PARADIGM SHIFT 1: THE HOLISTIC APPROACH INTEGRATED PLANNING WITH ARCHITECTS, ENGINEERS & CLIENT

Before construction – during construction – after construction.

From the very beginning, this project integrated all aspects of comfort: functionality, cost/benefit considerations and – of course – sustainability. Through an optimised architecture and landscape concept, air-conditioning becomes obsolete. Simulation tools have been used since the beginning and a new methodology was used to optimise the day-lighting/shading, reducing the need for artificial lighting by 86% during core school hours.

A long-term monitoring project is planned to further improve efficiency and comfort after completing the construction.

The holistic approach also includes the development of a new collective transport system, proposed by the architects and already being introduced.

PARADIGM SHIFT 2: OWN RESEARCH & DEVELOPMENT PATENT APPROVED

Many advanced solutions for sustainability from industrial countries are not easily applicable, due to different climatic conditions, different cost structures, different cultural background, etc. Every comfort parameter might be different. Many solutions in this project are based on own R&D activities by the main author.

Daylight controlling: Daylight / shadowing + 1 patent approved and set to be published in January 2006

Daylight controlling: development of a new methodology for energetic and economic evaluation

Green roofs: + 1 patent pending

Thermal Comfort: own research activities in the tropics since 2000

Acoustic comfort: 1 patent pending

PARADIGM SHIFT 3: REGIONAL MODERN STYLE

This project features a regional modern style, based on climatic parameters and regional (modern) traditions. This represents a change of paradigm, away from the international style towards an independent regional modern style as a basis for sustainable constructions.

PARADIGM SHIFT 4: AUTONOMY IN ENERGY & WATER

This project optimises energy & water efficiency and ensures a future supply with solar energy & rainwater to satisfy the resting demand.

The approach:

1. Reduce the demand to minimum through efficiency and
2. Organize the supply for the resting demand in a sustainable way.

This brings energy and water within an economically viable range.

An analysis of climatic data from Rio de Janeiro suggests a necessity of air conditioning in only 2% of the year's total, mostly during the period of school holidays in December, January and February. This corresponds to an approximate 20% of the total air conditioning which provides comfort in 61% of the year. So bio-climatic architectures and urbanization can provide comfort without artificial conditioning during the school year.

PARADIGM SHIFT 5: “ECOLITERACY” AND CITIZENSHIP

Children spend most of their time in schools. Therefore schools do have an enormous impact on their perception of environment, including social, built and natural environment. To provide an environment which encourages an interaction with its multi-layer is definitely an excellent investment into sustainability.

FULL TRANSFERABILITY OF ALL CONCEPTS AND TECHNOLOGIES

All concepts, building technologies and materials are locally available and comply with local financial possibilities, therefore a full transferability to similar projects in tropical countries is possible.
SCHOOL PHILOSOPHY
Sustainable development is about future generations, is about our children. Therefore schools play an extremely important role. Children are also effective autocrats and observers.
This non-profit private school carries out social and environmental projects in the poor neighborhood.
The philosophy of the school emphasizes e.g. social inclusion, the formation of critical spirits, personal & social responsibility, solidarity, environmental education and cultural diversity. The built environment is seen as of fundamental importance to support this philosophy.

RECYCLING
The best way to learn it is to do it.
Recycling, the project counts with a storage & collection unit for glass, PET, metal, paper and organic material. The organic material will be turned into compost and used in the school gardens, demonstrating the lifecycle of organic material.

SCHOOL GARDENS
82% of the Brazilian population live in urban environments. Nature becomes distant from many children. Therefore school gardens are extremely important to develop sensibility for nature.
Four different school gardens will be implemented:
- School garden A: painting, growing, harvesting a traditional local garden close to the laboratories closes the gap between theory and practice, e.g. in food production.
- School garden B: an extensive green roof to observe the adaptation of nature under harsh circumstances.
- School garden C: it takes minutes to cut down a big tree, but decades for it to grow. To develop sensibility for the dimension “time” in nature, all trees to be planted will receive a label with its “birth date”.
- School garden D: the water garden. Water as the basis of life will be presented with special emphasis on the use of rainwater.

ACTIVE CREATORS
In small big cities children are isolated from their urban environment and lack of contact time because of expensive, big cities, neglected and abandoned. Citizens strive to know the secrets of their own environment, to accelerate the vicious circle of isolation.
A similar phenomenon can happen in schools. Based on experience from the successful project “100 walks” in São Paulo [16], pupils of the college will be oriented to create images to be applied on the campus and the neighbourhood. A strong link with each school and neighbourhood will be established; a sense of ownership in their own environment will be developed, fostering citizenship.

LIFECYCLE
ADAPTATION OF NATURE DIMENSION “TIME”
WATER

CITIZENSHIP
Children of this school already participate in an urban reforestation programme, financed through donations from them-collecting PET for recycling. This programme also includes children from poor neighborhoods and serve as an excellent example of interaction between individual and society.

URBAN REFORESTATION PROGRAMME
FINANCED THROUGH PET-RECYCLING
INCLUSION OF POOR NEIGHBOURHOODS

ECOLITERACY
School as apprenticeship communities for a sustainable society. Fatiga Campus calls it “moderlity”, the deep understanding of man and nature, the comprehension of complex ecological contexts. The “Modernity” will become an integrated part of daily school life in the “Minimum-Energy School.”
INTEGRATED APPROACH
IMPROVEMENT OF MICROCLIMATE
NATURAL VENTILATION
DAYLIGHT-CONTROLLING OPTIMIZED FAÇADES
SOLAR ENERGY & RAINWATER USE

IMPROVEMENT OF MICROCLIMATE

Due to its important impact on the natural ventilation, great emphasis was given on the improvement of the microclimate. Off the total area of 10,220 m², 50% will be covered with grass for leisure activities, 37.7% with native trees from the 'Mata Atlântica' and 25.4% with intensive & extensive green roofs. That makes a total of 9.4% of unsealed surfaces. Computing the monthly potential of evaporation and the monthly precipitation, a maximum of 12,350 MWh/year of evaporation cooling can be achieved by natural means on the building site. The remaining rainwater runoff will be collected in cisterns and used in a solar driven high pressure evaporation cooling system. Since May 2004 a weather station is recording the climate data of the building site.

GREEN ROOFS IN THE TROPICS

RUN-OFF REDUCTION OF 60%
TEMPERATURE REDUCTION OF 12K

Scientific projects on extensive green roofs in the Tropics are going on since 2001. While extensive green roofs are common in industrialized countries with temperate climate, this approach is new for tropical climatic conditions. Measurements of surface temperatures on the underside of the roofs, in order to evaluate the effects on thermal comfort show a reduction of more than 12°C. Cooling with only 10 cm of substrate in order to limit the weight, measurements of the runoff rates prove a reduction of 60% on the long run, compared to conventional roofs. Due to the high number of storm water events, so called tropical rains, these results are quite encouraging. The green roof also works as a filter to the rainwater: elements like lead, phosphate, cadmium and NOx are significantly reduced.

BUILDING MATERIALS
TOXIC-FREE, TIMBER PRODUCTS WITH FSC-CERTIFICATE

Due to the combination of improvements of the microclimate, optimized natural ventilation, sun shading and thermally neutral building surfaces no air conditioning is necessary. Furthermore there are no toxic building materials being used. For timber and wood products a FSC-certificate (available in Brazil) will be required.

NEW COLLECTIVE TRANSPORT REDUCING CO2-EMISSIONS IN UP TO 114 T/YEAR

Traffic participations with around 1/10 in the non-carbon energy consumption. The campus, when finished, will host 2500 pupils and about 200 professors. The actual tendency is individual transport due to a lack of collective system. The authors of this project proposed a new collective transport system, reduces the kilometers driven up to 32 million per year and the emission of CO₂ in up to 114 t/year. The numbers are based on an assumption of 60 km driven per day and pupil/team on 240 days per year.
NATURAL VENTILATION WITH ACOUSTIC COMFORT

Due to glass boiler windows, cross ventilation is working in all classrooms. To tackle the biggest problem of natural ventilation the acoustic comfort, several measures were taken, the creation of a big tropical garden between the north and south wing, keeping distance between them, the placement of the mezzanine areas always opposite to the other wing, using each building as a noise barrier during the breaks, necessary due to different frequencies, the integration of artificial waterfalls in the south, fountains, creating a sound mask (it cooling effect patent pending).

As natural ventilation cannot be guaranteed permanently, a highly efficient backup system will be installed, a fan with 17,000 m³ at 40 rpm, consuming only 39 kW operating at full speed.

ZERO-WATER CONCEPT

The harvested rainwater, already pre-filtered through the green roof, will be collected in cisterns and used for a computer controlled evaporation system, as well as for irrigation purposes.

In order to prevent erosion problems, which are quite common in inclined terrains in Rio de Janeiro, special devices will collect the through unsealed terrain already extremely reduced runoff, flow it and supply it to the cistern. The aim is to reduce the evapotranspiration to almost zero, using it in an intelligent evaporation cycle:

- Evaporation (lower & directly through irrigation) into the soil and retention in the green-roof, cooling through natural evaporation
- Evaporation through a computer controlled, low cost & highly efficient "Tag" system.
- Fotive flushing, and, as soon as it gets economically viable, as drinking water.

ZERO-ENERGY CONCEPT

The approach in this project is to first reduce the energy consumption to a minimum and second supply the significantly reduced energy demand with solar energy: brings autonomy into an economic viable range.

The average daily energy consumption for artificial lighting in classrooms is 14 kWh/m² or 840 Wh/m² of classroom area, considering the core school hours from 8 am to 3 pm. Annualy, with 240 working days, the consumption sums up to 3,360 kWh/year.

Using photovoltaic panels on the roof of the north- and south wing, up to 192 kWh/month per year can be produced. That means, that 1 PV element of approximately 1 m² can supply the necessary electric energy for one classroom.

Hot water for showers will be provided through solar collectors, which are already economically viable.
PROJECT PHILOSOPHY
INVEST IN ARCHITECTURAL PROJECT & FACADES
SAVE ON AIRCON & ENERGY CONSUMPTION

HOLISTIC APPROACH
OPTIMISED RESOURCE ALLOCATION

Due to the holistic approach the resource allocation has been optimised. This is especially important for daylight-controlling / artificial lighting and bio-climatic concepts / air conditioning. Artificial lighting and air conditioning per se - in average - is responsible for 85% of the overall energy consumption in office buildings (comprehensive values for schools with air conditioning are not available yet), sharing the consumption about equal parts. The installation of air conditioning systems is expensive. The direct costs for equipment and installations, which make up 1/3 to 1/10 of the total construction costs, an additional cost for this suspended ceiling and increased floor height has to be added.

NEW METHODOLOGY
FOR ENERGETIC & ECONOMIC EVALUATION OF DAYLIGHT-CONTROL-SYSTEMS

To realize an economic analysis of different daylight solutions it was necessary to develop a new methodology, based on a Test Reference Year. With this methodology, i.e. on the so-called "Yearly Daylight Autonomy" for any space, geometry and geographic localization. This calculation is the key for any economic analysis on daylighting/daylight-control-systems. An extension of this methodology, i.e. on the "Internal Thermal Simulations", includes the thermal aspect of artificial lighting and daylighting.

YEARNLY DAYLIGHT AUTONOMY OF 86% FOR AN AVERAGE CLASSROOM

Artificial lighting participates with 40-50% to the energy consumption of air-conditioned buildings. The daylight offer in Rio de Janeiro is generous. Daylighting is obviously an interesting option to save energy (despite positive health and performance effects). To engineer the façades in order to guarantee thermal and visual comfort under variable conditions, the simulation tool RADIANCE was used. This tool calculates the daylight distribution under defined parameters.

For an average classroom a yearly daylight autonomy of 86% was calculated (8 am to 3 pm, minimum of 500lux > Brazilian legislation).

NATURE OFFERS FOR FREE
12,350 MWH/A COOLING THROUGH EVAPOTRANSPIRATION

What nature offers for free is its evaporative cooling through unsealed surfaces and plants. With 26.4% unsealed surfaces and a potential of evapotranspiration of 12,350 MWH per year. While it is difficult to calculate the exact economic benefit, it definitely brings down the cooling load where air conditioning is necessary and, we in the case of the Minimum-Energy-School where comfort is within reach without air conditioning, to avoid this expensive investment and the corresponding follow-up costs.

LOWER INVESTMENT COSTS PREDICTED
+ HUGE SAVINGS IN ENERGY COSTS
AVOIDING AIRCON SAVES 1/3 OF CONSTRUCTION COST
ENERGY CONSUMPTION 80-90% LOWER
SLIGHTLY HIGHER COSTS FOR FAÇADES
HEAT ISLAND WHILE NEW CONSTRUCTIONS CONTRIBUTE TO HEAT COOL ISLANDS, THIS PROJECT CREATES A COOL ISLAND

Buildings generally contribute to heat islands due to its thermal mass heated up by solar radiation. The "Minimum-Energy-School", on the contrary, creates a cool island with shaded facades, green roofs and a recuperated rain forest surrounding the complex.

Instead of worsening the microclimate for the neighbourhood, what generally happens with new buildings, this project improves the situation.

FLEXIBILITY THROUGH MODULATION

The school administration is following carefully actual discussions about changes in the size of classes, and how this decision might affect the physical space of building. To prepare the building for possible future demands, it counts with a modular layout system. The modules are based on the maximum width of the lower windows, the most expressive part of the facade. The flexibility gained with this modular system allows easy and fast changes in the layout of the building, reducing significantly the construction waste.

Horizontal installations supply for water, energy and media support the flexibility, allowing the multiplicity of functions possible for each room.

FUNCTIONS + SHORT WAYS DEVELOPED IN COOPERATION WITH CLIENT

The project is based on a clear spatial order and organization of spaces, meeting students and teachers creating an exciting and varied ensemble. It counts with optimised functionality and short ways, elaborated with the pedagogical staff of the college.

INTEGRATION INDOOR + OUTDOOR

The project emphasizes the integration of external and internal spaces, inviting students and teachers to use the natural environment as often as possible.