COOL SCHOOL
Design for an Extreme Climate Competition

DESIGN APPROACH
The main idea was to achieve an integrated design approach through combining social interaction, economic vitality, environmental connectivity and an inspired design. The concept ensures the architectural aesthetics can be achieved by using low-cost, energy-efficient, economically-constructive design, without any intricate details that cannot be learnt by locals. The project is adapted to the needs and the economic situation of the people in the region and responsive to the prevalent climatic conditions, and thus capable of achieving sustainability.

The functional program designated a school complex for 100 pupils (with a future extension plan), a multi-purpose hall (which can serve as a gym, classroom, theatre, community/public gatherings or consultations), ancillary building for toilets, a vegetable greenhouse, and a courtyard for sport activities or children’s workshops.

INTEGRATED DESIGN APPROACH

- **Inspired Design**
  - Holistic design
  - Seasonal responsiveness
  - Flexibility of use

- **Social Innovation**
  - Local Materials
  - Environmentally-friendly
  - Encourage local produce

- **Environmental Connectivity**
  - Respect nature
  - New learning techniques
  - Engaging the community
  - Outdoor connection
  - Safety

- **Economic Vitality**
  - Low-cost local materials
  - Reduced maintenance
  - Affordability
  - Profit from crops
  - Energy savings
The school building is made of local materials with local workforce and craftsmen. The aim is to encourage the community to make the most out of the materials that are easily available, so that they could apply the same construction techniques in the future extension project. As the materials are scarce, soil was utilized to make sun-dried soil blocks. The whole school is handmade. This allows employing many people from the community, and it keeps all techniques simple and transferable. The basic structure of the school comprises of load-bearing walls made from compressed earth blocks stabilized with 8% industrial cement, cast in hand presses on the construction site and jointed by earth mortar. The roof structure is of timber rafters (8” × 10” ) every 3.5-4m and purlins (6” × 8”) every 1.5m. The rafters rest on a groove in the mud brick walls set in parallel to the width of the building. The purlins are fixed on top in perpendicular manner. Straw bale is used to fill in for insulation which is finally covered with waterproof fully recyclable fabric. The school is raised on a 45cm platform from the ground made from rammed earth and natural stone and straw mixture. The sun-dried mud brick walls are 30cm thick to increase thermal lag and have textured surfaces to absorb and re-radiate more thermal energy providing the rooms with thermal comfort. The thick walls absorb solar energy during the day and releases it slowly at night, reducing the need for artificial heating and cooling. Mud bricks are fire resistant, cheap, sustainable and biodegradable. Internal temperatures in mud brick buildings remain fairly stable despite external fluctuations according to scientific findings and comparative studies.
SITE SELECTION

In order to select an appropriate site for the school, comparative studies were prepared to reach the final decision. However, each of the options had certain limitations in design, therefore, we proposed a new site based on the following reasoning.

Circulation
- Lowest physical effort to circulate from place to place within a safe and enclosed space (pathways that connect old school with the new one, with the back children play area and the greenhouse).
- Toilets on site have been compensated with additional area in the new ancillary building. It is placed where it can be reached by all within comfortable walkable distance and is provided by a low-cost environmentally friendly technique to thermally heat water so it’s not cold for the children in winter.

LOCAL ENVIRONMENT & CONTEXTUAL ISSUES

Climatic comfort is ensured by solar orientation, the nature of the wall materials and the airflow using natural Cross-ventilation. Landscaping consists basically of locally grown vegetable greenhouse on the western side of the school. Reforestation using Native trees and plants are placed in the northern side to act as sound and visual barrier for surrounding construction site as well as filters air to protect from cold winter winds, as well as using the trees in the future for timber construction of extension plans. Bio swales placed on boundaries facing the slope of the roof to collect water for plants to grow and to provide aesthetic value to the surrounding space as well as an improved microclimate.
Local Materials
Local materials and resources for the construction of the building (Sun dried mud brick walls – Timber roof – Waterproof, fully recyclable fabric) all environmentally friendly.

Green House
Local vegetable or produce greenhouse included on site for children a new interaction and learning space as well as encouraging local produce and increasing local economy.
Sunlight passes through transparent material (plastic). When it strikes an opaque surface inside (plant leaves, greenhouse floor, plants), some of the light energy is changed into heat.
It mades from a cheap material (Polyethylene or plastic film) is also flexible, readily available and easily applied covering. It is comparable to glass in transparency, lending to excellent light-permeability.

Passive Heating/cooling
The wall between classroom and glass acts as trombe wall to store enough heat. It is built from a material that has a lot of thermal mass (sun dried mud brick), painted by very dark color to help the heat gain.

Trombe Wall Heating
Day Time
Convective current starts when sun heats air between trombe wall and outer glass. Hot air rises, enters room through vents at wall’s top, gives off heat to room. Cooler air from floor is pulled through trombe’s bottom vents, recommences heating and rising cycle.

At Night
Heat gathered in trombe wall penetrates to wall’s north side by late afternoon; it radiates gradually into room during night, providing warmth. Dampers at top and bottom vents in trombe are closed to prevent convective current from reversing to cool room.

Trombe Wall Cooling
Cooling takes place when sun-heated air rises between trombe wall and south window, escaping out through opened vents at window’s top, the air pulls room air after it through bottom vents in trombe, in turn pulling cool air from shady side of house, from north, windows, and across room.