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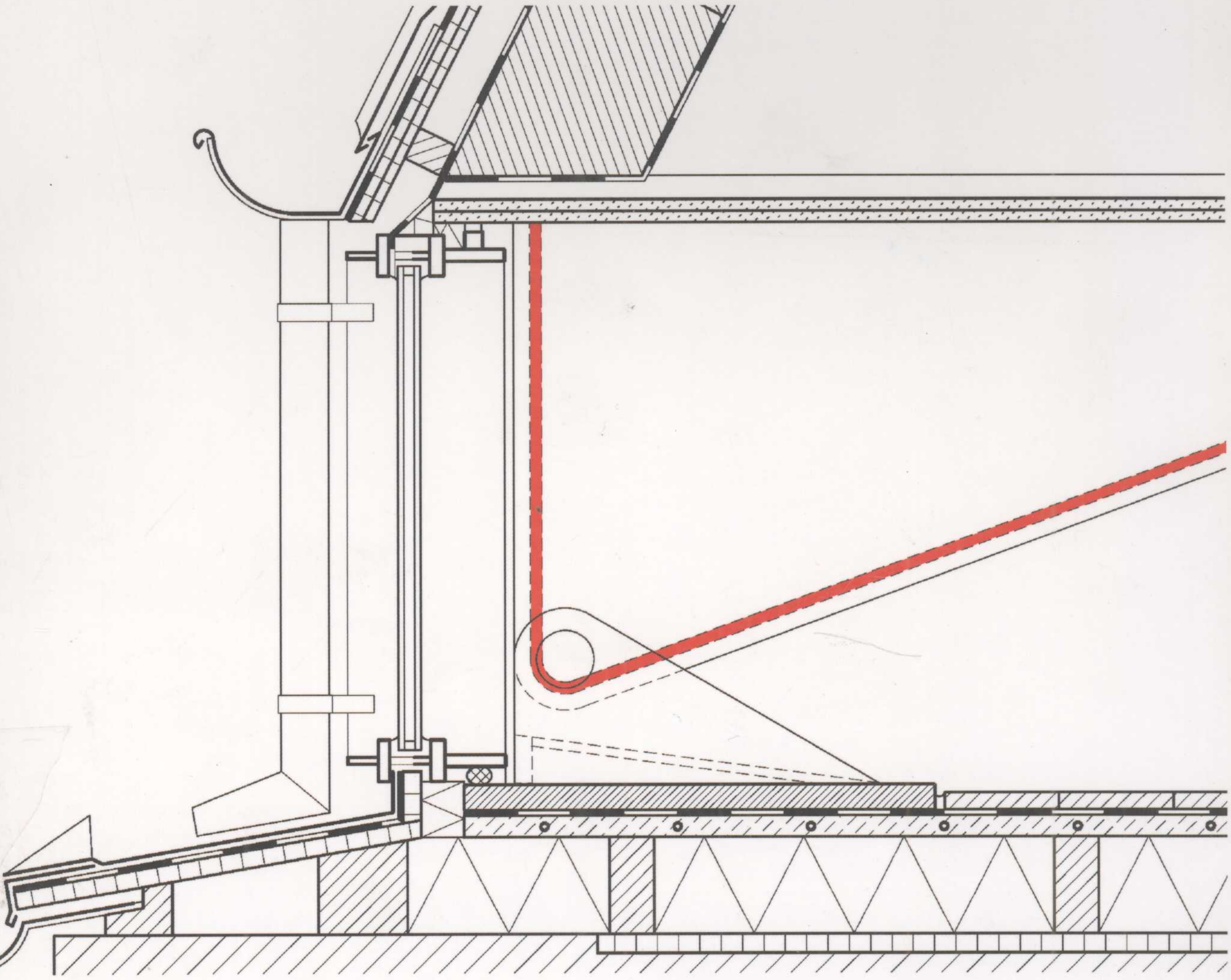

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　　　　传真:0411-84701466

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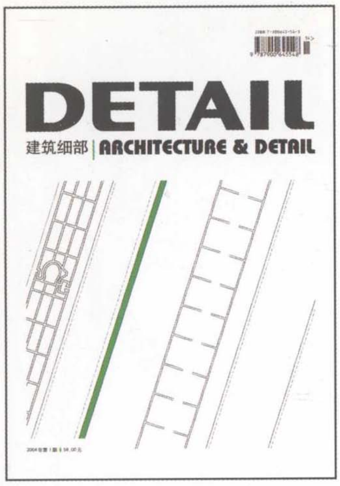

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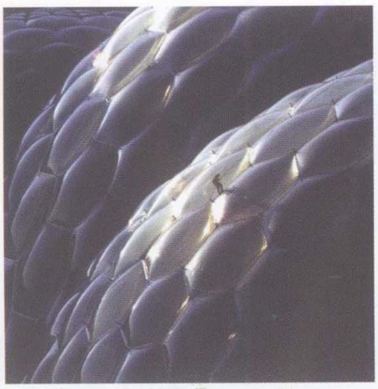

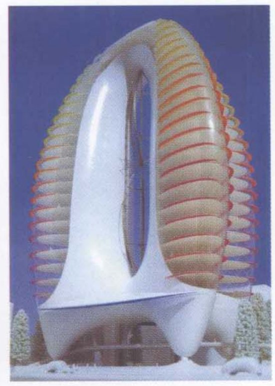

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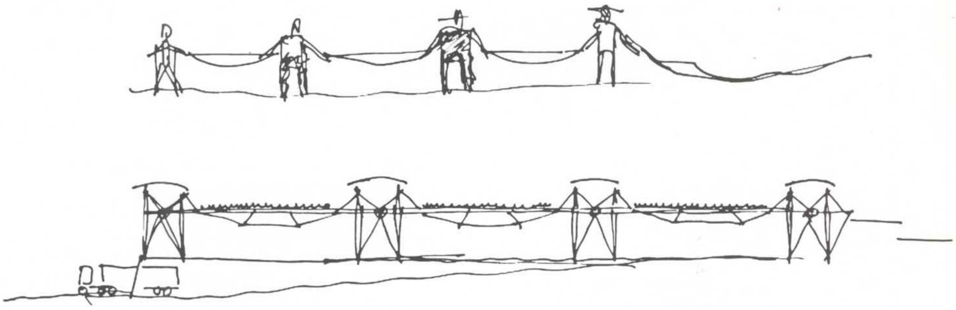
混合屋顶结构
Hybrid Roof Structures

Alexander Furche



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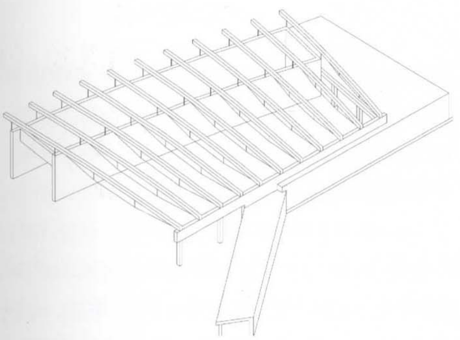


2

强调拥有"头上的屋顶"的重要性表达了人类对抗险恶的自然环境、寻求保护的需求。屋顶广泛地覆盖了人类活动的范围。为自己建立一个庇护所是人类试图征服自然的现象，也是社会发展的必然过程。为了这个目的人类必须建立科学的基本法则。无论如何，在为每一项新工程探寻不同的解决方案并以统治者的方式摆脱各种束缚时，设计者需要有洞察力和勇气，也要首先依靠他们的创造天赋。Jörg Schlaich说，在结构设计时，第一步要依靠他的直觉，第二步要通过计算来证明。各方面应该被联系在一起形成一个全面完整的概念。

建筑的天职是创造空间。为了这个目的，起封闭作用的外皮必须从支撑结构获取形式。因此，可以将承载结构看做是一个要求保持实体形态的系统。结构体系通过承受荷载来发挥作用。这种功能以力的传递和平衡状态的原理为基础。一种结构也可以由其他方面来定义，如几何学（尺度

3

1 Bad Münder 的 Wilkhahn 生产厂房，1992 年；
建筑师：Herzog 及合伙人；
绘图：Thomas Herzog 教授；
结构设计：Sailer + Stepan
2 Auenwald 的工场，2001 年；
建筑师：Büro für Architektur（bfa）；
结构设计：Mayr + Ludescher
3 柏林的 Lehrter 车站，2004 年；
建筑师：von Gerkan、Marg 及合伙人；
结构设计：Schlaich、Bergermann und Partner

1 Wilkhahn production hall in Bad Münder, 1992;
architects: Herzog + Partner;
sketch: Prof. Thomas Herzog
structural planners: Sailer + Stepan
2 Works yard in Auenwald, 2001;
architects: Büro für Architektur (bfa);
structural planners: Mayr + Ludescher
3 Lehrter Station in Berlin, 2004;
architects: von Gerkan, Marg + Partner;
structural planners: Schlaich, Bergermann und Partner

感）和材料。如果仅以力的流动形成了有序的工作原理，人们就可以归纳出一种承载系统。

Heinrich Engel在他的《结构体系》一书中总结了这个大家庭体系。根据力传递的特性或者更精确一点，根据在荷载加载方式和传送方式之间力的方向改变的不同，区分了体作用、向量作用、形态作用，以及面作用的荷载系统。

体作用体系的基本元素是刚性直梁在受到垂直于长轴方向的荷载时，将力转向到长轴方向。通过梁的截面获得必要的抵抗力，梁并没有被充分利用，因此需要使用大块体量的材料。这个系统内的主控力是侧向力（扭力）和弯力。这种结构体系包括梁、框架、井字梁和楼板。

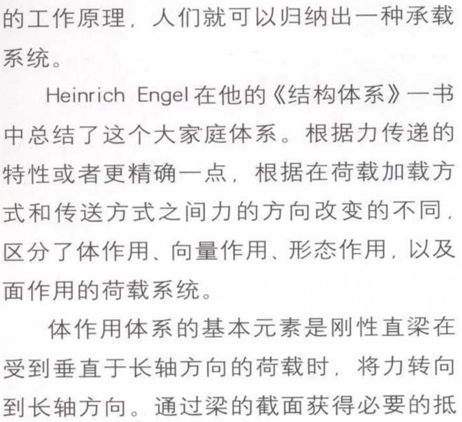
在向量作用系统中，力的转向是通过力的分解实现的。在这种情况下，基本组成包括仅在轴向上承受拉力和压力（普通受力）的直杆样构件。这一系统的特性是直杆构件的三角状排布。其典型代表是直的和曲的网格排布梁和空间网架。

在形态作用系统中，结构形式会完美精确地反映出力在自然状态下的方向，构件内部只有拉力和压力荷载产生。这种类型的基本组成构件是钢索和拱。从定型结构传来的荷载发生偏离，在弹性钢索内部会发生新的索状拉力线（伴随大幅度的变形）。对于刚性的拱，为了使力转向，必须有附加结构（侧向力然后受弯）。正像人们看到的，这些系统对参数的改变异常敏感。除了钢索和拱，这种体系还包括膜和气体力学结构。

平面构件是空间围合中最清晰的形式。适当利用材料，这种构件也能够承载。当力的方向作用于一个表面的中央部分时，对抗作用于表面的力是最大的。在这种理想的情况下，力的转向仅有拉力和压力发生。承载体系的面作用形式包括了隔膜结构、折叠板和壳体结构。

如果要开发一种组合体系，在这种体系里，有两个以上荷载群的典型的力的转向构件。这就是所谓的混合结构体系。这种组合结构体系可能依靠两种原理：即通过叠加或联结。然而，这两种情况，联结体系必须具有相同的承载功能。

混合承载体系的基本例子是带有强化或刚性结构大梁的悬索桥。悬索（形态作用）固定在承载简支梁上（体作用或向量作用）。受弯力作用的大梁将荷载从各个连接点处传给悬索。因此，可以减少大梁的结构高度（受弯多跨梁）。钢索利用了梁的弹性刚度，因此由不对称荷载引起的变形被限制在实际允许范围内。在建筑结构的王国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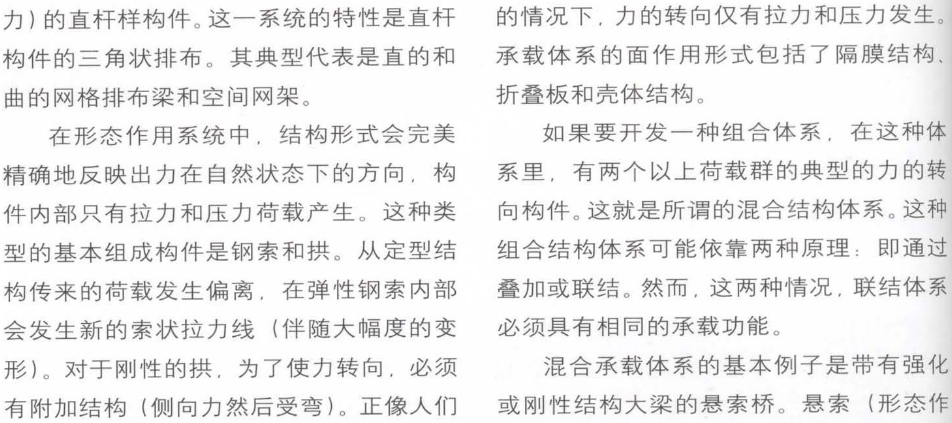
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4 Burkina Faso，Gando的学校建筑，2001年；
建筑师：Francis Kéré；
结构设计：Eddy Widjaja
5，6 Leipzig的训练大厅竞赛方案，2004年；
建筑师：Kaup、Jesse、Hofmayr、Werner；
结构设计：Furche、Zimmermann

4 *School building in Gando, Burkina Faso, 2001; architect: Francis Kéré; structural consultant: Eddy Widjaja*
5, 6 *Training hall in Leipzig; competition 2004; architects: Kaup, Jesse, Hofmayr, Werner; structural planners: Furche, Zimmermann*

里，等价体系是钢索捆绑梁。在这种情况下有效跨度被分成了许多间跨，减小了相应的弯矩。中间支撑件用梁下面的多边形索状张力带悬于空中（以悬杆的形式）。在支撑点产生的水平作用在梁（受弯力作用）的内部受到压力的阻碍。那么，这个概念是基于体作用（刚性）系统与形态作用（非塑性）系统的组合。

这个体系一个最新的例子是Auenwald工厂斜坡屋顶的梁体设计（见图2）：一种矩形十字截面的木材双层系梁，其尺度根据建筑下部小跨度的距离决定，工厂里较宽部分的跨度由相同截面的构件承载，但用的是钢材，并且在下部有两根悬杆支撑。材料的高强度使我们可以选用较小尺寸的构件，然而结构的混合形式可以使我们准确地对待不同功能的跨度。

Bad Münder的Wilkhahn公司生产厂房（图1）是这种结构的另一个有趣的例子。屋顶结构由一系列在下部捆绑固定的梁组成，梁由两个悬杆支撑在受拉的一边，这些梁成排地排列在多层框架之间，因此实现一个连续的三跨梁的承载系统。系杆的位置从跨度内的中轴线的下部变换到柱子支撑区的中轴线的上部。

到目前为止举的例子都是说明了下部捆绑梁的普通原理，这使得荷载能够沿长轴传递。在Leipzig训练大厅的竞赛方案中（图5、6），为屋顶做的解决方案是荷载会沿两个主要轴线的方向均等地传递给四面的墙体。平面上一个体作用的90 m × 60 m的板块由一个悬杆体系支撑，而这个悬杆体系以方形网格布置，并由尺度相同的网格体系的系杆支撑（形态作用）。在悬杆尽端发生的水平作用荷载受到板的阻碍（面作用）。根据点承载和隔膜效应，选择了钢筋混凝土来发挥整体板材的优势。混凝土的自重也给系杆施加了预应力。因此所需板材的精确重量可以在混凝土的间跨内通过与空心球体构件结合而获得支撑。

这种混合结构方式有助于支撑一种屋顶结构，这种屋顶结构沿承载方向的钢筋混凝土结构高度只需要40 cm，在大厅中部的有效结构高度是500 cm（楼板加下部桁架的总高）。因此屋顶结构能够确保坐席上的观众在纵向和横向上的视线不被打断，而不必增加屋顶的高度。

柏林Lehrter车站屋顶为承载构件的纤细程度确立了新的标准（图3）。它是通过将一系列承载体系的特性叠加、整合而获得支承的。

玻璃外层由一个穹隆状、壳体样的钢结构支撑，它由许多受压杆形成一个方形的网格体系，由钢缆将方形分成三角形。于是，一个向量作用系统从一个面作用的结构方式中获得。这种纤细尺度的格状壳体在不均匀荷载的条件下会变得不稳定，因此以规则的间距（形态作用）在穹隆的上方设计了拱形结构。通过一个叠加绑结的系统（向量作用）使这些拱形结构获得了必需的刚度。这个复杂的体系明显地基于以下事实：负责这一项目的工程师采用"张力钢索结构拱框架"作为其支撑构件。

不仅为了结构的需要，而且为了室内气候、建筑物理和其他的功能需求，最近试验了大量的集成构架体系。一个同时解决了结构和室内气候需求的典型例子就是在汉诺威Laatzen的26号贸易大厅（图7）。通

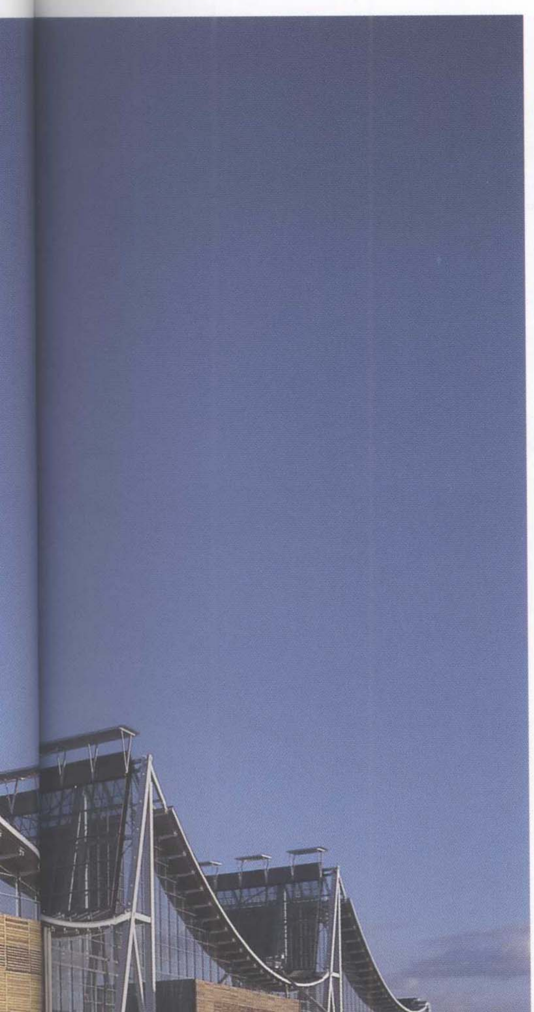
6

作者是汉诺威大学建筑设计院、建筑系结构专业教授。

The author is a professor at the Institute for Design and Construction, Department for Load-Bearing Structures in the Faculty of Architecture of the University of Hanover.

7 汉诺威，Laatzen的26号贸易大厅，1996年；
建筑师：Herzog及合伙人；
结构设计：Schlaich、Bergermann und Partner

7 *Trade-fair hall 26 in Laatzen, Hanover, 1996; architects: Herzog + Partner; structural planners: Schlaich, Bergermann und Partner*



7

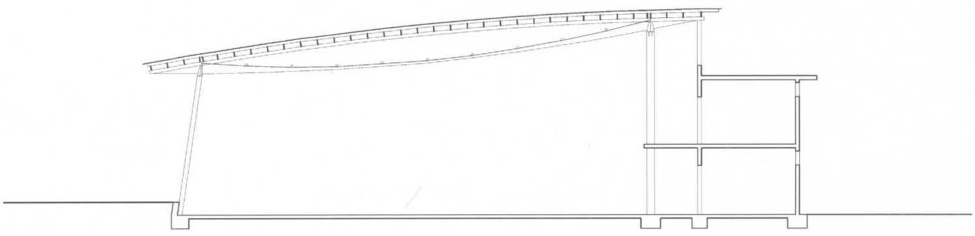
过成排布置一系列的悬挂屋顶结构，创造了一个顶部高低相差悬殊的室内空间，这些尖顶形成了大厅节能空调概念的基础。新鲜空气大约从5m的高度吹进室内然后向大厅的地面流动。随着空气变暖，它又升向屋顶。这种结构形态意味着受污染的空气在室内的高点汇集，从那儿通过室外空气流的作用经百叶窗被排出室外。

在Burkina Faso的一所新建的学校建筑（图4）有一种简单的屋顶结构——一种帐篷样搭法的褶皱金属屋面，屋面可以挡雨，它由许多自成体系焊接在一起的强化钢杆组成的三角形结构支撑。整个教室的封闭外层是由排布在钢杆上的晒干粘土块组成的，这些钢杆架在钢筋混凝土大梁之间。这些框架的下弦杆也联结在混凝土梁上。屋顶结构的承重形式和气候条件紧密有效地联系在一起，覆盖层保护了易受雨水损坏的粘土块，而且提供了阴凉，使室内之人免受炎热之苦。清凉的空气在两层屋面之间不断吹过。

Stuttgart的学校体育馆（图8、9）的委托书要求屋顶表面和次梁用木材和合成木质产品建造，而且主梁的高度也相对较小。这些要求规定首先要从经济效益考虑，其次是设计，并希望有大面积的悬挑屋顶。在实施方案中，主梁由悬挂在长向墙面之间的成对的钢索组成。在支撑点水平方向的反作用力由屋顶平衡。钢索通过合成木板与受压弦杆成八字形分开，而这些合成木板则悬挑于立面之外。这种形式是从钢索的抛物线（抛物线的间距是跨度的十六分之一），以及从屋顶悬挑部分的矩形木材截面的必要的结构高度中获得的。这里开发的结构体系是一种有细网和精致的上下弦杆的鱼肚形大梁还是一种布满悬杆的下部由钢索固结的梁？抑或它是一种在整个形式内部有支架支撑的双索？最后一个定义看来最为贴切，因为合成木板并没有成为结构上有效的横膈膜：考虑到必要的连接，它并没有承载的功能。上面部分的钢件也没有起到结构作用，因为它整个都由板支撑。

用Engel的术语来讲，就是在形态作用体系（钢索）上，加载了面作用体系（板），其上又加载了向量作用体系（承压杆）并与块体效用体系结合（悬臂梁）。这里描述的各种不同的叠加在一起的承载体系，要与材料的组合相配合，这反映了生态学、建筑物理、产品技术和其他方面的要求。

作为第五立面的屋顶的景观暗示了立面起到的连接作用，而屋顶作为一个独立的空间围合面，提供了抵御风和其他下坠物的保护作用，而且也许可以对室内空间起到隔热和隔声的作用。如果外围护体被作为一个独立的整体来处理，而不要把它分成垂直面和水平面，就可以避免对风荷载与雪荷载的不同反应。关于这一点，可以两个多层百货商店为例。这两个例子的外围护体都可以被人们假设是特意做成这种强有力的广告效果。最近在伯明翰开业的Selfridges商场（图11），其表面闪闪发光，是由许多紧密排列的经抛光处理的铝片组成的。外皮由常见的钢筋混凝土支撑，尽管



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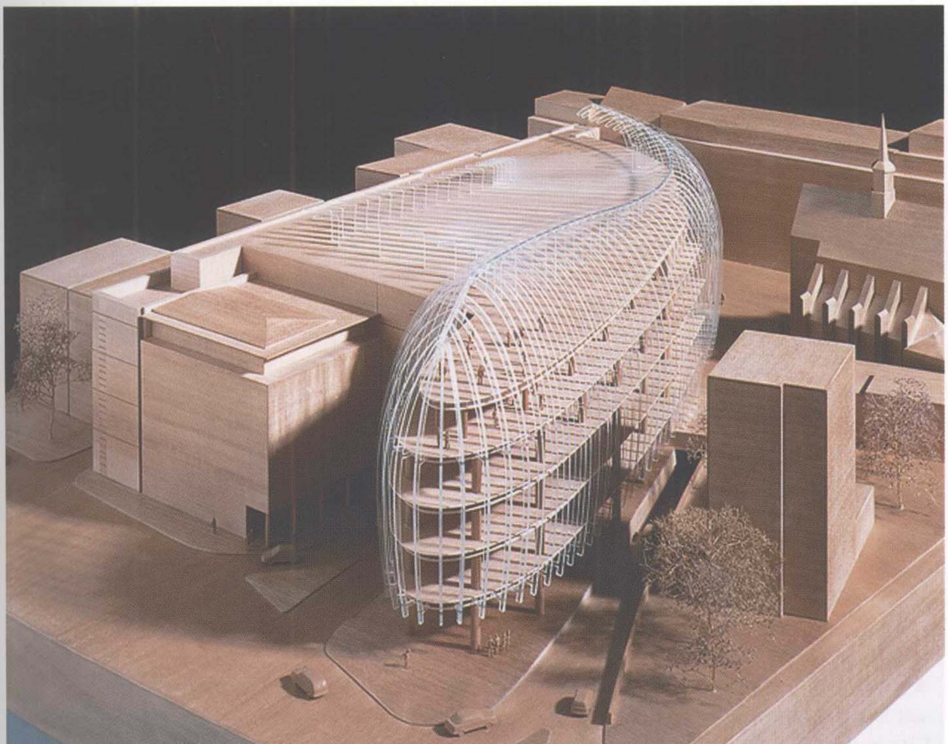
8,9 Stuttgart 的学校体育馆，2002 年
建筑师：FAI
结构设计：Furche、Zimmermann
10 Cologne 的商场
完成日期：2004 年底；
建筑师：Renzo Piano Building Workshop；
结构设计：KHing Knippers，Helbig

8, 9 School sports hall in Stuttgart, 2002;
architects: FAI;
structural planners: Furche, Zimmermann
10 Department store in Cologne;
completion date: end of 2004;
architects: Renzo Piano Building Workshop;
structural planners: KHing Knippers, Helbig

以空间曲线的形式。外墙以带状逐层固定，圆滑过渡到平屋顶上的顶楼。尽管混凝土层有 18cm 厚，但它惟一的作用就是支撑覆层。这个外围护体既沉重又不透明。

在 Cologne 即将完工的商场（图 10）的外围护体就非常不同。它由透明玻璃组成，玻璃的表面透露出建筑物里面的内容。外围护体的支撑结构沿一条曲线将坚固的骨骼框架包围起来。微微弯曲的立面柱子从最顶层悬挂下来，并柔和地过渡成一个拱形的体系，它以正压力曲线的形式横跨这个建筑的宽度。一套叠加的钢索网架确保了这些极为纤细的木构件的稳定。

这篇论文试图为混合结构概念建立一个更为宽广的理论依据，使它从单一纯粹的结构功能中脱离出来。这里选取的例子意在表明何种特性能够有效地相互结合，尽管没有对混合结构家族的潜在范围做充分而广泛的论述。建筑师和结构工程师们如果认识到建筑整体的重要性要超过其所有部件的总和，他们会去设计和采用能够符合客户需求的混合结构体系，这种体系既美观又环保。设计混合结构体系要求有多学科的基础知识，了解很多机械原理，不能只从特定的建筑任务、基本的类型学或材料、设计特点来考虑它。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The importance of having "a roof over one's head" expresses a basic human need for protection against inclement environmental conditions and covers a broad spectrum of human situations. Creating a shelter for oneself is an attempt to exercise control over natural phenomena and socially determined processes, for which purpose man has developed scientifically based rules. Nevertheless, a designer needs insight and courage in seeking a different approach to each new project and in ordering the various constraints in a hierarchical manner, for the planner has to rely initially on his or her creative talent.
Jörg Schlaich says that in designing a structure, he depends on his intuition in the first instance, justifying this in a second step through calculation. All aspects should be united in a holistic concept.
It is in the nature of architecture to create spaces. The enclosing skins needed for this purpose acquire their form from the supporting structure. A load-bearing structure, therefore, may be seen as a system required to maintain the form of an object. It performs this role by offering resistance to the forces that act upon it. This function is based on the principles of the flow of forces and states of equilibrium. A structure may also be defined by other aspects, such as geometry (dimensions) and materials. If the flow of forces alone forms the ordering principle, one speaks of a load-bearing system.
In his book "Tragsysteme", Heinrich Engel proposes a family of systems of this kind, differentiating between bulk-active, vector-active, form-active and surface-active load-bearing systems, according to the characteristics of the flow of forces – or, more precisely, based on the redirection of forces between the application of loading and the act of load transmission.
The basic element of bulk-active systems is the straight, rigid beam that can bear loads at right angles (vertically) to its longitudinal axis and redirect them along this axis. The necessary resistance is achieved through the cross-sectional area of the beam, which is not fully exploited, and thus the mass (or bulk) of the material used. The dominant forces within the

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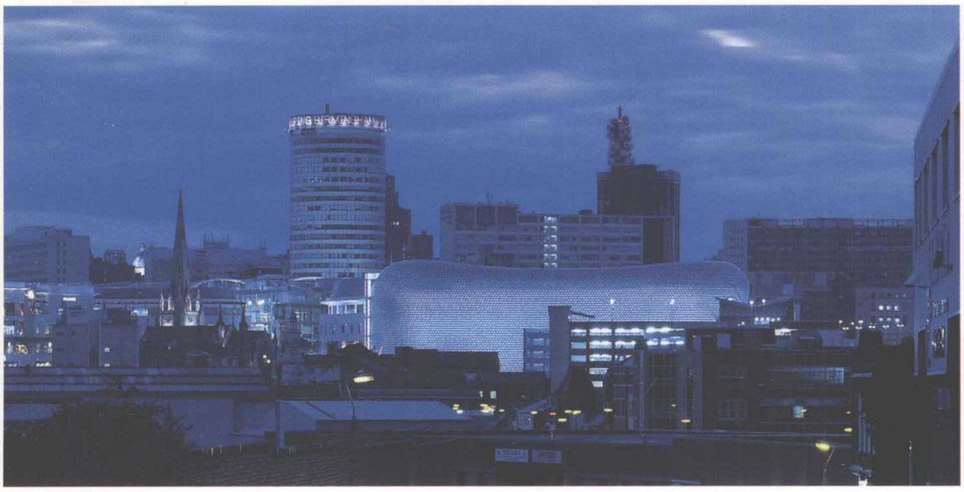


11 伯明翰 Selfridges 商场，2003 年
建筑师：Future Systems；
结构设计：Arup

11 Selfridges department store in Birmingham, 2003; architects: Future Systems; structural planners: Arup

system are lateral (shear) forces and bending moments. This type of structural system includes beams, frames, beam grids and slabs. In vector-active systems, the redirection of forces is achieved through their resolution. In this case, the basic elements consist of straight bar-like members that are subject to tension or compression loading (normal forces) solely in the axial direction. A characteristic feature of vector-active systems is the triangulation of bar members. Typical of this system are straight and curved lattice beams and space frames.

In the case of form-active systems, the structural form will ideally reflect the natural direction of forces precisely; only tension and compression loading will occur. The basic elements of this type are cables and arches. In the event of a deviation of the loading from the form-giving configuration, new funicular tension lines will occur in the flexible cables (accompanied by great deformation). With rigid arches, additional mechanisms for the redirection of forces will be necessary (lateral forces and, as a result, bending). As one sees, these systems are highly sensitive to changing parameters. In addition to cables and arches, this type includes membrane and pneumatic structures.

Superficial or planar elements are the clearest form of spatial enclosure. With an appropriate use of materials, such elements can also be load-bearing. The resistance to forces acting on a surface is greatest when the line of action lies in the median plane of the surface. In this ideal case, the redirection of forces occurs solely with tension and compression loading. The surface-active group of load-bearing systems includes diaphragm, folded-plate and shell structures.

If systems are developed in which the characteristic force-redirection mechanisms of two or more load-bearing families are combined, one speaks of hybrid structural systems. There are two possible principles by which such a combination can occur: by superimposing or coupling the systems. In both cases, however, the jointly active systems must be of equal status in terms of their load-bearing function.

A prime example of a hybrid load-bearing system is a suspension bridge with reinforcing or stiffening girders. The suspension cable (form-active) is superimposed on the load-bearing bracing girder (bulk- or vector-active). The girder subject to bending transmits the loads at the respective points of connection to the cables. As a result, the girder can have a smaller constructional depth (multi-bay beam subject to bending). The cable exploits the flexural rigidity of the beam so that deformation from the asymmetrical loading is restricted to a functionally acceptable level.

In the realm of building construction, an equivalent system would be a cable-trussed beam. In this case, the effective span is divided into a number of bays to reduce the relevant bending moments. Intermediate supports are suspended in the air (in the form of sag rods), with a cable-like tensioning strip beneath the beam that creates a polygonal form. The induced horizontal reactions at the bearing points are short-circuited in the beam (subject to bending) by compression forces. Here, the concept is based on the combination of a bulk-active (rigid) system with a form-active (non-ductible) system.

A modern example of this may be found in the beam design for the sloping roof over the works yard in Auenwald (ill. 2): a timber double tie beam with rectangular cross-sections dimensioned according to the needs of the small span of the building beneath. The greater width of the works yard is spanned by members with the same cross-sections, but in steel, and trussed on the underside with two sag rods. The high material strength enabled smaller dimensions to be used, while the hybrid form of construction allowed a sensible treatment of the different functional spans.

The production hall for the Wilkhahn company in Bad Münder (ill. 1) is another interesting example in this context. The roof structure consists of a series of beams trussed on the underside. Beams with two sag rods strutted off the tension flange are suspended in rows between multi-storey frames, thereby achieving the load-bearing behaviour of a continuous three-bay beam. The tie member changes position from below the neutral axis within the bay to above the neutral axis in the area of the columns.

The examples described so far illustrate the common principle of beams trussed on the underside, which enables loads to be transmitted along the longitudinal axis. In a competition project for a training hall in Leipzig (ills. 5, 6), proposals were made for a roof in which the load transmission would occur equally along the two main axes to all four enclosing walls. A bulk-active slab 90 x 60 m on plan is borne by a system of sag rods laid out to a square grid and supported by tie members to the same grid dimensions (form-active). The horizontal reactive loads occurring at the peripheral bearing points are short-circuited via the slab (surface-active). Reinforced concrete was chosen to exploit the advantages of a monolithic slab in terms of point bearings and the diaphragm effect.

The dead weight of the concrete also serves to prestress the tie members. The precise weight of a slab required for this purpose can be achieved by incorporating hollow spherical elements in the bays of concrete.

This hybrid approach helps to achieve a roof structure in which the depth of the reinforced concrete construction is only 40 cm along the line of support, with a structurally effective depth of 500 cm in the middle of the hall (slab plus trussing on the underside). The roof structure thus ensures uninterrupted sight lines for spectators in the stands in both the longitudinal and transverse directions, without having to increase the height of the roof.

In terms of the slenderness of load-bearing members, the roof over Lehrter Station in Berlin (ill. 3) sets new standards. It was achieved through a superimposition and coupling of the properties of a number of structural systems.

The glazed outer skin is supported by a vaulted, shell-like steel structure, consisting of compression bars that form a square grid, with cables that divide the squares into triangles. Here, a vector-active system is derived from a surface-active approach. Since the slenderly dimensioned lattice shell would be unstable under asymmetrical loading conditions, arch structures were created over the

vaulting at regular intervals (form-active). The arches attain the requisite rigidity through a superimposed trussing system (vector-active). The complexity of the system is evident from the fact that the engineers responsible for the project described the bracing element as a "cable-tensioned basket arch frame".
A number of integrative approaches have been tried in recent times that serve not only structural purposes, but the needs of indoor climate, building physics and other functions. An outstanding example of a combination of structural and indoor-climate requirements can be seen in trade-fair hall no. 26 in Laatzen, Hanover (ill. 7). By setting out a series of suspended roof structures in a row, an internal space was created with boldly contrasted high and low points, which form the basis of the energy-saving air-conditioning concept for the hall. Fresh air is blown into the internal space from a height of about 5 m and disperses over the hall floor. As the air is warmed, it rises to the top. The constructional topography means that the vitiated air gathers at the high points of the internal space, from where it is sucked out via flaps through the action of external air currents.
A new school building in Burkina Faso (ill. 4) has a simple roof structure – a pitched corrugated metal covering – that provides protection against rain and is supported by triangular trusses made from steel reinforcing bars welded together on a self-help basis. The entire enclosing skin of the classrooms consists of sun-dried clay blocks laid on steel rods that are spanned between reinforced concrete beams. The lower chords of the trusses are also connected to the concrete beams. The dual form of roof construction is an effective means of coping with the climatic conditions: the covering protects the easily damaged clay blocks from the rain and also provides sunshading, shielding the internal spaces from overheating. A constant cooling current of air flows through the intermediate space between the two parts of the roof.
The brief for a school sports hall in Stuttgart (ills. 8, 9) required the roof surface and the secondary beams to be in timber and composite wood products, while the main beams were to have a relatively small depth. The first of these requirements was dictated by ecological considerations; the second was a question of design and the wish for large cantilevered roof areas. In the solution that was implemented, the main beams consist of pairs of steel cables suspended between the long facades. The horizontal load reactions at the points of support are balanced by a steel compression member in the roof plane. The cables are splayed apart from the compression chord by a composite wood slab that is cantilevered out beyond the plane of the facade. The form is derived from the parabolic curve of the cable (with a rise equal to one sixteenth of the span), and from the requisite construction height of the rectangular timber sections in the cantilevered areas of the roof. Is the load-bearing system developed here a fish-belly girder with a slender web and elaborate upper and lower chords? Is it a beam that is cable-trussed on the underside, with sag rods distributed over the entire area? Or is it a cable pair with bracing within the overall form? The last definition seems most appropriate because the composite wood slab does not act as a structurally effective diaphragm: in view of the requisite joints, it cannot function as a load-bearing web. The upper steel section does not perform a structural role either, since it is supported by the slab over its full length.
To use Engel's terminology, a form-active system (cable) is overlaid by a surface-active system (slab), overlaid by a vector-active system (compression bar) and coupled with a bulk-active system (cantilevered beam). The various superimposed load-bearing systems described here are paralleled by a combination of materials, which reflect the needs of ecology, building physics, production techniques and other aspects.
The view of the roof as a fifth facade indicates the joint role played by facade and roof as a single space-enclosing skin, providing protection against wind and precipitation, and possibly serving to screen the indoor space thermally and acoustically. Different responses to wind and snow loading can be avoided if the outer skin is treated as a single entity and not divided into vertical and horizontal elements. As examples, two multi-storey department stores may be cited at this point. In both cases, one assumes that the outer skin is meant to have a powerful advertising effect. The recently opened Selfridges store in Birmingham (ill. 11) has a gleaming surface of closely spaced, polished aluminium discs. The skin is borne by conventional reinforced concrete elements, albeit in a spatially curved form. Fixed in strips floor by floor, the outer wall curves seamlessly up over the attic storey on the flat roof. In spite of the 18 cm thickness of the concrete skin, its sole function is to support the cladding. The skin structure is heavy and non-transparent.
The skin for a department store soon to be completed in Cologne (ill. 10) is quite different. It consists of transparent glass, which will reveal the contents of the building. The supporting structure for this skin is wrapped around the solid skeleton frame in a single sweep. Lightly curved facade posts are suspended from the topmost floor and are harmoniously transformed into an arch system that spans the entire width of the building with a correct pressure-line form. A superimposed cable network ensures the stability of the extremely slender timber elements.

This paper seeks to establish a broader basis for hybrid concepts and to move away from their singular, purely structural function. The selection of projects presented here is meant to show which properties can be effectively combined with each other, although no claim is made to comprehensiveness in terms of the potential range of hybrid constellations. An awareness that the whole can be more than the sum of its parts should lead architects and structural planners to develop and apply hybrid systems that serve the needs of their clients, that are pleasing to observers and that protect the environment. The foundation for the interdisciplinary thinking this implies is laid in our universities. Hybrid systems call for an understanding of many technical disciplines and cannot be identified with specific building assignments, elemental typologies, materials or design features.

From Vision to Reality: Takashi Yamaguchi in the Lobby of the »Dynamic Tools Corporation Office« in Kyoto.

From Vision to Reality

To Awaken a New Place
Architectural creation is an act of breaking down the totality of elements time, history, tradition, and so forth that exist in a place, in order to reunite those elements in a world of new meaning. When inserted in its place, the new architecture and meaning it embodies transforms the existing meaning with its presence. Indeed, the history of architecture is nothing more than an endlessly evolving repetition of such reunification.

Image embodiment is the process by which the elements of a place are reunited to produce a new world. Place can be defined as a condensation of human activities, activities which seek development in a spatial form. Through spatial development, human activities obtain physical embodiment. A building is the result of this process.

For me, architectural thinking means to contemplate all human actions. Architectural thinking is a philosophy that reflects my own values concerning how people should live. The built architecture is nothing else than a crystallization of this thinking. Thought takes form as image; its figure is visually expressed.

An image is simply an image and doesn't exist in reality; yet when an image becomes a vision, it obtains an awesome power to transform reality. A vision seeks its optimum form, its ultimate point of development in order to find realization in substance. To guide the vision in that direction demands more thinking.

Design is a further act of embodiment in the process of taking the image to physical realization. The image seeks a clearer expression of its figure in concrete terms of dimensions and materials, and the envisioned architecture adjusts to reality and becomes rooted in its site. The aim, in this stage, is to achieve a realization through a confrontation with reality.

The part seeks its natural position within its relationship with the whole and achieves integration. The whole determines the parts and the parts determine the whole. Dream and reality, exterior place and interior space, periphery and center. Architecture attains physical embodiment as a crystallization of thinking that has considered such relationships from their reciprocal vantage points.

Architecture exists not as an end in itself but rather to give new life, with its existence, to the totality of its place.

Takashi Yamaguchi, Architect

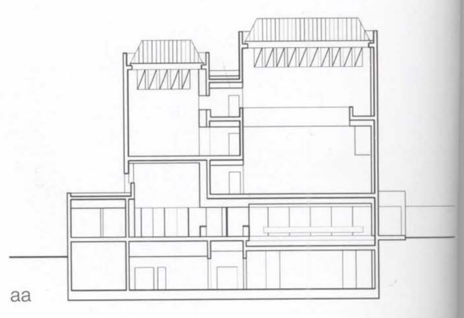
Documentation

Almeria 的考古博物馆

Archaeological Museum in Almeria

建筑师：
Paredes Pedrosa Arquitectos, Madrid
工作人员：
Silvia Colmenares, Manuel G. de Paredes, Eva M. Neila, Danko Linder, Luis Calvo
结构工程师：
GOGAITE S.L., Madrid
weitere Projektbeteiligte S. 922

2003 年，在西班牙南部安达卢西亚的 Almeria 市新建了一座考古博物馆。它是将分散广泛的一些单位汇总起来，使它们集中在一处展现给公众。进入这个博物馆要经过一个稍高于街道标高的广场。与外部紧凑的大理石贴面的建筑体量形成对比，内部的设计则根据不同的空间形式来区分。中庭为游客提供了方向感，同时也将专题展厅和博物馆的其他功能联系起来。围绕中庭的各种不同展室分置在三层的空间里，而办公部分则垂直分布在五层的空间里。通过减少开窗，建筑师能够最大限度地利用墙体表面，同时却仍能够在室内的历史氛围与室外的现代世界之间创造特殊的视觉联系。为了在自然光线下呈现展品，中庭上空的屋顶部分被设计成锯齿结构，太阳光能够从西北方向进入。这些单元的钢框架由许多斜向伸展的钢筋混凝土 V 形梁支撑。直射光线和眩光被锯齿形屋顶下的木格栅滤除。格栅形成的角度和三维的设计即使在光线强烈的情况下也同样有效。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