Harnessing Traditional Building Techniques to Produce Sustainable Architecture

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I come from Burkina Faso, a landlocked country in West Africa where building and rebuilding are a part of everyday life. Every year the rainy season takes its toll, and people have to start again. This process is a part of the local culture, but it is also a problem for village communities. Rebuilding demands valuable time and resources which could be invested elsewhere, and holds back development. Building methods are in need of a radical overhaul.

Africa’s development is hampered by a lack of education and architectural knowledge. In francophone West Africa there is just one school of architecture, and few can afford to attend it. In addition to this, most African architects look to the West for their inspiration, or have clients who require them to emulate Western designs. This produces buildings which are not well suited to the climate and culture, and which are dependent on imports for their construction and maintenance. Africa is in desperate need of infrastructural buildings such as schools, and of a type of architecture which takes the socio-cultural and economic context of the region into account. The challenge is how to achieve durability while using minimal resources and technology.

Unfortunately in modern day Africa, ‘progress’ often means concrete buildings which rely on air conditioning. Even in cities this is problematic, as the materials are prohibitively expensive. But in rural villages where there is no electricity, air conditioning is simply not an option. Western designs and materials are often inappropriate in the developing world.

Achieving sustainability in developing countries requires confronting the conventional conception of progress and modernity. Bernard Rudofsky’s 1964 book “Architecture without Architects” challenged the prevailing views of the day and remains highly relevant today. Rudofsky opposed the ideas of Le Corbusier and other architects that Western technology was the solution to problems around the world. He believed that developing countries are not backward – they have their own technologies and know-how. Together with a host of emerging contemporary architects around the world, I am trying to revive traditional building methods and materials, and to combine them with modern innovations. Here are some examples of how this can be achieved:

In 1998 I designed a climatically adapted school for Gando, the village where I was born, 200 kilometres east of the capital city. I still remember being one of 160 pupils in a concrete classroom, and the intolerable heat inside. I wanted to build a school which was better, simply better. A school which was built out of locally available materials, but which would also withstand the rain season. A school with a cool interior and good working environment. In order to do this, I decided to build the school out of clay.

The beauty of clay is its abundance. We have the earth to make bricks; we just have to dig. Clay is available locally, and the people are used to working with it. When I first proposed building a school out of clay, the village community was sceptical. They were enthusiastic about having their own school – until then the children had had to walk or cycle 15 kilometres to the nearest town, and many had to work in the fields. But they were doubtful as to whether a clay building could withstand the rain season. In order to
persuade them, I had to build models, inviting the villagers to test their strength, and demonstrating its durability. The school was completed in 2001. 11 years on the school is still standing and has required no maintenance. Clay had been thought of as a primitive building material – a resource for the poor. Today the school with its clay walls, ceiling and floor is a source of pride.

The three classrooms are arranged in a linear fashion and separated by covered outdoor areas that can be used for teaching and for play. The walls are made of stabilized and compressed mud bricks, which keep the interior far cooler than conventional concrete buildings. Concrete beams and steel bars run across the width of the classrooms, supporting a mud brick ceiling. To protect the walls from erosion the school is built on a base of cement, and a wide overlapping tin roof shields them from rain.

The roof design was determined by practical considerations. Due to the prohibitive cost of cranes and transportation, the design used steel bars to make lightweight trusses, with tin sheeting laid on top to form the roof. This could be assembled on site, and once taught how to use a handsaw and a small welder, the villagers themselves could do the work. The roof is raised above the clay walls by a steel structure. Hot air in the classrooms rises through slits in the ceiling, drawing cooler air from below. Kéré set out to build what he calls ‘buildings that breathe’ – buildings that work with the climate and not against it - and this is the result. This technique reduces the temperature in the classrooms by 6 - 8°C without any electricity.

Construction was carried out entirely by people from the village, and this is crucial to the sustainability of the project. Only those who are involved in the development process can appreciate the results achieved, develop them further and protect them. Men made clay bricks, women patted down the floors and children brought stones to build the foundations. Local craftsmen received on-site training, and the skills were transferrable for further initiatives in the village and elsewhere. Two neighbouring village communities subsequently built their own schools as a cooperative effort. The local authorities have also recognized the value of the project: not only have they provided and paid for the teaching staff, but they have also endeavoured to employ the young people trained there in public sector projects, using the same techniques.
The impact of our projects has been strengthened by a long term attachment with Gando. Each project builds on what has come before – it doesn’t take shape in isolation. When the primary school became too small we built a school extension (Figure 8). Difficulties in ensuring staff attendance have been tackled by offering on-site teachers’ housing (Figure 9).

Education is the starting point of development. However, in a community such as Gando, it is essential to serve the broader needs of the people. Therefore we have undertaken complementary projects including a library (Figure 11), new wells, a vegetable garden (Figure 12) and a mango tree nursery (Figure 13). In order to assist a locally based women’s cooperative, we are currently building a women’s centre (Figure 10). And in 2014, our biggest project yet will see the light of day: a secondary school for Gando.
The secondary school complex will consist of 12 classrooms, teachers’ housing, offices and a circular building comprising a library and meeting hall. Between the classrooms there will be shaded areas where pupils can study or relax. In the style of traditional compounds, the secondary school will be surrounded by a wall, protecting it from wind and dust. Sandstorms come from the north east, and therefore the building faces west.

In terms of the construction, the secondary school displays a radical new innovation. Clay is no longer made into individual bricks: instead, the walls of the secondary school are made by pouring a mixture of clay, gravel and cement into a mould, producing much larger sections. In this sense, clay can be cast just like concrete. Using this method, the clay no longer has to be sifted – it can be used as it is when dug out of the ground, which saves time. This is a classic example of a way in which traditional materials can be combined with simple modern innovations and methods to produce a sustainable form of architecture.

Construction of the secondary school began in January 2012, and by March the foundations had been finished. It takes two days to complete three wall sections, which are slightly curved to make them more robust. They are produced using a two-piece iron mould, bought with the prize money from winning the Holcim Regional Award Gold last year.

The protective wall will be a bank of earth, shielding the buildings and courtyard from the heat and from sandstorms. Trees will be planted in the courtyard and on the earth banks to provide shade for the pupils during break times. And finally, what has been called a “passive ventilation system” will be put in place (Figure 15).

Perpendicular to the earth bank, a concrete pipe 120cm in diameter leads to each classroom, which is water-cooled. Wind power is harnessed to pump groundwater into a water system, which channels it into the pipes. The water and moisture lead to a reduction in temperature. The water then flows out of the pipes, and is used for irrigation of the fields. Inside the pipes the air is cooled, and emerges in the classrooms through slits in the floor.

A simpler back-up system will also be installed. Vegetation on the earth banks must be watered while minimizing water loss through evaporation. This is done by storing water in traditional clay pots, and
placing them next to trees and plants, with drippers directly targeting the roots. The clay pots only have to be filled once a week, keep the water cool, and the plants are provided with a small but constant supply of water. Moisture from the plants seeps through the soils, and enters the concrete pipes.

The corrugated tin roof, which is raised above the clay ceiling, is heated by the sun. Air between ceiling and roof heats up and rises, drawing cool air from below and thereby creating a current. The classrooms are protected from the heat above them by the thick clay ceiling, and hot air inside can rise through slits in the ceiling (Figure 14).

Cool air enters the classroom through the floor, leading to a reduction in room temperature of between 6 – 8°C. This is a zero emissions under floor cooling system, using a combination of solar, wind and thermal energy. This passive ventilation system requires no electricity and very little maintenance, making it well suited and acceptable to the community. In this way the project revives two building techniques of the Sahel, which were used for centuries, but which have sadly been forgotten since the era of industrialization.

Reforestation of the area is another important aspect of the project, in an attempt to halt the desertification of the region. Due to global warming and deforestation, the Sahara desert is expanding southwards, and sandstorms are becoming increasingly common. Due to the rapidly increase in population and predominant use of firewood as fuel, 60% of Burkina Faso’s trees have been chopped down in the past 15 years. With its plants and mango trees, the secondary school complex will be a green island in the Sahel. Through the spreading of education and ideas such as the clay pot dripper technology, the village community will in the long term have the know-how to preserve these ideas, and to spread them to other parts of the region.
Another innovation is the use of eucalyptus to wood as a construction material. Although not an indigenous plant, eucalyptus is a popular of plant as it grows very quickly. The disadvantage is that it produces little shade, no fruit, and soaks up vast quantities of water, which endangers agriculture in the surrounding area. Therefore we encourage replacing them with mango trees.

Due to the training of local people and the simplicity of the technologies used, the villagers are not dependent on external specialists should the buildings require maintenance. This distinguishes the project from many other well-meaning but ultimately problematic ventures. A building is not sustainable if there is nobody in the local area who can repair it. The necessary skills to produce and maintain buildings such as the first primary school will be passed on to future generations, and in this way, a new culture of building will develop.

Despite the fact that more than 80% of people in Gando are illiterate, and the demands on children to work in the fields, the scale of our projects is increasing. The first primary school was designed to accommodate 120 pupils, and today it has 300. The school extension created space for a further 500. The secondary school will be large enough for 800, with a full capacity of 1000. This is the estimated level of demand in five years’ time; by planning ahead, we can cater for future needs and ensure that the project doesn’t rapidly become obsolete.
The secondary school project aims to combine the qualities in all of the projects implemented over the past decade. Firstly, the local community will continue to be involved in the construction process. The villagers of Gando are extremely poor and in desperate need of development. But they are also the country’s greatest asset, and the key to solving their own problems. They want to be part of the development process, not just in implementing it, but in conceptualizing it in the first place. The enthusiasm and willingness of the community to participate is essential to the project’s sustainability. The project to build a secondary school is an attempt to enable the community of Gando to help themselves, and to achieve development through education. Of course this is neither the quickest nor the simplest way, but in the long-term, it is the sustainable one.

Secondly, the combination of traditional materials and methods with modern innovations will be implemented and further developed. Traditional clay structures can only span a small area and are not appropriate for building a school. Only by putting together the local materials with a new approach, drawing on western know-how without relying on hi-tech solutions, can the project succeed.
There have been problems and setbacks, but I believe that in a few years, it will be fashionable to build houses out of clay in Burkina Faso. As yet the Burkinabè are still convinced that clay isn’t as durable as concrete. You just have to show them that clay needs to be handled differently. In this country, a house made of clay is far better than a concrete one. There have already been several cases of projects using a similar design based on clay. A building has been erected in Garango along precisely these lines, and a businessman in Laongo used the same principles to build accommodation for his workers.

In March 2012 the secondary school project was awarded the Global Holcim Award Gold and fittingly, a second ceremony was held in Gando in December (Figure 20). It was an unexpected honour and a great source of encouragement to be presented with such a prestigious prize. But most important of all, it was a call for action, to continue our work, and to take our projects to the next level.

References

Rudofsky Bernard, Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture, 1964