朱竞翔 | 三十天在九千公里外的贫民窟建设一座学校

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“如何克服九千公里的距离，在肯尼亚内罗毕的贫民窟里建设一座房屋？”MCEDO学校项目位于肯尼亚首都内罗毕东北郊的一个“贫民窟”中，而设计师在九千公里外的香港运筹帷幄。设计必须充分发挥轻型预制结构的特长，严格控制现场施工时间，以应对“贫民窟”的复杂社会情况，为贫民窟改造提供新的可能。

“How to construct a building in one of Nairobi’s slums 9,000 kilometers away. ”With its Hong Kong-based architects overseeing the entire process, the MCEDO School located in one of Nairobi’s informal settlements, features a lightweight, prefabricated structure, which ensures a tight control of on-site construction duration, as a way to deal with social complexities there and to inspire new potential for slum redevelopment.

↓ 轻型建筑的无限可能

Inexhaustible Potential of Lightweight Architecture

▶项目背景

Background

MCEDO学校全称马萨雷儿童教育与发展组织，扩建工程由肯尼亚中国经贸协会赞助。该项目是中国独立建筑师第一次在非洲大陆的贫民窟中设计和建造学校，将“中国设计”带到了世界上最“贫困”的地方。

MCEDO's full name is Mathare Children's Education and Development Organization. The expansion project was sponsored by Kenya-China Economy and Trade Association. It was the first time that a Chinese independent architect designs and operates in a slum in Africa, bringing 'Design-in-China' to the least developed place.

2014年9月，一座崭新的轻钢结构的校园建筑落成于肯尼亚首都内罗毕东北郊的“马萨雷谷”社区中。这座建筑低调地矗立在这片被常人看做“贫民窟”的社区的边缘，亮眼但不突兀。它采用了灵活的轻型预制结构，所有构件在中国制作，并经过一个月的海运到达内罗毕，现场施工的工人均来自当地，耗时一个月完成建造。两座二层楼的教室，中间形成一个内院，面向西边的立面设立了可移动的遮阳格栅，以低廉的造价为大约600名贫民窟儿童提供了学习和娱乐的空间。

In September 2014, the construction on a light steel structure school was completed in the Mathare Valley community on the northeastern outskirts of Nairobi, the capital city of Kenya. Standing on the edge of what is known as an “informal settlement”, the building features a flexible lightweight prefabricated structure, whose components are all made in China and shipped to Nairobi. The local workers spent one month constructing the school, which has a couple of two-storey buildings that enclose a courtyard, with sliding aluminum sunshades on the west facade. The low-cost project offers brand new classrooms as well as recreational spaces to nearly 600 students from the community.

| 新校舍低调地站立在贫民窟的边缘 |

The new school building sitting in the margins of the settlement

| 西立面上可移动的遮阳格栅 |

The movable sun-shading grating on the westelevation

| 学校的内院 |

The internal courtyard

肯尼亚当地的材料、工具、熟练技术工人的条件和中国相比，非常不足，而陌生的语言、文化环境，使远程的建造工作充满了种种不确定性。在充分考量这些难题期间，团队基于过去的工作，构想了可折叠的轻型结构系统——它能够通过易于操作的机械变形来实现预制建筑的装箱、远程海运与现场组装，同时也在内部提供了别具一格的空间品质。

The remote-control construction work is riddled with uncertainties due to the underdevelopment of building industry in the country, coupled with the alien language and cultural environment. Confronted with these hurdles, the team has conceived a foldable lightweight structural system featuring easily operated mechanical deformation, which could guarantee the encasement, cross-border shipping and on-site assembly of prefabricated structures and distinctive, quality interior spaces.

| 二层教室墙板安装前 |

The second-floor classroom before its wall panels were installed

可折叠的结构系统采用Y型柱支撑整体结构，在内部空间形成有趣的序列。

The Y-shaped pillars that underpin the foldable structural system constitute an interior sequence.

| 一层教室内景 |

The interior of the ground-floor classroom

| 可折叠结构单元 |

The foldable structural units

可折叠的轻型结构系统是这样工作的：两块标准大小的上下层楼板通过端部的四根Y型支柱连接。每个支柱使用三个铰接点，其中一个带插销。当插销被移除后，这个基本结构单元可以拍平折叠。

This is how the structural system works: two standard-sized floor slabs are connected by four Y-shaped pillars, each of which has three joints-one of them with a latch. The unit is easy to fold up after the latch is removed.

| 可折叠单体在现场的拉伸过程 |

One of the foldable structural units being unfolded

▶总体设计

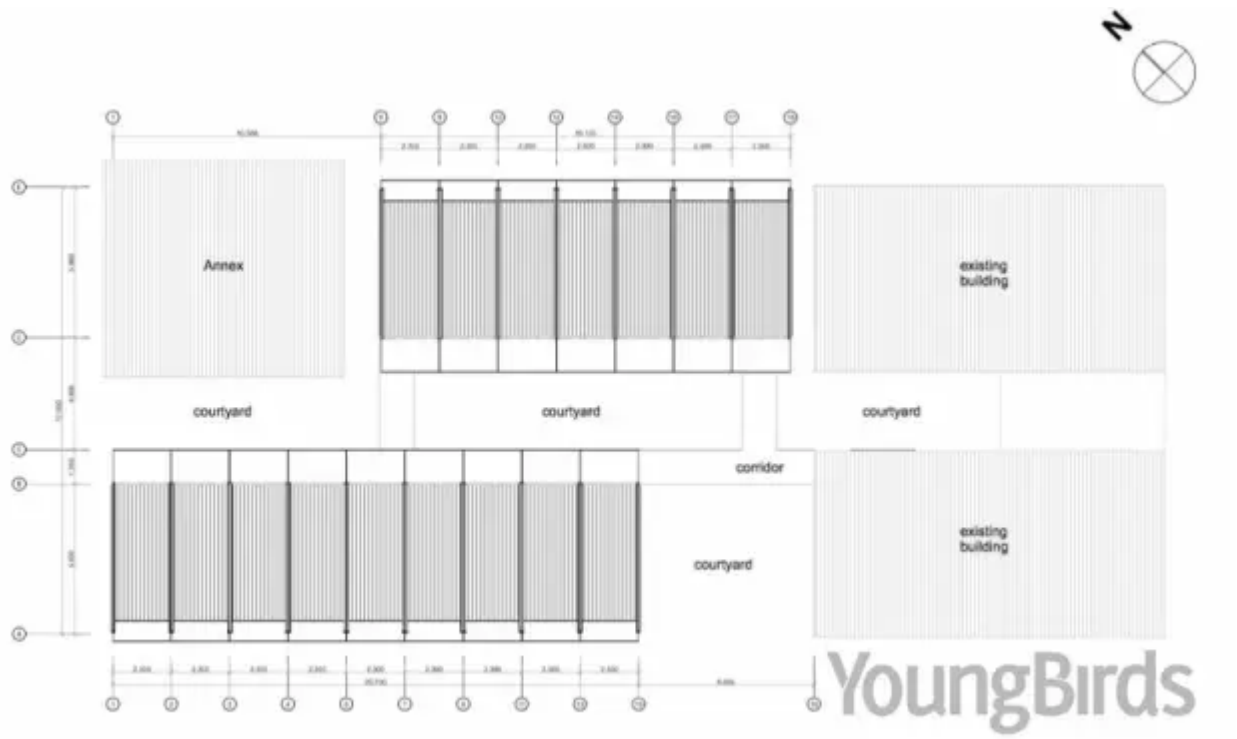
Master scheme

MCEDO学校项目的建设面临很多挑战，包括造价控制、时间紧迫（从设计到建成不到半年）、现场施工技术差以及复杂的施工环境。在实施过程中能够一一应对这些挑战，这主要得益于设计师对于流程的把控以及以此为出发点进行的设计。

The construction work is full of challenges such as cost control, a tight schedule (less than six months from design to completion), poor building techniques and complicated construction environment. All this has been overcome thanks to the precise control of procedures and strategies based on that.

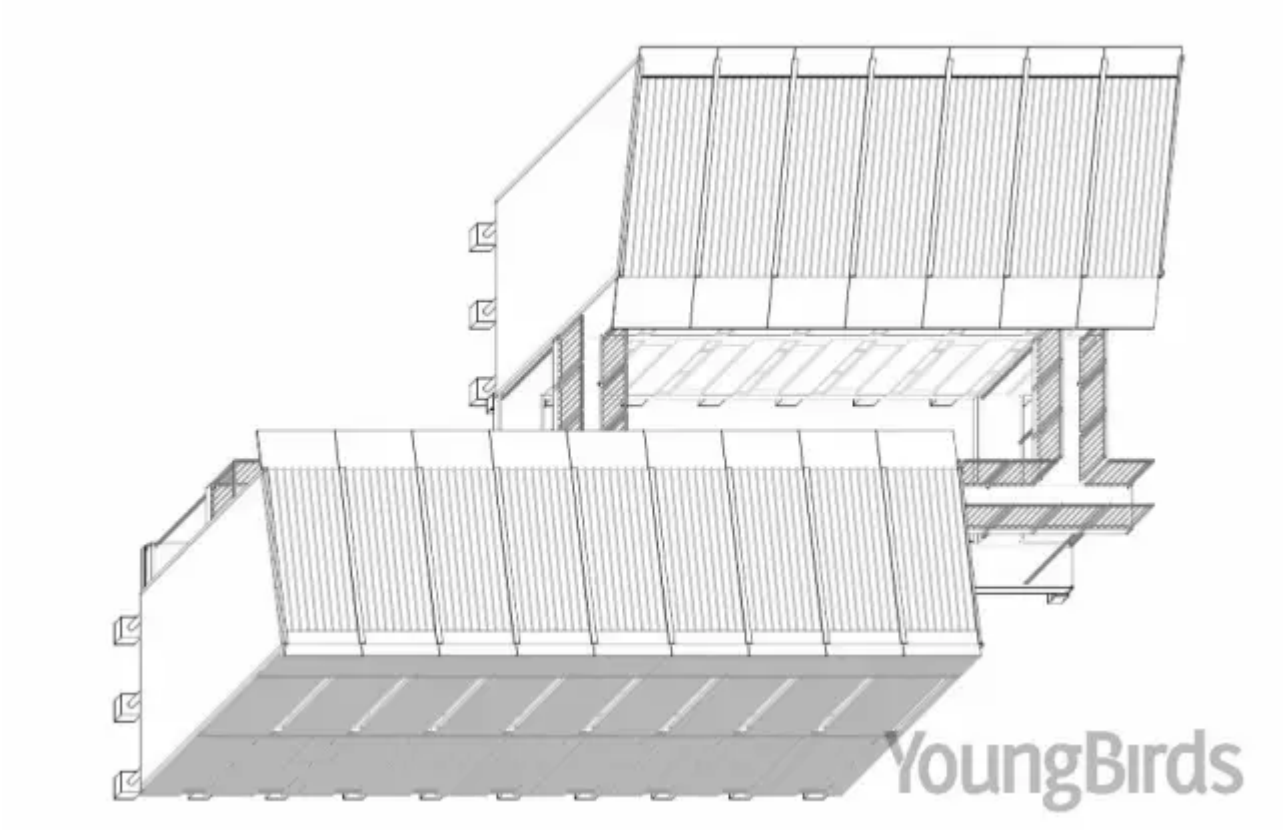
由于跨国运输依赖集装箱海运，集装箱尺寸参数与运输成本的调查分析帮助决定了结构单元尺寸：结构单元的宽度由集装箱净宽2.35米减去容错界定，长度则为6米，40英尺集装箱长度方向可以放置两件，结构单元打包后多层叠放，接近填满集装箱的净高。

Given that cross-border transportation relies on container shipping, the analysis of container measurements help determine the dimensions of the basic unit: its width is the result of the container's net width of 2.35m minusing the error range and it is 6m in length. A container 40 feet in length is able to contain two unfolded units. The units, after folded up and stacked on top of each other, almost fill the container.



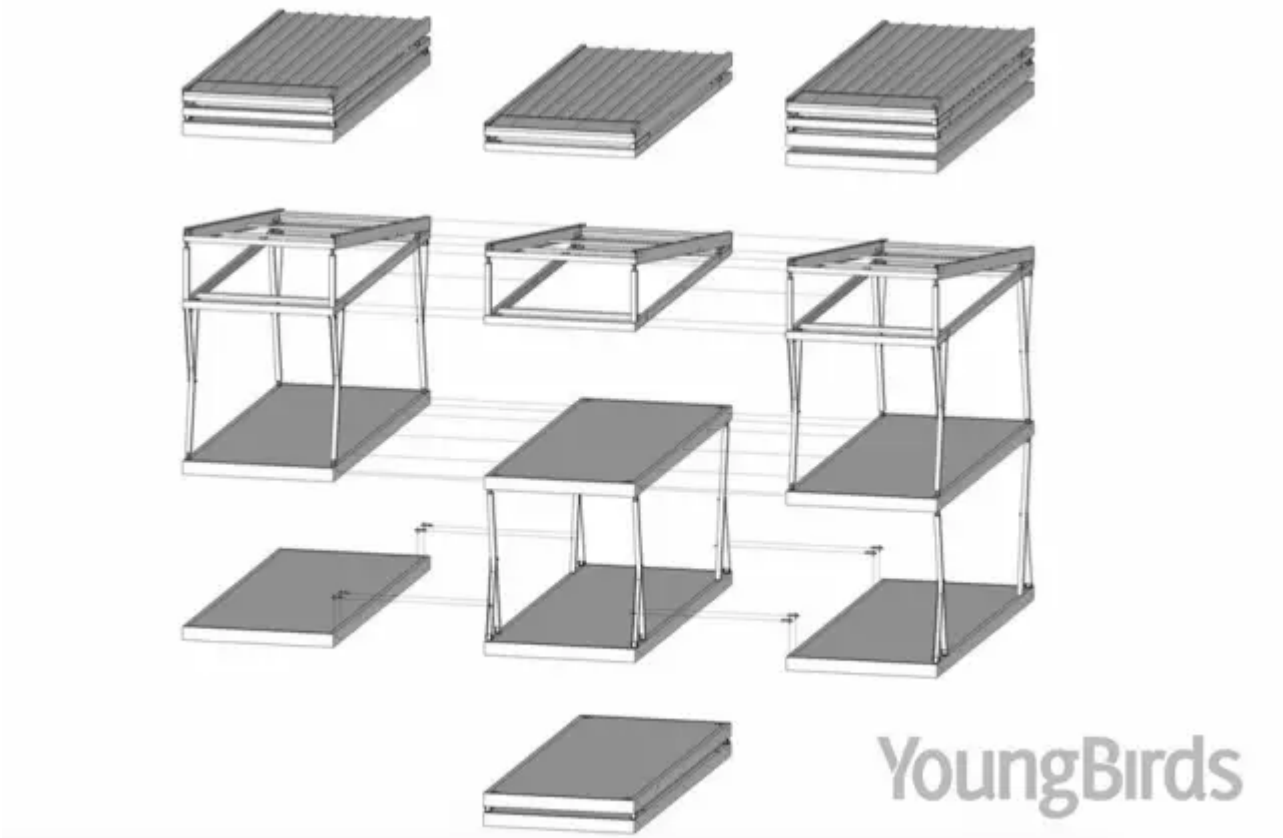
| 屋顶平面图 |

Rooftop plan



| 立体模型 |

Three-dimensional model



| 单体构件的类型和组合示意图 |

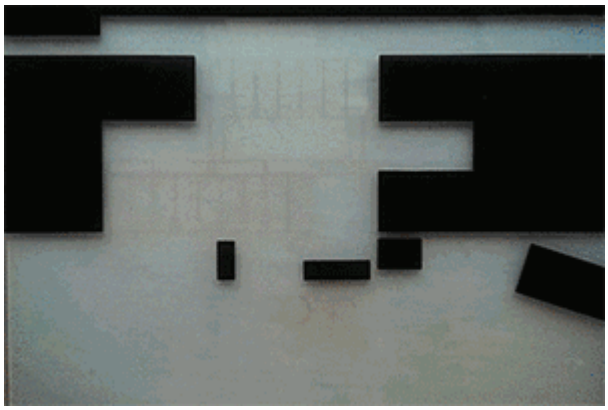
Various single units & diagram of assembly

| 结构单元构件的打包计划和实景 |

Unit-encasement plan & implementation

所有集装箱由一艘法籍货轮承运，经过一个月的海运从深圳赤湾码头驶抵肯尼亚蒙巴萨港。清关提货后，货物被转运至工地现场。接下来是建造过程最核心的部分结构吊装。结构安装必须依靠吊车进行，由于当地的吊车租用高达国内的三倍，并且吊车在现场的工作空间十分有限，而特定起吊重量下都有一定工作半径。整个吊装过程预先需要精密计划。这项工作通过模型推演的方式做了安排，并将流程记录，用于与吊装作业人员沟通。

A French cargo ship tasked with the shipping of these units set sail from the Chiwan Port in the southern Chinese city of Shenzhen and arrived at the Port of Mombasa in Kenya one month later. After customs clearance, the goods were picked up and transported to the construction site. Then came the most vital part of structure assembly, something impossible without cranes. However, the crane rental there is three times that in China. The site offers quite limited space for the crane to operate. And for safety reasons the crane has a working radius that does not allow the cantilever to reach every corner all at once. Since the moving of the crane is costly, the working proceure needs serious planning.The team, therefore, worked out a plan: use physical models to simulate the effect in advance, record the process and later discuss with the workers.

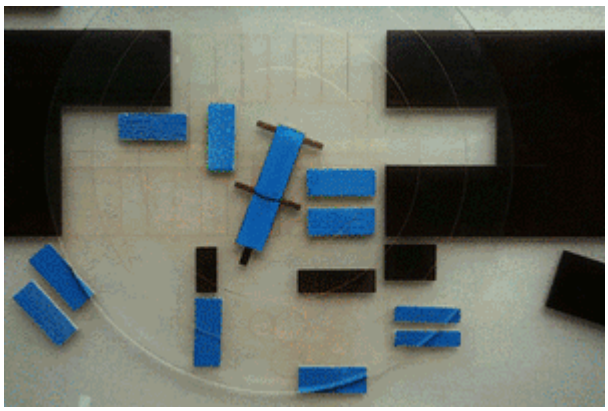


| 驶抵施工现场的计划示意 |

Diagram of the plan after arriving on the site

吊车（图中为蓝色）和货车（图中为灰色）

The crane (blue) & the truck (grey)



吊车和结构单体堆放的精确点位（图中为蓝色）

和结构单体（图中为绿色）

Precise position of the crane and units (blue) & the units (green)

为了节约时间和配合吊车的工作半径，设计师对每个结构单体的卸货—堆放—起吊—定位—安装次序都做了详细计划。

To save time and comply with working radius of the cranes, the architects made elaborate plans regarding the unloading, stacking, hoisting, positioning and assembly of all the units.

整个吊装过程中，除了吊车司机与两名吊装工以外，所有的安装工人均是从贫民窟本地临时招募而来，有不少人甚至连螺栓安装过程中最常用的棘轮套筒扳手都没见过。安装计划被设计分解为几个简单、重复的工作步骤。主体一共包含42次楼屋面板起吊定位和27次结构单元展开固定，吊车先将结构单元起吊至设计位置固定，再以吊钩将楼板或屋面拉起，四名本地工人各自负责一个角柱的螺栓固定。工人通过最初两三个结构单元的安装，熟悉了工具和操作流程，培养起协同工作的默契。每一个结构单元的安装时间由最初的2小时缩短到半个小时以内。所有吊装工作最终在5个工作日内完成。

All the workers, except the crane driver and two hoisting workers, were locally hired on a temporary basis. Many of them had not even seen ratcheting socket wrenches most commonly used to fix bolts. The assembly plan was broken down into multiple simple, repeated steps. For the main part, the floor slabs were hoisted and positioned 42 times and units unfolded and fixed 27 times. The units were first hoisted into positions as planned, then fixed. After that the floor slabs and roofing were lifted with lifting hooks and pillars were bolted onto the slabs. After assembling two to three units, the workers picked up how to use tools, to work in accordance with the procedures and to coordinate with each other. As a result, each unit took less than half an hour to assemble as opposed to the initial two hours and all the hoisting work was completed in just five working days.

| 建造过程 |

Construction process

▶建成环境的意义

The significance of built environment

建筑落成后，吸引了许多附近的居民甚至区议员前来参观，Y型立柱被维护掩盖了，很多人开始赞赏建筑外表呈现的整洁品质。当人们进入室内，会发现光线从通高的窗扇中进入空间，照亮了成排的Y型支柱。黑板墙两侧是两块半透明玻璃，使临近教室的结构隐约显现，强化了结构的序列表达。下沉式的内院提供了学生午休和嬉戏的场所，朝向西侧的双重立面也让当地的儿童惊喜不已。

After the completion, the school attracted plenty of residents living nearby, even local councilors to visit. With the Y-shaped pillars covered as a result of the maintenance work, the building's neat facades were widely praised. Upon entering, people tend to feel the sunlight penetrating from the French windows and lighting up rows of pillars. The two translucent glass blocks that flank the blackboard reveal part of the adjacent classrooms' structures, enhancing the structural expression. The sunken courtyard is a place where students can take a lunch break and have fun. The double facades on the west elevation also impress them.

在物理环境的作用之外，这座学校的建设还有更深层的社会意义。通过这一项目，团队有效地将工作机会与技能培训带到不同地方，从而为问题的深入、持续解决提供了铺垫，也传递了了能动高效、积极向上的海外形象。这种复杂问题快刀乱麻式的解决方法，提示了新的城市更新模式，项目其后潜力巨大的社会价值已被当地社群的反响和媒体的讨论所证实。

The school also has a profound impact on the local community. Through this project, the team has brought jobs and training to this area, provided a model for how to come up with sustainable solutions to problems within a tight timeframe and represented a proactive and highly efficient image from overseas. Such solutions contribute to new urban renovation models. The high social value behind the project is mirrored in responses from locals and media coverage.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| 学生对铝制格栅的可调节外遮阳系统非常好奇 |

Students impressed by the movable aluminum shading

项目名称：肯尼亚MCEDO学校
建筑设计：朱竞翔，吴程辉
设计支持：韩国日，夏珩
建造管理：吴程辉，黄正骊
研究助理：曾博，陈不染
行政支持：彭嫱
建造时间：2014年9月
房屋系统：可折叠钢框架结构，标准模块系统
建筑面积：480平方米，2层建筑
建筑功能：8间课室，2间多功能用室
施工耗时：房屋结构30天，基础准备与场地清理15天
环保特性：完整的立面外遮阳系统,优化的自然采光 ,集成防盗格栅,房屋可整体 多次拆卸异地重建。
抗震能力：麦加利地震烈度 八度

Project name: *MCEDO School*

Architects: *Zhu Jingxiang, Wu Chenghui*

Design support: *Han Guori, Xia Heng*

Construction manager: *Wu Chenghui, Huang Zhengli*

Research assistant: *Zeng Bo, Chen Buran*

Administrative support: *Peng Qiang*

Project Year: *September 2014*

Structure: *modular foldable steel frame*

Floor area: *480sqm, two-storey*

Programs: *8 classrooms, 2 multiuse rooms*

Construction duration: *30 days for the structure, 15 days for foundation preparations and site clean-up*

Environmental-friendly nature: *the building that features an external sun-shading system, abundant natural light, modular anti-theft gratings can be dismantled and reassembled in other sites for multiple times.*

Earthquake resistance capacity: *VIII degree by Mercalli intensity scale*

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