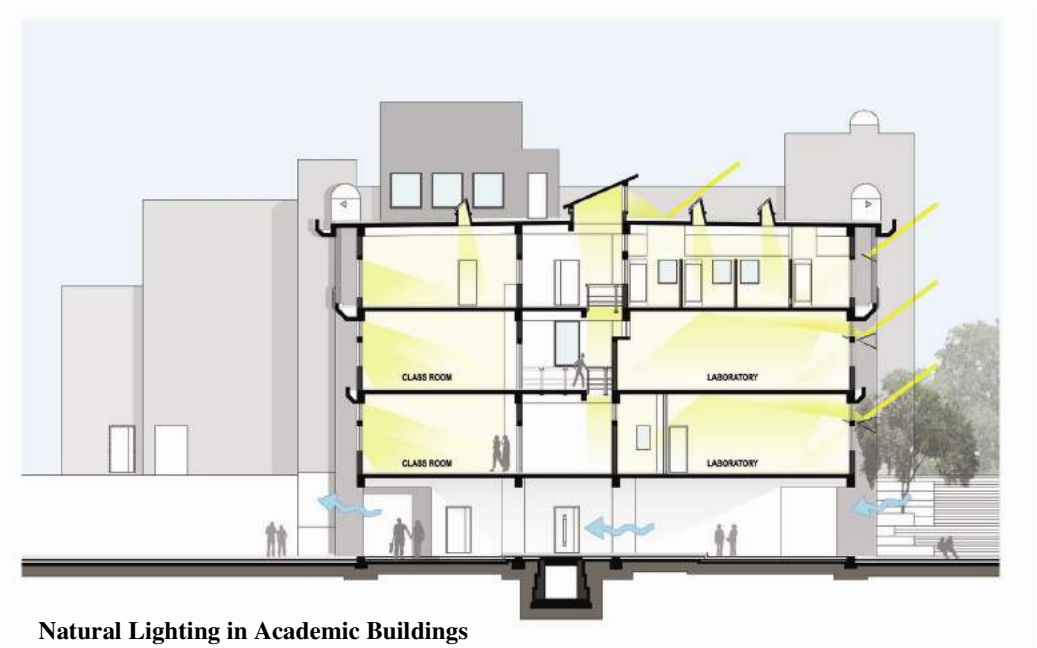
Section through the site

Academic and Residential Buildings

Lighting

The academic buildings are mainly day lit and artificial lighting is used only when daylight is not available. The building blocks are designed with deeper rooms (10.8m) for laboratories on the south side and shallower spaces (7.2m) for class rooms on the north side. The south side rooms have high level windows with external and internal light shelves that improve the distribution of day light in the deep laboratories. These rooms also get light from skylights above the central corridor. Windows at eye level provide external views.

Faculty rooms and cubicles at the top floor are daylit by small skylights. The passages are also lit through skylights. Those parts of the buildings that cannot get daylight directly will have efficient artificial lights powered by Solar Photo Voltaic (SPV) energy. The grid interactive SPV system will work without batteries.



Natural Lighting in Academic Buildings

The artificial lighting system uses high efficiency fixtures and lamps (T5) that achieve the requisite levels in work areas with a very low lighting power density of 7 watt per sqm. This has been achieved by using lower levels of lighting in circulation areas. Multiple light controls allow lights to be switched on and off as required.

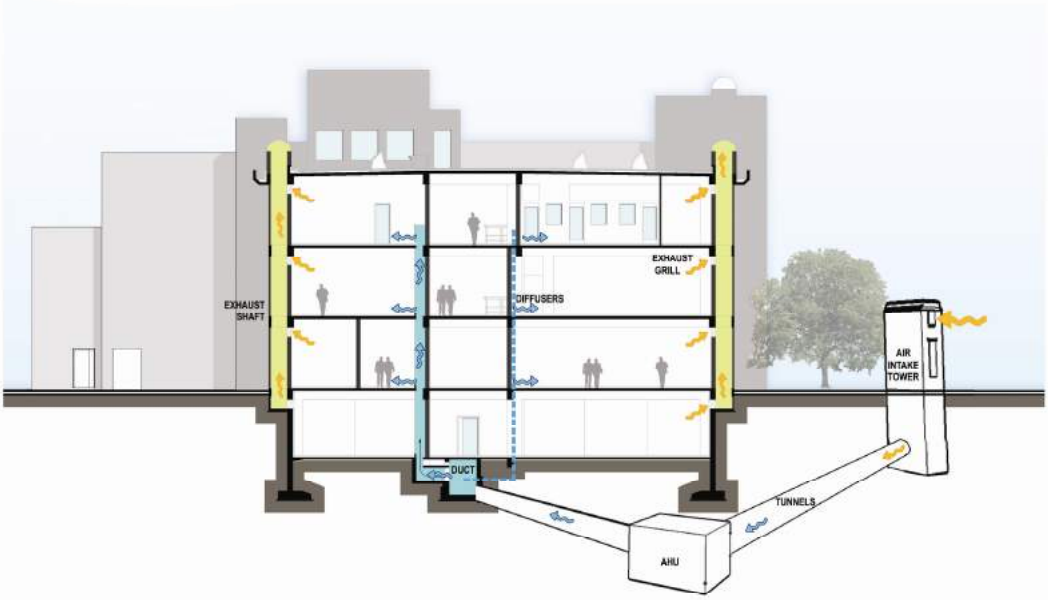
Daylit corridor in academic building

Heating/ Cooling and Dust Control

Air-conditioning seems to be the one major factor that shapes modern buildings. In spite of its huge energy cost, air-conditioning is becoming the accepted standard for all kinds of buildings. Medium budget old non air-conditioned office buildings are

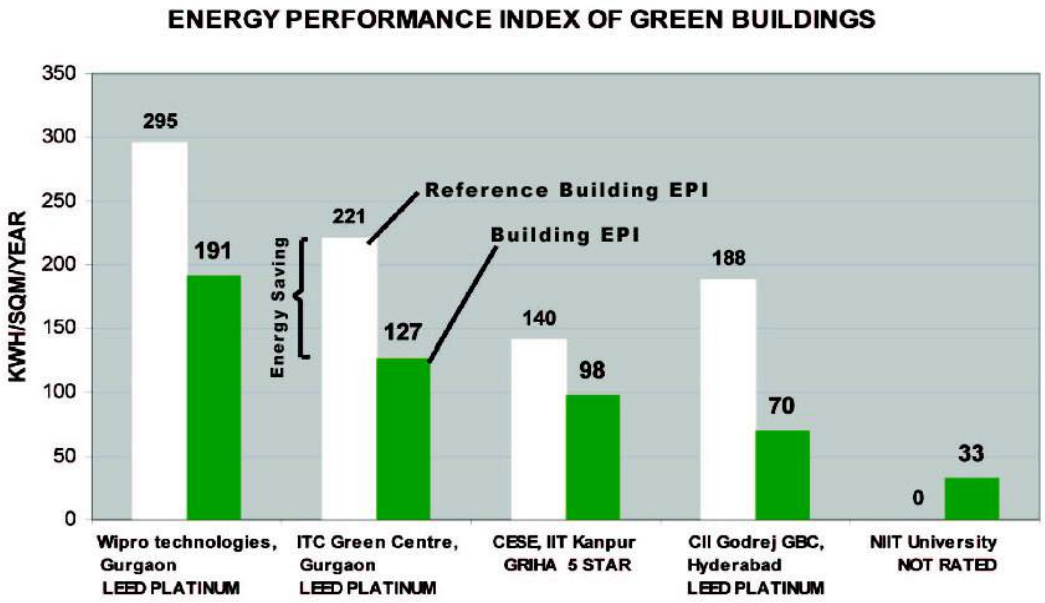
being fitted with window and split unit air-conditioners. Traditionally educational buildings have been non air-conditioned spaces, private universities today and even government institutions are opting for air-conditioning in parts of the campus. At Neemrana, in addition to heat, there is an acute problem of atmospheric dust that appears as dust storms in the afternoon. What is needed is an integrated, economical and sustainable way of cooling and dust control, an alternative to conventional air conditioning.

At NIIT University the earth is being used as a heat sink and earth air tunnels are being used for pre cooling air before it is supplied to rooms. The same tunnels also provide a degree of heating in winter. At any given place, the temperature of the earth at about 4m depth remains nearly constant through the year. Air drawn through tunnels laid at this level cool the air passing through it in summer and heats it in winter. That air is further humidified in dry summer months and dehumidified in monsoon season and then supplied to each room in the building. To keep the energy costs down, a displacement system of ventilation is used in the rooms. Cool air (at 20 deg C) enters the rooms at the floor level displacing warmer air to the top. This system provides 100% fresh air with low energy expenditure. The combined energy bill for lighting and air conditioning will amount to no more than 33 kwh per sqm of built space per year. This is less than the norm of 140 kwh per sqm per year that the Energy Conservation Building Code provides for fully air conditioned buildings.



DISPLACEMENT VENTILATION SYSTEM

The performance of NIIT Neemrana as compared to ECBC Norms and other rated buildings in India is given in the table.



Microclimate Modification

In the traditional towns of Rajasthan, open spaces are more important than the built up spaces. In the hot climate, except for the hottest part of the day, the open spaces are intensively used. For the hottest part of the day, special cool community spaces are used. The campus of NIIT University attempts to modify the climate so that the micro climate is modified favorably. With tight packing of buildings, breezeways oriented away from the prevailing winds, tree plantation at strategic places, the campus will have plenty of open spaces for rest, contemplation and community activity.

Landscape court between academic buildings

Sustainability

It is commonly understood that environmental sustainability carries a heavy additional cost. NIIT University set out to demonstrate that financial sustainability can go hand in hand with environmental sustainability. This may not always be possible in

individual buildings but where larger developments are visualized, local challenges can be met effectively if available natural resources are understood and deployed properly.

Cost savings:

1. High density
2. Small area of development in the beginning
3. Fewer roads
4. Solar passive design Earth tunnel cooling system

Entry to academic and Hostel Buildings from Pedestrian spine