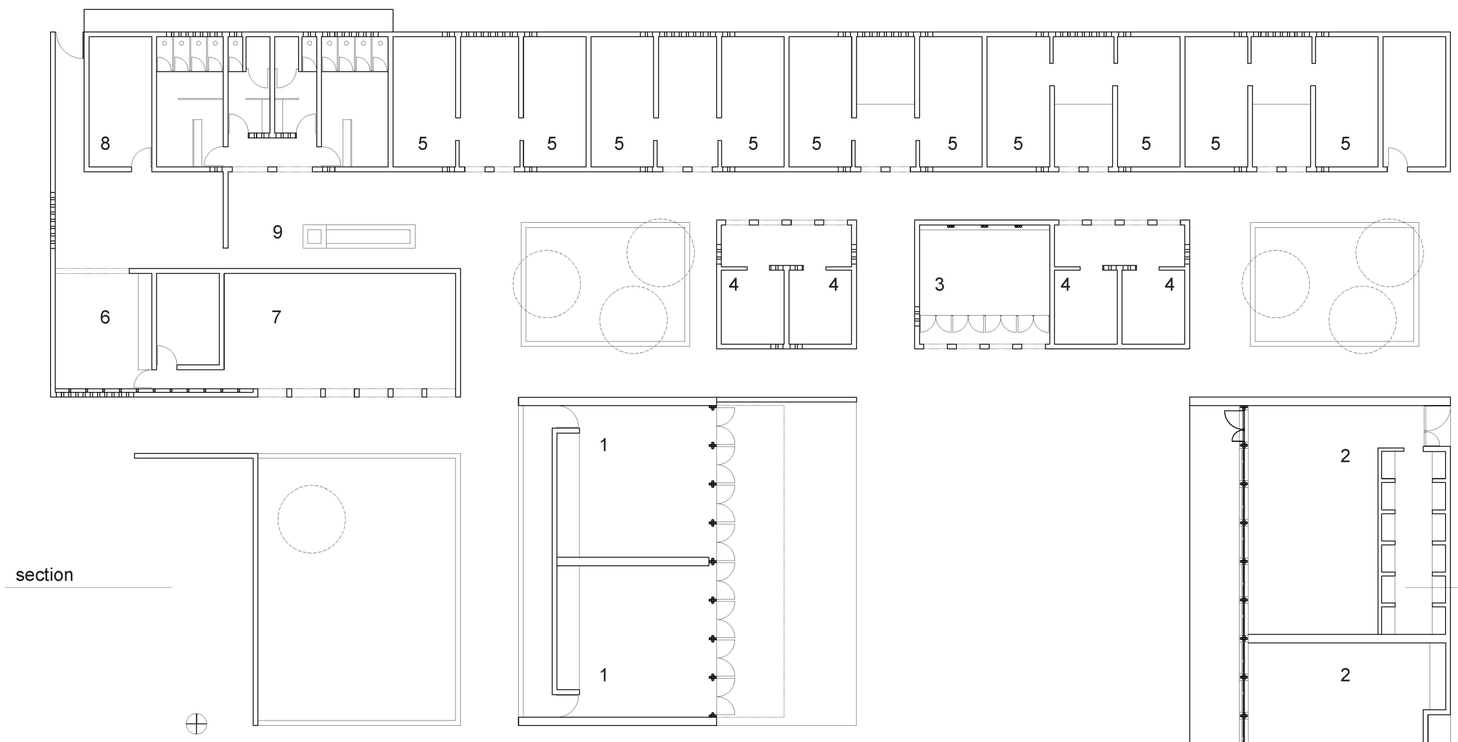
Skills Centre Malaa - a vocational school near Nairobi, Kenya

main facade of workshop building, photo © M.Kestel



1 workshop
2 classroom
3 staff room and office
4 teachers rooms
5 student dormitories
6 kitchen
7 common room
8 solar power room
9 well

floor plan of shool facilities, scale 1:200

facts and collaboration

size GFA	850 sqm
construction time	10 months (2011/2012/2014)
latitude	-1° 18‘ 20‘ (South)
longitude	37° 9‘ 7“ (East)
altitude	4.907 ft / 1.495,70 m above mean sea level
client	promoting Africa e.V., Germany Youth Support Kenya, Kenya
architecture	students from Technische Universitaet München (Chair for Timber Construction, Prof. Hermann Kaufmann) and Augsburg University of Applied Science (Faculty of Architecture and Civil Engineering, Prof. Susanne Gampfer)
supervision and project architects Germany	Prof. Stefan Kroetsch (Munich/Kaiserslautern) Prof. Susanne Gampfer (Munich/Augsburg)
project architect Kenya	Martin Mbidhi (Jomo Kenyatta University of Agriculture and Technology, Nairobi)
project management and site supervision	Prof. Stefan Kroetsch, Munich Prof. Susanne Gampfer, Munich/Augsburg Matthias Kestel, Munich/Augsburg Christoph Perl, Munich Kalle Ulrich, Augsburg Sybille Ritzkowsky, Augsburg Benjamin Bauer, Augsburg
consultant bamboo construction structural engineering bamboo	Andry Widyowijatnoko, RWTH Aachen Hannes Hofmann, Stefan Kroetsch, Thomas Horejschi, Susanne Gampfer
structural engineering stone/concrete structural consultant	Stefan Kroetsch Ing-Buero Kaspar und Teuteberg, Munich

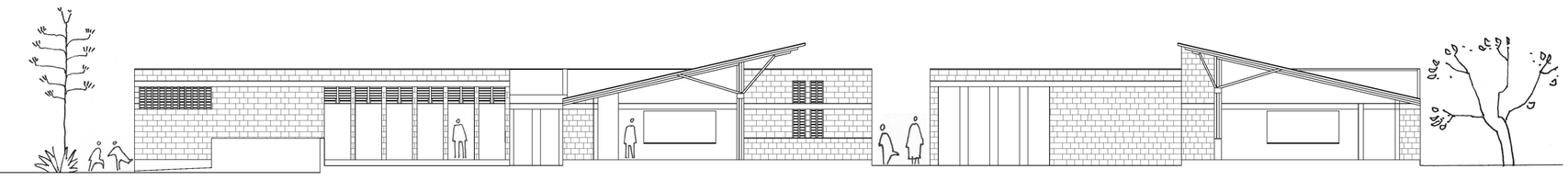
about the project

The project was initiated by cooperating Kenyan and German NGOs, who have been successfully supporting juveniles of Nairobi’s second largest slum Mathare for almost a decade. In order to offer practical advanced training following secondary school education, the vocational school offers courses for mechanical, technical or agricultural skills as a basis for self-employment or high quality jobs in cooperating businesses. On large site in a rapidly developing peri-rural area East of Nairobi selected by the local operator a master plan for the training complex was designed to ensure sustainable growth and development of the school. The school buildings have been brought up in several stages, within a total construction time of only about 10 months spread over a period of three years. During this time, the training concept and administrative structure of the facility have been developed in close collaboration between Kenyan and German operators.

The final stage of the school has been completed in September 2014. The boarding school now has four workshop and classroom units, dormitories for about 60 students and four teachers, a multi-use office and preparation space, sanitary rooms, a communal kitchen and a large community room. There are separate store rooms for the kitchen, for farming and for the classrooms, as well as a technical room for the solar power unit and hot water generation. Generous open spaces for the workshops and for recreational use are provided and a large portion of the land was kept clear for organic farming. Here students are trained in vegetable gardening, producing food for their own supply and for income generation. The same principle is used for other goods like furniture produced in the joinery class, which is made to order and sold to support the school. The general architectural concept of the complex is a system of cubic buildings and courtyards creating a variety of indoor and outdoor spaces. Each courtyard has a different atmosphere according to its use (garden court, water well court, kitchen court). The sequence of these outdoor spaces forms a gradient of intimacy from the more public common spaces to the private courtyards in front of the sleeping rooms. This creates a sense of place and space within the open agricultural area surrounding the site.

design and build

The problem-oriented teaching method of design-build offers an intensive approach to architectural studio projects, which is both challenging and motivating for the participants. While conventional architectural education is usually limited to theory, design-build projects offer the possibility to combine design and research with the practice of experimental building. The goal is an in-depth understanding of the relation between material, construction and aesthetics. On the broader scale of buildings in their local context, design- build is an excellent method of improving social and environmental awareness of participating students through personal experience.



East-West section through shool facilities, scale 1:200

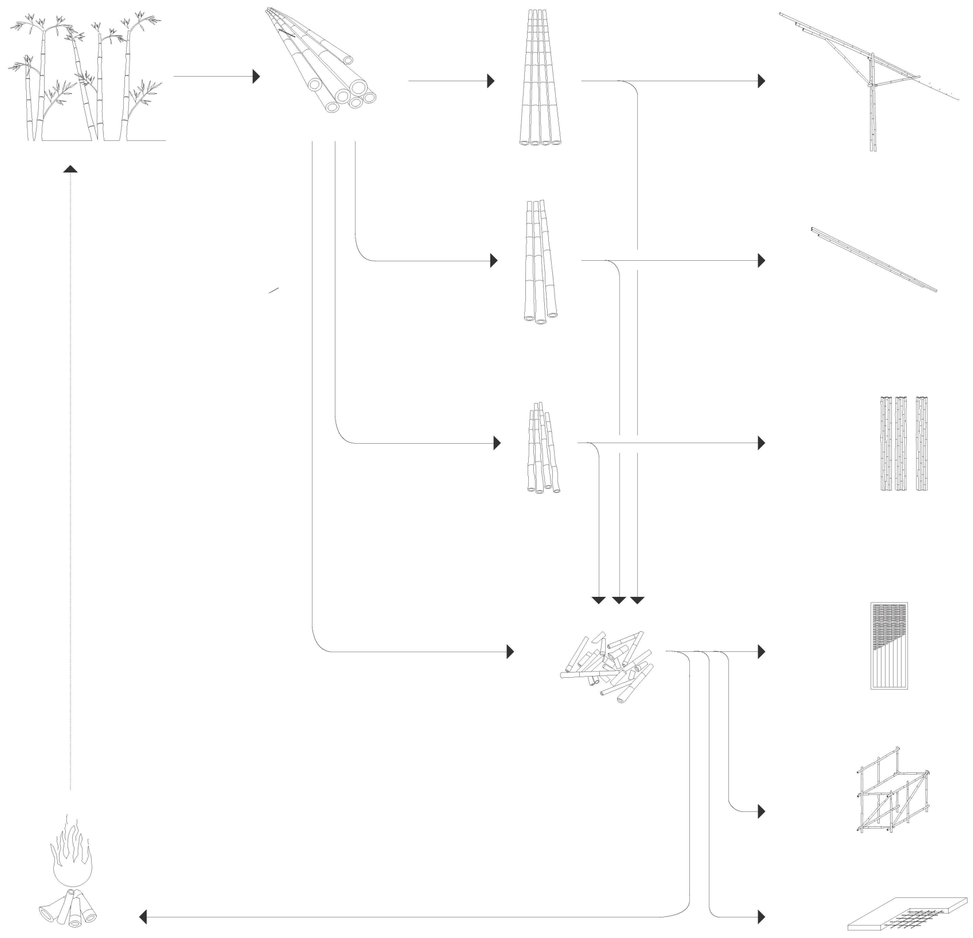
view of main access with kitchen building, photo © M.Kestel

view of courtyard and student dormitories, photo © M.Kestel

African bamboo forest

bamboo harvest

cleaning of bamboo culms photos © S.Gampfer



bamboo culms stacked for sorting

roof of the classroom building under construction

natural building materials: stone and bamboo

sustainable materials - natural stone and bamboo

The choice of materials was based on two principles: firstly, to use the traditional, labour-intensive local natural stone, in order to root the building in its context, create income for local workers and benefit from the physical qualities of walls with thermal mass in a hot and dry climate; secondly, to work with bamboo as an exceptional building material with unusual structural and environmental potential in order to substitute timber in the wide-span roof construction. The natural stone was processed on site and built up with the know-how of the local construction team. The stone walls were left visible on all exterior surfaces to contrast with the colour and texture of the filigree bamboo structure.
The commercial use of indigenous African species of bamboo is very limited as yet. In this project, Yushania alpina, the African mountain bamboo, is not only the main structural material but dominates the appearance of the buildings and the atmosphere of interior spaces. Bamboo is an extremely interesting ecological alternative to wood, concrete or steel in East Africa. At the outset of the project, physical properties, quality and availability of Kenyan bamboo were largely unknown, buildings with a load-bearing bamboo structure of comparable size do not exist in Kenya. Therefore, little was known about its durability, nor were craftsmen available who had any experience of working with it. Information about the availability and qualities of Kenyan bamboo was only gained in the course of a preparatory journey.
The bamboo for construction, harvested less than 200 km from the site, was treated for insect protection immediately after harvest, using a salt solution, then cleaned and dried carefully. To avoid cracking, the culms need to be perforated in every internode, which was done by piercing each diaphragm lengthwise. The bamboo material was then sorted, following a grading system especially developed for this project (see diagram), which allowed utilising as much of the harvested material as possible. Only about 10–15% of the material was suitable for sophisticated truss construction, other strong but not so straight culms were used for smaller roofs.

view from inside a workshop, photo © M.Kestel

Western facade of the classroom building, photo © S. Gampfer

For three different types of roof spans - accommodation, kitchen and workshops - load-bearing structures and requirements were designed that allow bamboo canes of quite different quality to be used. Lower grade stems went into auxiliary constructions like scaffolding. The remaining bamboo material was split to strips to form reinforcement for small floor slabs or to make door fillings. The structural qualities of the Yushania were carefully tested, using material testing laboratory equipment to determine the strength. For the rigidity and strength of connections, however, no reliable values were available, until prototypes of different types of trusses and beams provided more extensive information about the structural properties. The beams in the workshop buildings were manufactured complete with columns and struts. Despite the size of the elements, it was possible for five or six workers to assemble them quite simply and without an additional supporting construction. In addition to the bamboo structure, all roofs have a ventilation space between a continuous layer of woven papyrus underneath the roof sheets. Roofs over dormitory rooms are made of a continuous bamboo ceiling and covered with an additional layer of straw-clay for thermal insulation.

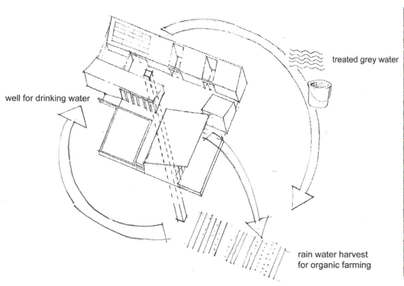
The use of renewable materials in construction has a positive effect on the use of energy and emission of CO_2 caused by construction activities, while cultivation of crops used as building materials is an ecological income generating measure and can help to stabilise the eco-system of man-made environments. With harvesting cycles of about three to five years, which are much shorter than those of timber, bamboo also has great potential for fast reforestation of abandoned agricultural land in Kenya, helping to reduce erosion and to sustain natural watersheds.

view from inside the kitchen, photo © M.Kestel

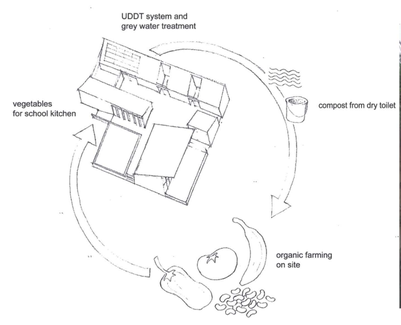
dormitory roof construction with clay cover, photo © M.Kestel

sustainable concepts for energy, water, recycling and waste disposal

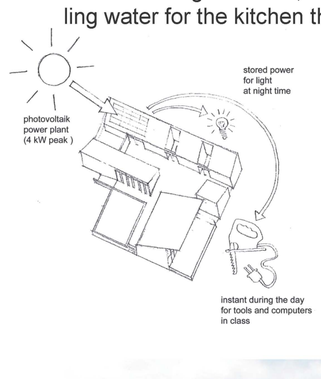
Several aspects of a sustainable building design have been the guiding principles for the Skills Centre: Renewable or local building materials, low-tech construction with little environmental impact, a climate related design of layout and structures as well as a supply and waste management concept independent of public infrastructure. Building on a rural, undeveloped site, a self-sufficient supply of water and regenerative sources of energy were as relevant as a concept for on-site waste-disposal. Therefore, the school is independent of public power supply and separates and recycles its wastewater on site. The roofs have a low pitch towards the courtyards so that much of the rainwater can be collected for agricultural use.



Water and sanitation are among the most pressing challenges for rapidly developing rural areas aroung Africa‘s large cities. While it was necessary to dig a deep well to satisfy the demand for clean drinking water for cooking and personal hygiene, large storage tanks for rainwater harvesting were also provided. The master plan allows for enough farm land on the site of the Skills Centre to produce the fresh vegetables used in the school‘s own kitchen as well as a surplus which can be sold off site.
The school is using UDDT (Urine Diversion Dry Toilets) as a prototype strategy, which has been tested successfully in similar contexts. The toilet chambers are slightly raised and fitted with solar chimneys to ensure ventilation. Toilets are used alternatingly to ensure sufficient time for the contents of the waste chambers to dry before being used as fertilizers on the agricultural land.



Photovoltaic collectors produce the power needed for the workshops as well as for lighting and the electrical pump refilling the fresh water tank. Batteries with a total capacity of 4 kW provide the necessary energy store to be independent of daytime and weather, as there is no accessible public grid. There are additional thermal collectors for hot water generation, as well as a large solar cooker, which is used to provide boiling water for the kitchen throughout the day.



mounting of solar collectors, photo © L.Hinterholzer

Susanne Gampfer was born in 1965 in Stuttgart. She studied architecture at the Technical University in Munich and the University of Bath, and received her diploma in Munich in 1991. She has worked in several architectural practices and since 2003 on her own projects for the conservation and restoration of listed buildings. From 2002 until 2011 she was scientific and teaching assistant for the Department of Timber Construction (Prof. Hermann Kaufmann) at the Technische Universitaet Muenchen. In 2011, she was appointed Professor for Sustainable Building Construction and Materials at the University of Applied Science in Augsburg, and was elected Dean of the Faculty of Architecture and Civil Engineering in 2013.

Stefan Krötsch was born in 1973 in Munich.
He studied architecture at the Technical Universities in Munich and Wroclaw. After graduating in 2001 he worked at well known architectural offices in Munich until he founded his own architectural office in Munich in 2005.
From 2007 until 2014 he worked as scientific assistant and teacher at the Departement of Timber Construction (Prof. Hermann Kaufmann) at the Technische Universität München.
Since 2014 Stefan Krötsch leads the new established Department of Timber Construction at the faculty of architecture at the Technical University Kaiserslautern.