Druk White Lotus School

4.01 The school is located in the village of Shey in Ladakh, in far north India.

1. **Project Basics:**
   - Location: Shey, Ladakh, India
   - Latitude/Longitude: 34º N, 77º 40’ E, alt. 3,700m
   - HDD, CDD; annual precipitation: N/A
   - Building type: School
   - Square footage; stories: ????; 1 story
   - Completion: First phase in 2001, phase 2 in 2004, all phases by 2009
   - Client: Drukpa Trust
   - Design team: Arup Associates and Arup

2. **Background and Context:**

4.02 The setting is a high desert valley, bound on the north by a gorgeous mountain range.

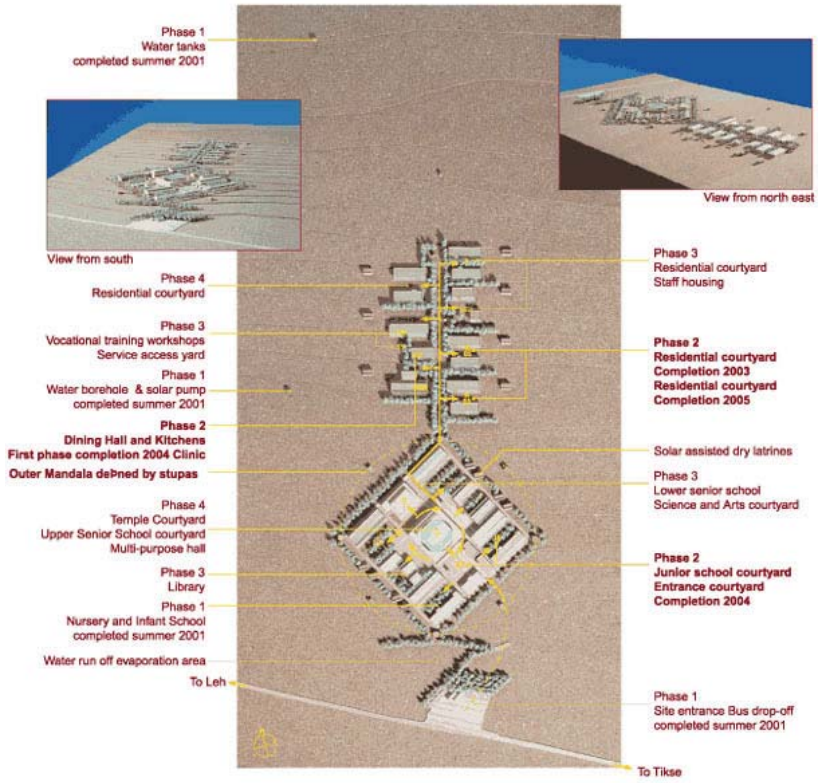
The Drukpa Trust, a UK-registered charity under the patronage of His Holiness the Dalai Lama, initiated the Druk White Lotus School project in 1997, involving Arup from the beginning. During that time the masterplan, concept, and detailed designs of each phase were developed. Every year Arup gives leave-of-absence to an engineer or architect from the design team to reside on the site for 3 or 4 months, act as ambassador for the Trust, and assist the local constructors and building committee. The project team is diverse, including the British engineers and architects, carpenters from Punjab, and Nepalese laborers, many of whom are women. During the construction of the first building there was a steep learning curve for the team in terms of appropriateness of design, materials supply, understanding local construction techniques, and overall project management.

Eventually the school will serve 750 students from nursery through high school. Residential accommodations will be built to house students from distant towns and villages as well as their house parents.

The overriding goal for the school was to provide flexible, high-quality teaching spaces in a sustainable building that takes advantage of local sustainable building materials and appropriate building technologies (traditional and modern). It should become a model for appropriate and sustainable modernization in Ladakh. Inherent in this goal were the needs to import no energy, maximize the solar potential of the high desert, and supply

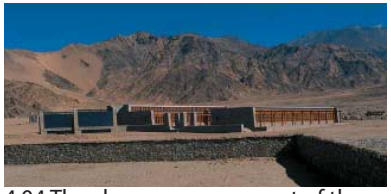
and treat all water on site.

The architects and engineers carried out a two-year study before starting the construction phase. This region experiences a severe climate and seismic activity comparable to that of California, so they realized that modern concrete construction would be unsuitable. Phase 1 was completed under budget and within acceptable local

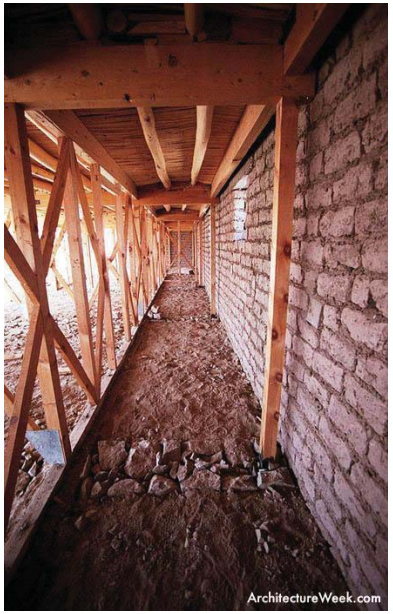


4.03 Phased masterplan for the school shows the solar geometries of the residential (true north-south) and the school (30˚ east of north-south) areas.

cost parameters—around 15% of the cost of a similar school in the UK. The team's aim is to further optimize expenditure, given the limited resources of the Trust and the balance of value between capital investment and a financially sustainable operating model.



4.04 The classrooms grow out of the high desert landscape.



4.05 Mud brick inner walls (t) with granite block facing (b) are stable and made of local materils.

3. Design Intent & Validation

The Drukpa Trust's intent to develop a model sustainable school was ambitious, not only in terms of 'hardware'—energy, site infrastructure, buildings, material resource use—but also in 'soft' skills like building up the local project management team, establishing a cost database, and in optimizing the use of local resources. The whole project is intended to demonstrate a new approach to teaching in such an unique rural community. It was also clear that the school could have a wide influence, contributing to the development of appropriate building technologies elsewhere in the world. In order to share this vision, the project was presented at the September 2002 Earth Summit in Johannesburg.

4.06 A high-quality, sustainable teaching environment was the goal.

Rory McGowan, Project Director from Arup said, "We had great ambitions when we began this project believing that high-powered engineering software and the latest thinking in design could be applied just as easily to Ladakh as to a London office block." Arup realized that approach wouldn't work when they saw that the cost and difficulty of importing materials to the remote area would make mud brick, granite, and wood preferable to steel. Sonam Angdus, the site manager, who was raised in the nearby village of Shey said: "Everyone agreed on granite walls with a mud core. These are stable and well insulated and they blend in naturally with the surroundings. They are also available locally." The resultant design balances economic and environmental factors while meeting the human needs of the children and their teachers.

Adapting to local conditions, Arup developed and used powerful software tools that allowed accurate analysis of the ventilated Trombe walls, the feasibility of using wool as an insulating layer, and the use of double glazing. Such analytical tools were also used extensively in the daylighting studies. In addition, the design team had access to the firm's broader experience in seismic engineering, as many members have been involved in examining the aftermath of earthquakes, often in developing countries. Lessons learnt elsewhere were applied on this project.

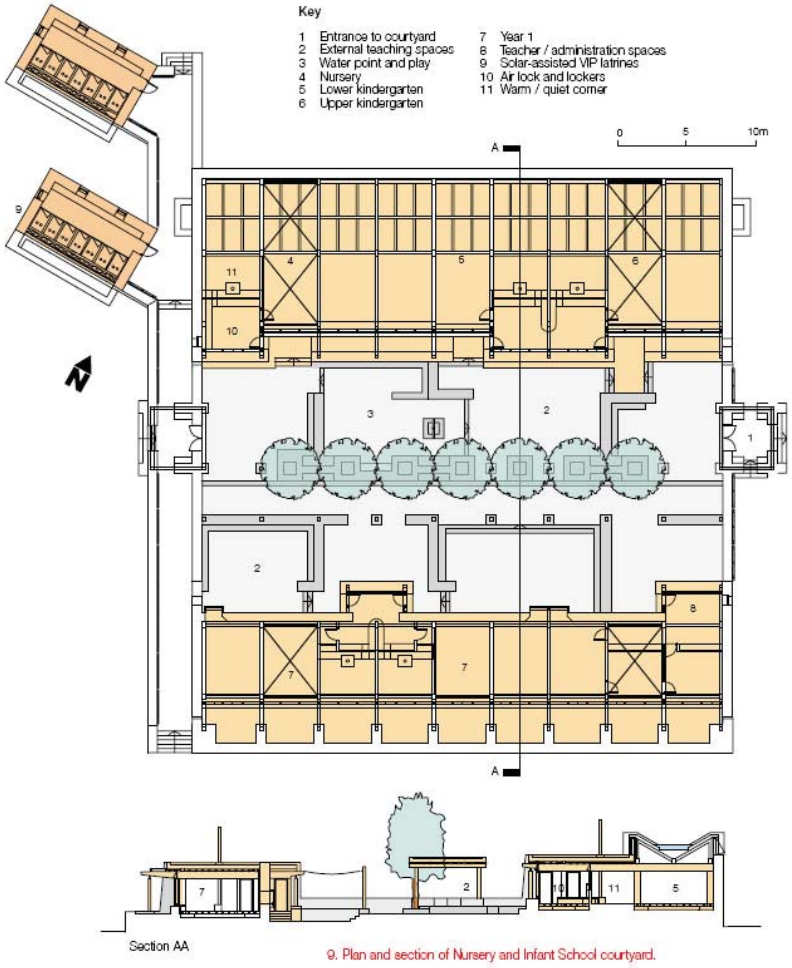
4.07 School rooms feature southeast-facing direct gain windows that ensure early morning warm-up in Shey's sunny climate.

4. Key Design Strategies

The Druk White Lotus School employs a range of strategies appropriate to its remote high desert climate.

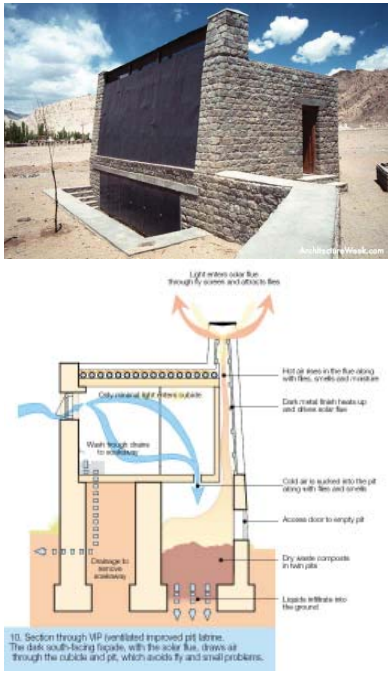
Passive Solar Heating. The classroom buildings are oriented 30° east of true south with

an elongated east-west axis to assure early morning warm up. The high desert climate provides abundant sunshine all year, even during the winter months when -30° C (-22°



9. Plan and section of Nursery and Infant School courtyard.

F) temperatures are reached. Trombe walls made of ventilated mud brick and granite cavity walls with double glazing are used to provide evening heating in the dormitories. All the buildings in the residential area are oriented on a true north-south axis to maximize solar gain. Small wood stoves are provided for back-up heating.



4.08 The composting VIP latrine uses solar assisted stack ventilation for drying and odor control.

4.09 Clerestory and view windows provide daylight to the classrooms.

The solar-assisted latrines have a solar wall that faces directly south for maximum solar gain.

Superinsulation. The roofs are constructed of local poplar rafters, willow sheathing topped with mud and rock wool and felt insulation. The weather skin is sand and aluminum sheets.

Air locks. The entries to the classroom buildings are all air locks to act as a buffer between the winter cold and the warm interiors.

Daylighting. The classrooms are designed for optimum daylight. In the wider Nursery and Kindergarten Building, the light from the direct solar gain windows is balanced by toplighting from north- and south-facing clerestories and a splayed ceiling. No electric lighting is typically used in the classrooms.

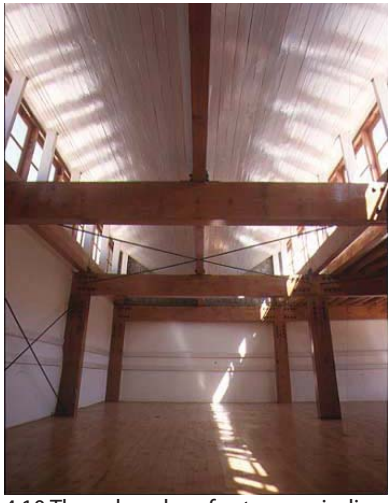
Natural ventilation. All the rooms have well-shaded operable windows that allow natural cross-ventilation that provides a cool, glare-free, high quality teaching environment.

Migration. The courtyards between the classroom buildings are subdivided into smaller spaces appropriate for teaching during mild sunny days. The buildings and trees provide shade and wind protection to these spaces.

Water use. It's a desert, so water is precious. Groundwater is extracted from a 105-foot deep well and pumped by PV power to a 16,000-gallon tank located on higher ground than the buildings it serves. A new well is planned for a location above the storage tank in order to eliminate the need for pumping. When not needed for pumping, the PVs charge batteries that run the school's computers.

Waterless ventilated improved pit (VIP) toilets were designed to use solar-assisted stack ventilators to help create odorless compost which is an excellent fertilizer.

Materials. An emphasis was placed on using local materials. Soil from the site was used in the roof construction and the mud bricks for the inner wals were hand made in Shey. The granite blocks of the exterior wall are formed and finished from stone found on the site or gathered from the surrounding boulder field. Nearby monastery plantations grew the willow used in the roof construction.



4.10 The splayed roof acts as an indirect daylight source in the classroom. Note lack of electric lighting fixtures.

4.11 The courtyard is subdivided into a series of outdoor classrooms. Planter boxes await deciduous tree planting.

4.12 The pumphouse at the wellhead is powered by a sun-tracking PV array.

5. Performance Studies

Arup is interested in learning from the building, thus have been monitoring performance in practice and seeking site feedback. Construction will continue for up to eight years (2001-2009), with a senior design team member visiting at the beginning of each year's building season in April, followed by the Arup resident who typically remains on site for around four months from late June. With the Nursery and Infant School and Junior School now complete and functioning, building performance feedback is already being collected.

The design team and the Drukpa Trust both look forward to a process of continuous learning about the school's performance in practice as it grows over the next few years, and feeding back the results of the lessons learned into the remaining construction work. As well as other considerations, 'sustainable' for such a project means that the buildings must be constructed within local cost parameters. From a position of having no reliable cost information at the outset, the design team has established a cost database for budget management throughout the future detailed design phases and construction phases up to the school's completion.

The school has also gained feedback from the architectural community. It won World Architecture Awards in 2002 as Best Education Building of the Year, Best Green Building of the Year (joint winner), and Regional Winner—Asia.

4.13 Roof construction uses local poplar rafters and willow sheathing.


4.14 Arup worked with local construction crews.

6. Further information

Arup Associates web site http://www.arupassociates.com
Druk White Lotus School web site http://www.dwls.org

7. References

Barker, Don. "Building a School in India," *Architecture Week*, 31 July 2002.
Fleming, Jim; Rory McGowan; Dorothee Richter; and Jonathan Rose. "Druk White Lotus School, Ladakh, Northern India," *The Arup Journal*, 2/2002.