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MACHINIC PROCESSES
ARCHITECTURE BIENNIAL BEIJING 2010
STUDENTS
学生建筑设计作品

尼尔·林奇（英）/ 徐卫国 编
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前言 / Preface

这本作品集收录了“数字现实”学生作品展中的作品，该作品展作为北京 2010 建筑双年展的一部分，将会在 798 时态空间举办。这次展览是北京国际青年建筑师及学生建筑设计作品双年展系列的第四次展出。第一次是 2004 年在 UHN 国际村举办的“快进”，之后两次分别是 2006 年在世纪坛举办的“涌现”和 2008 年在 798 时态空间举办的“数字建构”。

这次的主题是“数字现实”，不光是指数控机床和 3D 打印那样的数字建造过程，也包括在参数化算法设计技术方面的创新。从 2004 年以来，中国对这些新技术接受得很快，像鸟巢那样的建筑，如果离开了参数化建模技术和 BIM 软件的帮助，要想建成几乎是不可能的。虽然中国的制造业在过去很依赖手工劳动，但是数字建造技术在建筑方面扮演着越来越重要的角色，相信将来这种势头会继续下去。

本作品集为世界上顶尖建筑院校的先锋数字设计作品提供了一个展示的平台，包括英国建筑联盟建筑学院、美国南加州大学、美国哈佛大学设计研究生院、美国南加州建筑学院、耶鲁大学和清华大学等。

本书收录的作品是同一主题展览的一部分，展览也包含了世界上最具潜力的建筑师和设计师的先锋数字设计作品。这些作品经过九位地区策展人的挑选：美国东海岸、美国西海岸、澳大利亚、中国、英国、亚洲、拉丁美洲和欧洲，另外也包括国际部分。

展览的举办离不开许多个人和组织的帮助，特别感谢广州康逊贸易公司、LG Hansys、Spanish Ceramic Tile Manufacturers’ Association 和金晶集团的慷慨支持，以及 798 为展览提供了场地支持。

我们也十分感谢为作品集编排和设计付出努力的所有人，特别感谢：陈寅、明晔、姜赛双、娄晓一、林秋达、赵明、周实、梁其伟和顾芳。

尼尔 · 林奇
徐卫国

This is a catalogue of the works on display in the ‘Machinic Processes’ exhibition of students’ work at 798 Space, Beijing, as part of the Architecture Biennial Beijing 2010. The exhibition is the fourth in a series of exhibitions at the Architecture Biennial Beijing that have addressed advanced digital design in architecture. The first exhibition, ‘Fast Forward >>’, took place in UHN in 2004. This was followed by two further exhibitions: ‘Emerging Talents, Emerging Technologies’ in the Millennium Museum in 2006, and ‘(Im) material Processes: New Digital Techniques for Architecture’ in 798 Space in 2008.

The theme, ‘Machinic Processes’, refers not only to new digital fabrication processes, such as CNC milling and 3-D printing, but also to the innovative use of new parametric and algorithmic design techniques. Since 2004 the adoption of these techniques in China has been rapid. The design of buildings such as the Birds Nest stadium would not have been feasible without the use of new parametric modeling techniques and Building Information Modeling software. Meanwhile, although the construction industry in China has relied heavily on manual labor in the past, digital fabrication technologies are beginning to play an increasingly important role in the construction of buildings throughout China, and are set to play an even more significant role in the future.

The catalogue offers a showcase of the most progressive digital design work from some of the leading schools of architecture in the world. These schools include the Architectural Association, University of Southern California, Harvard GSD, SCI-Arc, Yale University and Tsinghua University.

The work included here is part of a larger exhibition on the same theme, which also encompasses some of the most progressive digital design work by some of the most talented emerging architects and designers in the world. Their work is selected by eight curators from nine different regions - East Coast USA, West Coast USA, Australia, China, United Kingdom, Asia, Latin America and Europe. There is also an international selection.

This exhibition would not have been possible without the help of several individuals and organizations. In particular the organizers are grateful to Guangzhou Kangxun Trading Company, LG Hansys, the Spanish Ceramic Tile Manufacturers’ Association and Jinjing Group for their generous support of the exhibition, and to the directors of 798 Space for permitting the exhibition to take place.

The organizers are also grateful to all who have contributed to the preparation of this catalogue. In particular they would like to thank Chen Yin, Ming Ye, Jiang Saishuang, Lou Xiaoyi, Lin Qiuda, Zhao Ming, Zhou Shi, Liang Qiwei, Gu Fang for their invaluable contribution in helping to design and compile this catalogue.

Neil Leach
Xu Weiguo

机器过程 / Machinic Processes

我们怎么理解“machinic”这个词呢？当然它并不仅仅指机械上的机器，在实证主义的框架中，它意指工程世界。当然，在数字建造展的背景下，它的确包括了机器生产过程的使用，但不能仅仅归结为这个过程。

“机器过程”来自法国哲学家德勒兹和他的合作者法国精神分析理论家瓜塔里的论著。德勒兹和瓜塔里以一种相当独特的方式使用术语“机器”。Philip Goodchild 认为德勒兹和瓜塔里的“机器”是装配和生产的零件组合。[1] 机器是“运行”，以材料流动为条件。机器因此超越了早期机械和有机体之间的区别，换句话说，人类也可以被描述为“机器”。正如 John Marks 指出的那样：“一切都是机器，到处都有生产。对于德勒兹和瓜塔里，机器不是一个比喻，现实是真正的机器，这个机器的概念根据生机论和机械学之间的传统对立而设立……总之，生活与机器分类之间没有任何区别。”[2]

对德勒兹和瓜塔里而言，机器最重要的是与欲望相关：“机器和欲望之间有着直接的联系，机器进入欲望，机器欲望和被欲望着，被机器着。”[3] 他们认为欲望是一个过程：“欲望不是形式，而是一个程序，一个过程。”[4] 此外，与那些相信拉康精神分析学逻辑的人不同，他们并没有认为欲望是建立在缺乏基础之上的视觉化冲动，相反他们将其视为一个基于现实的积极和富有成效的力。通过“机器过程”我们因此明白一个积极、创造性的过程，铭刻于人类的欲望逻辑中。

然而在德勒兹与瓜塔里作品中关于“欲望机器”的概念存在一个发展谱系。由于“欲望机器”的名词所产生的持续的混乱，最终德勒兹和瓜塔里用“组合”将其取代。无论是有机或无机，一个组合取决于一个元素与其他元素组合的能力或性能，但不能仅仅归结为它们。一个组合得很好的例子是动物与地面之间，由于重力约束形成的关系。[5]

“组合”的概念仍然与机器相连，形成“组合机器”。事实上，组合的全名是“欲望机器组合”。[6] 正如德勒兹和瓜塔里写的那样：“我们所知道的是组合。而唯一的组合是欲望和阐述集体组合的机器组合……一个组合在某些多样性之间建立联系。”[7] 事实上欲望不存在于组合之外：“没有欲望而只有组合着、组合了的欲望。”[8]

“组合”可以被定义为一组松散独立部件组成的单个群体，但从来没有一个组合体是稳定或统一的。“组合”是一组在单一背景下事物的集合，虽然是一个集合，仍然抵抗分层化。正如 Ansell Pearson 观察到的它有“作为置于不断运动和变化的多样性”作用。[9] 重要的是，它创造了联系和关系，它形成了“共生”或“和谐”：“什么是组合？它是一种呈现许多不同条件，穿越不同的年龄、性别、种类 - 性质，而在其间建立联系、关系的多样性。因此，组合的唯一单元是共同运作：它是一种共生，一种“和谐”。重要的是，永无派生物，而是联合和混合；不是遗传，谱系的联系，而是感染，如风、如疫情。”[10]

德勒兹和瓜塔里的另一个相关术语“语群”，呼应了“组合”的逻辑，并与“机器”相连，得到“机器语群”。[11] 对于德勒兹和瓜塔里而言，“机器语群”是“流动、变化、同步的物质，是奇点的传送带。”[12]“机器语群”

What are we to understand by the term ‘machinic’? For sure it does not refer simply to the machine in the sense of the mechanical, understood within a positivistic framework to signify the world of engineering. Of course, in the context of an exhibition of digital fabrication it does include the use of mechanical processes of production. But it is not reducible to them.

The term ‘machinic processes’ is a reference to the work of the French philosopher, Gilles Deleuze, and his collaborator, the French psychoanalytic theorist, Félix Guattari. Deleuze and Guattari use the term ‘machine’ in a quite unique way. Philip Goodchild defines the ‘machine’ in Deleuze and Guattari, as ‘an assemblage of parts that works and produces’. [1] The ‘machine’ is anything that ‘operates’, and is conditioned by material flows. The ‘machine’ therefore extends beyond any earlier distinction between the mechanical and the organic, to include both domains. In other words, human beings could also be described as ‘machines’. As John Marks observes, ‘Everything is a machine, and everywhere there is production. For Deleuze and Guattari, the machine is not a metaphor; reality is literally ‘machinic’. The concept of the machinic is set against the traditional opposition between vitalism and mechanism. . . In short, there is no difference between categories of living and the machine.’[2]

Most importantly for Deleuze and Guattari the machinic is associated with desire: ‘A direct link is perceived between the machine and desire, the machine passes into the heart of desire, the machine is desiring and desired, machined.’[3] They see desire as a process: ‘Desire is not form, but a procedure, a process.’[4] Moreover, in opposition to those who subscribe to the logic of Lacanian psychoanalysis and see desire as an imaginary impulse based on absence or lack, they see it is as a positive, productive force based on reality. By ‘machinic process’ we should therefore understand a positive, creative process that inscribes human beings within a logic of desire.

There is, however, a genealogy to the concept of the ‘desiring machine’ in the work of Deleuze and Guattari. Owing partly to the persistent confusion that the term ‘desiring machines’ seemed to generate, eventually Deleuze and Guatarri replaced it with the term, ‘assemblage’. An assemblage depends on the capacity or capability of an element to form assemblages with other elements, whether organic or inorganic, but is not reducible to them. A good example of an assemblage would therefore be the relationship formed between an animal and the ground on which it is walking, constrained as it is by the forces of gravity. [5]

The notion of ‘assemblage’ remains connected with the machine, as in the ‘machinic assemblage’.[6] In fact the full name for an assemblage is a ‘machinic assemblage of desire’. As Deleuze and Guattari write: ‘All we know are assemblages. And the only assemblages are machinic assemblages of desire and collective assemblages of enunciation. . . An assemblage establishes connections between certain multiplicities.’[7] Indeed desire does not exist outside of an assemblage: ‘There is no desire but assembling, assembled desire.’[8]

An ‘assemblage’ could be defined as a loose affiliation of individual components that have come together to form a single body — but a body that is never stable or unified. An ‘assemblage’ is a collection of things brought together in a single context, yet a collection that resists stratification. It functions, as Ansell Pearson observes, ‘as an acentred multiplicity that is subjected to continuous movement and variation’.[9] Importantly, it makes connections and relationships; it forms a ‘symbiosis’ or ‘sympathy’: ‘What is an assemblage? It is a multiplicity that assumes many heterogeneous terms and which establishes connections, relations among them, passing through different ages, sexes, species - natures. Thus, the only unit of an assemblage is that of co-functioning: it is a symbiosis, a 'sympathy'. What is important, there are never the filiations, but the alliances

是指一旦其满足了一定的临界值，物质在空间中进行合作的潜力。一个例子是白蚁进行协作筑巢的能力。物质需要在具有自组织倾向的形态学的逻辑范围内理解。根据 Manuel DeLanda，“机器语群”可以是“总的自组织的过程，也可以是可以整合的过程力的特定组合。从某种意义上说，这个词涉及任何群体（原子、分子、细胞、昆虫），其全局动力学被奇点（分叉和吸引）控制；从另外的意义上说，它指的是一个集合的元素形成整体大于局部的组合，即不是通过个体组件显示全局特性。”[13]

现在变得清楚的是，统一这些名词的主题是连接性。对于德勒兹而言，他最终成为连接性的思想家。正如德勒兹评论的那样：“严格来说，是连接形成了机器”。[14] 最终“机器过程”是指系统或者关系。如果——而非机械本身—— 我们谈论社会关系的机械性，我们将更接近名词背后德勒兹和瓜塔里的意图。

也许“块茎”的概念，让我们更好地理解德勒兹哲学中连接的逻辑。块茎是一个概念工具，从块茎作为根系系统的生物模型而来，其不断以横向和跨物种的方式扩张，而非竖向和线性的树状模型。草是植物通过蔓延能力展示其块茎特性的一个例子。另一个例子是毛毡，一种不连续的非等级化的纤维，与编织的、等级化和被控制的织物不一样，毛毡被压缩为单一的一团。

必须理解块茎与有机体不同，有机体总是有成为组织中的整体、摩尔量和分层的危险。取生物体而代之的是德勒兹和瓜塔里所谓的“无器官的身体”。正如 Ansell Pearson 描述的那样：“‘没有器官的身体’指的是能量和生成的身体，被高度未成形的和不稳定的物质所渗透，以自由流动为特点，具有‘自由强度’和‘游牧奇点’”。[15] 具有器官的身体问题，不在器官，而在于有机体内的器官组织。无器官身体的思考方式是人群和集群的形成：“没有器官的身体……以布朗运动的方式，通过群体现象分布……这是一个有多样性组织的身体。”[16]

让块茎具有如此启发性的是，它是一种关系，它必须与互动相关。德勒兹和瓜塔里用黄蜂和兰花之间的相互作用说明块茎。这个例子足够熟悉——昆虫被吸引到植物上，促进植物的交叉授粉。[17] 黄蜂被兰花所接待，从而对某种建筑相关性做出描绘。但是最引起德勒兹和瓜塔里兴趣的是黄蜂和兰花之间的相互作用。兰花发展了吸引黄蜂的特性，黄蜂通过特定的行为服务于兰花。正如德勒兹和瓜塔里所观察到的，黄蜂和兰花进入互惠关系，使得黄蜂适应了兰花，兰花也适应了黄蜂。德勒兹和瓜塔里将此称为一种相互“生成”形式。黄蜂变得像兰花，兰花变得像黄蜂，或者——更确切地说——黄蜂已进化为呼应兰花，正如兰花为呼应黄蜂进化一样。

重要的是，对德勒兹和瓜塔里而言，我们必须从多样性的角度观察黄蜂和兰花。Greg Lynn 解释说：“多种黄蜂与兰花的关系组成了单一的体。这种统一体不是封闭整体，而是多样性：黄蜂和兰花同步形成。重要的是，没有一个预先存在的可被关于性欲望寄生性交换所代替的集合体，而是一个新的稳定体，由这些不同的体之间错综复杂的联系组成。多样性中存在异质性，通过对其他外部力开放的合并，产生新的稳定体。”[18]

and mixtures; not the heredities, the genealogic lineages, but the contagions, the epidemics, the wind.'[10]

Another related term in Deleuze and Guattari that echoes the logic of 'assemblage' and is connected with the 'machinic' is the 'phylum', as in 'machinic phylum'.[11] For Deleuze and Guattari, the machinic phylum is 'matter in flux, in variation, and both simultaneously; it is matter as a conveyor of singularities'.[12] The machinic phylum refers to the potentiality for matter in the universe to cooperate, once it meets a certain critical threshold. An example would be the capacity of termites in a colony to collaborate on the building of a nest. Matter should be understood here within the logic of morphogenesis, with a tendency for self-organization. According to Manuel DeLanda, the term machinic phylum can refer 'both to processes of self-organization in general and to the particular assemblages in which the power of these processes may be integrated. In one sense, the term refers to any population (of atoms, molecules, cells, insects) whose global dynamics are governed by singularities (bifurcations and attractors); in another sense, it refers to the integration of a collection of elements into an assemblage that is more than the sum of its parts, that is, one that displays global properties not possessed by its individual components.'[13]

What becomes clear is that the key theme uniting these terms is connectivity. For Deleuze himself is ultimately a thinker of connectivities. As Deleuze comments, 'Strictly speaking, what makes a machine are connections'.[14] Ultimately then machinic processes refer to systems or relationships. If then – instead of the mechanical per se - we speak of mechanisms of social relationships, we will get closer to Deleuze and Guattari's intentions behind the term.

It is perhaps the related concept of the rhizome that we can best understand the logic of connectivity that informs Deleuze's philosophy. The rhizome is a conceptual tool that is taken from the biological model of the rhizome as a root system that spreads endlessly not according to an arborescent model with vertical and linear connections, but with horizontal and trans-species connections. Grass would be an example of a plant that exhibits rhizomatic behavior in its capacity to spread. Another example would be felt as a matted mass of discontinuous non-hierarchical fibers compressed into a single mass, in opposition to a woven fabric that is hierarchical and controlled.

The rhizome has to be understood as different to the organism, which always threatens to become totalizing, molar and stratified in its organization. Instead of the organism Deleuze and Guattari celebrate what they call 'the body without organs'. As Ansell Pearson describes the term as follows: 'The 'body without organs' refers to the 'body' of the energies and becomings of the earth that gets permeated by matters which are highly unformed and instable, characterized by free-moving flows, 'free intensities' and 'nomadic singularities'. [15] The problem of bodies with organs are not the organs as such, so much as their organization within an organism. One way to think of the body without organs is as a form of crowd or swarm: 'A body without organs... is distributed according to crowd phenomena, in Brownian motion. . . [It] is a body populated by multiplicities.'[16]

What makes the rhizome so suggestive is that it is always relational. It has to do with an interaction. Deleuze and Guattari illustrate the rhizome with the interaction between a wasp and an orchid. The example is a familiar enough one – of an insect being attracted to a plant, and thereby serving to cross-pollinate that plant. [17] The wasp is of course being 'housed' by the orchid, thereby giving the description a certain architectural relevance. But what interests Deleuze and Guattari most of all is the interaction between wasp and orchid. The orchid has developed attributes that attract the wasp, but so too the wasp has developed

德勒兹和瓜塔里以此形容块茎形成过程："黄蜂和兰花，作为异质元素，形成块茎。"[19] 块茎逻辑应该与树区分开。正如 John Marks 解释的那样："树的模型是等级化和集中的，而块茎是增殖和系列的，通过连接和异质性的原则方式运作……根茎是一种多样性。"[20] 块茎概念的核心是"生成"原则，与另一个形成一种关系的原则，正如在黄蜂和兰花的例子中，其中一个将另外一个去领域化："植物的智慧在于，即使它们有根，也总有一个外部，使它们与其他事物（风、动物、人类）形成块茎（也有一个方面是让动物形成块茎，人类也一样）。"[21]

块茎的经典例子也许是书。块茎实现"生成"，它影响自我和他者之间的联系形式。但是，应该强调的是，块茎不是表现形式。块茎超越表现的限制。例如，写作并不代表世界，它与书形成了块茎："这同样适用于书和世界：与根深蒂固的信念不同，书并不是世界的形象。它形成了与世界的根茎，书和世界之间同步进化；书保证世界的去领域化，世界保证书的去领域化，从而使本身也去领域化（如果有能力，如果可以）。"[22]

当我们谈到欲望机器，那么，关键的问题是这些机器所提供的连接。即使它们是机械机器，它们的目的还是连接。它们形成了与世界的块茎——共生、和谐。此外，这种连接的本质是动态的，它是基于自由流动和游牧强度。但是，最重要的是，机器可以被看作是欲望，欲望可以被理解为积极、创造性的行为。

机器化建筑

德勒兹和瓜塔里将机器认为是"抽象机器"，并将其与图解的概念相连："抽象机器本身不是物质或有形的，也超越了符号；它是图解（它对人为和自然的区别完全一无所知），它是纯粹的物质功能——一个独立于形式和物质、表现和内容的图解。"[23] 通过图解的使用，很明显可以把德勒兹和瓜塔里作品中"机器"的意图运用到建筑中。这里更重要的是图解应被理解为不是一张代表了已经存在的草图，正如德勒兹和瓜塔里评论的那样："图解或抽象机器对表现甚至某些现实不起作用，而是建造一个即将到来的现实，一个新类型的现实。[24] 我们必须明白，图解作为一个在虚拟世界中操作的实体（即一直没有实现），有可能在材料领域中将虚拟真实化。

此外，这一概念似乎意味着自生成或自组织过程的潜力。德勒兹将"图解或抽象机器"看作是"不同力之间关系的密度、强度的地图……其作为一个非统一的内在原因，与整个社会域共存。抽象机器，有执行其关系的如固定组合的原因；这些关系发生于它们产生的组合的组织中。[25]

在 Las Spuybroek 的书《机器化建筑》中，他引入"机器"的概念，并将其应用到建筑设计。[26] 在这里 Spuybroek 描述了选择一个系统的设计过程，从而发展机器，可以生成建筑形态的形式：

a. 我们需要选择一个系统，并基于选择创建一个机器配置。

b. 我们需要在那个系统中操作元素和关系 。

c. 我们需要一个巩固环节，最终得到系统。

d. 导致建筑形态。[27]

a pattern of behavior that serves the orchid. As Deleuze and Guattari observe, wasp and orchid enter into a mutual reciprocity, such that the wasp has adapted to the orchid, no less than the orchid has adapted to the wasp. Deleuze and Guattari refer to this as a form of mutual 'becoming'. The wasp becomes like the orchid, and the orchid becomes like the wasp, or – more precisely – the wasp has evolved in response to the orchid, just as the orchid has evolved in response to the wasp.

Importantly, for Deleuze and Guattari, we must perceive both wasp and orchid in terms of a multiplicity. As Greg Lynn explains: 'The multiple orchids and wasps unify to form a singular body. This propagating unity is not an enclosed whole, but a multiplicity: the wasps and orchids are simultaneously one and many bodies. What is important is that there is not a pre-existing collective body that was displaced by this parasitic exchange of sexual desire but rather a new stable body is composed from the intricate connections of these previously disparate bodies. Difference is in the service of a fusional multiplicity that produces new stable bodies through incorporations that remain open to further influence by other external forces.'[18]

Deleuze and Guattari describe this process as forming a rhizome: 'Wasp and orchid, as heterogeneous elements, form a rhizome.'[19] The logic of the rhizome should be distinguished from that of the tree. As John Marks explains: 'The model of the tree is hierarchical and centralised, whereas the rhizome is proliferating and serial, functioning by means of the principles of connection and heterogeneity. . . The rhizome is a multiplicity.'[20] Central to the concept of the rhizome is the principle of 'becoming', of forming a relationship with the other, as in the case of wasp and orchid, where the one deterritorializes the other: 'The wisdom of plants: even when they have roots, there is always an outside where they form a rhizome with something else — with the wind, an animal, human beings (and there is also an aspect under which animals themselves form rhizomes, as do people, etc).'[21]

The classic example of the rhizome is perhaps the book. The rhizome achieves a sense of 'becoming'. It effects a form of correspondence between the self and the other. But it should be stressed that the rhizome is not a form of representation. The rhizome steps beyond the limits of representation. Writing, for example, does not represent the world. It forms a rhizome with it: 'The same applies to the book and the world: contrary to a deeply rooted belief, the book is not an image of the world. It forms a rhizome with the world, there is an a parallel evolution of the book and the world; the book assures the deterritorialization of the world, and the world assures the reterritorialization of the book, which in turn deterritorializes itself in the world (if it is capable, if it can).'[22]

When we speak of desiring machines, then, the key question is the connectivity afforded by those machines. Even if they are mechanical machines, their purpose is to connect. They form a rhizome with the world – a symbiosis, a symphony. Moreover, the nature of this connectivity is dynamic. It is based on free flows and nomadic intensities. But, above all, machines can be seen as the conduits of desire, where desire is construed as a positive, creative act.

Machining Architecture

Deleuze and Guattari refer to machines in terms of 'abstract machines', and connect them with the concept of the diagram: 'An abstract machine in itself is not physical or corporeal, any more than it is semiotic; it is diagrammatic (it knows nothing of the distinctions between the artificial and the natural either). It operates by matter, not by substance; by function, not by form. . . The abstract machine is pure Matter-Function – a diagram independent of the form and substances, expressions and content it will distribute.'[23] This opens

机器因此为生成图解的某种形式服务。它基于分析，这种分析产生信息，然后机器必须以某种方式运转并组织信息生成设计。设计通过处理信息操作，作为机械化的成型方式："总之，对自生成的设计技术，我们需要现存形式的经验（经验都在现实中发生）研究，我们需要通过分析从研究中建立主体计划，这些机器可以处理那些通过操作具有拓扑关系的部件而得到的信息，再获得形式，这个过程首先是一个设计，然后才作为一个真正的建筑。"[28]

如果我们将世界理解为机器组成的，我们可以看到，机器的概念，可以在三个不同的层次操作。首先，物质世界的某些方面——最初的"机器"——被选择和被分析以提供信息，随后通过第二台机器加工——"设计机器"——以产生设计，最终在第三个机器"建筑机器"中实现。

居住的机器

这与柯布西耶著名的"房子是居住的机器"的论述建立起了有趣的联系。在很多人看来，这个论述暴露了现代主义建筑的贫乏，在现代主义中，功能主义没有考虑人的存在。但是问题也许就在于，对这个论述的理解完全是表面化的。据推测，就字面意义来看，房子对于柯布西耶来说就是机械。然而，如果我们不在机械的正面论述中重新思考"机器"的概念，而是作为一个渴望机器，或者作为一个滋生和促进欲望的物体，我们可以重新评价柯布西耶的论述。这个房子，对柯布西耶而言，应该是一部欲望流动的机器。[29]

但是，即使我们理解了"机械"字面上"居住机器"的含义，仍然存在另外一种解读。当然柯布西耶决不可能读到德勒兹和瓜塔里的哲学。事实上，他是否深入阅读哲学仍然值得怀疑，但他肯定深入涉足艺术圈。如果我们观察超现实主义中机器的处理——例如，在杜尚的"光棍机器"中——我们会发现另外一种解读：机器不再作为人存在的对立，而是植根其中，在组成人类想象的幻想领域深深铭刻。[30] 我们甚至可以以几乎幻想的方式谈论机械。正如科学可以通过科幻小说的镜头来看待一样，机械也可以以几分浪漫、机械幻想的方式去理解。

无论柯布西耶在他的"房子是居住的机器"中所要表达的是什么，很清楚，今天的房子深深依赖于技术——从客厅中的电视、视频和音响系统，到厨房中的冰箱、微波炉炊具和洗碗机。此外，很显然，我们人类已经开始处理技术物件——我们的电脑、手机或其他个人设备—— 随着我们亲自操作而拓展，所以，正如我们驾驶汽车时几乎没有意识到驾驶、制动、转向、换档等实际动作，这些设备已经被纳入到我们的潜意识，并已成为我们自身存在的假肢。

事实上，如 Donna Haraway 那样的网络理论家做的假设一样，人与非人之间的界面被削弱，因为技术越来越多地统治我们的想象空间。[31] 因此，我们正在发展一个混合人与机器特征的半机械突变的产物。技术不再仅仅作为一个人类操作的假体，它已经被真正地吸收到我们的意识之中。

因此，我们应该质疑那些论断，如海德格尔的，他认为技术是异物，没有看到人类将新技术纳入意识视野的能力。[32] 然而，最重要的是我们不应该忽视设计在人们意识内促进技术吸收的作用。因为正是设计，促进了机

up the obvious possibility of connecting the notion of the 'machine' in the work of Deleuze and Guattari to architecture through the use of the diagram. Importantly here the diagram should be understood not in the literal sense of a sketch that represents what is already existing. As Deleuze and Guattari comment: 'The diagrammatic or abstract machine does not function to represent, even something real, but rather constructs a real that is yet to come, a new type of reality'.[24] We must therefore understand the diagram as an entity that operates within the realm of the virtual (i.e. that which has not been realized), and that has the potential to actualize the virtual within the realm of the material.

Furthermore, the concept seems to imply the potential for processes of autopoesis or self-organization. Deleuze refers to the 'diagram or abstract machine' as 'the map of relations between forces, a map of destiny, or intensity, which. . . acts as a non-unifying immanent cause which is coextensive with the whole social field. The abstract machine is like the cause of the concrete assemblages that execute its relations; and these relations take place 'not above' but within the very tissue of the assemblages they produce.'[25]

In his book, Machining Architecture, Lars Spuybroek has taken the notion of the 'machinic' and applied it to the world of architectural design.[26] Here Spuybroek outlines a process of design that depends upon selecting a system, and from that developing a machine that will generate some form of architectural morphology:

a. We need to select a system and create a configuration for the machine based on this selection

b. We need to mobilize the elements and relations in that system

c. We need a phase of consolidation to finally have the system

d. Result into an architectural morphology.[27]

The machine therefore serves as some form of diagram. It is based on analysis. This analysis produces information, and then the machine has to operate as a way of processing this information in order to generate a design. The design then operates as a formation that is literally formed machinically by the processing of that information: 'In short, for self-generative design techniques we need empirical (since it all happens within the real) research of already-existing forms, then we need to construct body-plans out of this research through analysis, then these machines need to be able to process information (or difference) through a mobilization of its topologically connected components, then these need to be able to consolidate and take on a form, first as a design and then as a real building.'[28]

If, however, we understand the world itself as consisting of machines, we can see that the notion of the machine can operate at three different levels. First, some aspect of the material world – an initial 'machine' - is selected and analyzed to provide information that is subsequently processed through a second machine – a 'design machine' - to produce a design that is eventually realized in a third machine - a 'building machine'.

A Machine to Live in

This opens up an interesting connection with the famous comment of Le Corbusier, 'The house is a machine to live in'. For many this comment exposes the poverty of Modernist architecture where functionalism is promoted over concerns for human existence. But the problem, perhaps, is that the comment has been judged at face value. It has been supposed that the house for Le Corbusier should be mechanical in the literal sense. If, however, we rethink the notion of the 'machine' not within a positivistic discourse of the mechanical, but as a desiring machine, as an object, in other words, that engenders and promotes desire, we can reassess Le Corbusier's comment. The house, for Le Corbusier, should be a machine that channels the flow of desire. [29]

器过程中的连接性，润滑了过程本身；正是设计，培养了与世界的“知觉联系”，通过美学表达，在同化作用的关键时刻闪耀。[33]

从这本书中，我们可以观察到数字技术的一个关键转变。不久之前，我们的注意力几乎还全部集中在技术本身，它们的新奇成为我们的迷恋对象。然而，我们现在似乎已经超越了这种诱惑，进入了一个新的范式，技术已经被之前没有见过的知觉所鼓舞。本书展示的项目，挑战了屡见不鲜的认为技术与人对立的假设，同时也提供了强有力的实证：设计有能力改善人类环境，将我们与生活世界相连。

尼尔·林奇

宋刚 何峥鸣（翻译）

But even if we understand the 'machine to live in' in the literal sense of the 'mechanical', there is still another reading possible. Le Corbusier, of course, could never have read the philosophy of Deleuze and Guattari. Indeed it is questionable whether he read any philosophy in great depth. But he was certainly involved heavily in artistic circles. If we look at the treatment of the machine in Surrealism – as, for example, in the 'bachelor machine' of Marcel Duchamp - there is another reading to be found, one that sees the machine not as antithetical to human existence, but deeply embedded in it, and inscribed, moreover, within the very realm of fantasy that constitutes the human imagination.[30] We might even talk then of the mechanical in almost fantasy terms. Just as science can be viewed through the lens of science fiction, so the mechanical can be understood in terms of a somewhat romantic, mechanical fictions.

Whatever Le Corbusier might have intended by his notion of the house as 'a machine to live in', it is quite clear that the house of today is deeply reliant upon the technological – from the televisions, videos and sound systems in the living room to the refrigerators, micro wave cookers and dishwashers in the kitchen. Moreover it is clear that we human beings have begun to treat technological items – our computers, cellphones or other personal devices – as extensions of our bodily operations, so that, just as when we drive a car, and are barely aware of the actual operations of driving – braking, steering, changing gear and so on – these devices have become absorbed within our unconscious, and have become prostheses of our own existence.

Indeed the assumption has been made by cybertheorists such as Donna Haraway that the interface between the human and the non-human is being eroded, as increasingly the technological colonizes the space of our imagination.[31] As a result we are developing increasingly into a mutant generation of cyborgs with a form of hybrid human-technological identity. It is as though the technological has been not only been embraced as a prosthesis to human operations, but also absorbed into our very consciousness.

We should therefore be suspicious of the discourse of those such as Martin Heidegger, who see technology as alienating, and who fail to take account of the capacity of human beings to absorb the new – including the technological – into their horizon of consciousness.[32] What is most important, however, is that we should not overlook the role of design in facilitating the absorption of the technological within human consciousness. For it is precisely design that facilitates the connectivity that lies at the heart of machinic processes, and lubricates the processes themselves. And it is design that fosters the 'sensuous correspondence' with the world, that flares up at that vital moment of assimilation afforded through aesthetic expression.[33]

From the evidence in this catalog we can now detect a crucial shift in the treatment of digital techniques. It was not so long ago when attention was focused almost exclusively on the techniques themselves. Such was their novelty that they had become objects of fascination. It would seem that we have now transcended this fascination, and entered into a new paradigm where technique has been enthused with a sensuousness never seen before. Not only do some of the projects in this catalogue challenge the all too common assumption that technology is antithetical to the human condition, but they also provide eloquent demonstration of the capacity of design to improve the human condition and to connect us with the lifeworld.

Neil Leach

注释

1. Philip Goodchild, Deleuze and Guattari: An Introduction to the Politics of Desires, London: Sage, 1996, p. 218.
2. John Marks, Gilles Deleuze: Vitalism and Multiplicity, London: Pluto, 1998, p. 98.
3. Deleuze and Guattari, Anti-Oedipus: Capitalism and Schizophrenia, Minneapolis: University of Minnesota Press, 1983, p. 285.
4. Deleuze and Guattari, Kafka: Towards a Minor Literature, Minneapolis: University of Minnesota Press, 1986, p. 8.
5. See Manuel DeLanda, Intensive Science and Virtual Philosophy, London: Continuum, 2002, p. 72.
6. For a more detailed discussion of 'assemblage' see: Deleuze and Guattari, Kafka, pp. 81-90. I am grateful to Dana Vais for her advice on this subject.
7. Deleuze and Guattari, A Thousand Plateaus: Capitalism and Schizophrenia, Minneapolis: University of Minnesota Press, 1987, pp. 22-23.
8. Deleuze and Guattari, A Thousand Plateaus, London: Athlone, 1988, p. 399.
9. Keith Ansell Pearson, Germinal Life, London: Routledge, 1999, p. 156.
10. Gilles Deleuze, Claire Parnet, Dialogues, Paris: Flammarion, 1977, p. 84
11. For a discussion of the machinic phylum and its relationship to urbanism, see Peter Trummer, 'Morphogenetic Urbanism, Digital Cities, AD, vol. 79, issue 4, September 2009, p. 64-67.
12. Deleuze and Guattari, A Thousand Plateaus, p. 409.
13. Manuel DeLanda, War in the Age of Intelligent Machines, New York: Zone, 1991, p. 20. The idea that the whole is greater than the sum of its parts seems to echo to the principle of emergence.
14. Deleuze, Kafka, as quoted in Rajchman, The Deleuzian Connections, Camb., MA: MIT Press, 2000, p. 7
15. Keith Ansell Pearson, Germinal Life, London: Routledge, 1999, p. 153.
16. Deleuze and Guattari, A Thousand Plateaus, p. 30.
17. Deleuze and Guattari appear to be referring to the digger wasp (Gorytes mystaceus and Gorytes campestris) and fly orchid (Ophrys insectifera). It is curious that they do not refer to the particular sexual nature of this relationship. Usually an insect is attracted to a flower by the promise of nectar. Here, however, the sole attraction for the wasp is the potential of copulation. The orchid looks and smells like a female wasp. It attracts the male wasp, whose excited behaviour serves to dislodge pollen from the plant on to the back of the wasp, which then transfers it to another orchid as it seeks gratification elsewhere. Biologists refer to this process as one of 'pseudocopulation'. See Friedrich Barth, Insects and Flowers, trans MA Biederman-Thorson, George Allen and Unwin (London), 1985, pp. 185–192.
18. Greg Lynn, Folds, Bodies and Blobs, Brussels: La Lettre Volée, 1999, p. 139.
19. Deleuze and Guattari, A Thousand Plateaus, p. 10. Deleuze and Guattari's opposition to signification is an integral part of their theoretical position. Signification subscribes to the discourse of 'binary oppositions'. Moreover, it belongs to the realm of 'representation' rather than 'process', and can therefore never account for the complexity of the rhizome.
20. John Marks, Gilles Deleuze: Vitalism and Multiplicity, Pluto (London), 1998, p.45.
21. Deleuze and Guattari, A Thousand Plateaus, p. 11.
22. Deleuze and Guattari, A Thousand Plateaus, p. 11.
23. Deleuze and Guattari, A Thousand Plateaus, p. 141.
24. Deleuze and Guattari, A Thousand Plateaus, p. 142.
25. Gilles Deleuze, Foucault, Minneapolis: University of Minnesota Press, 1988, p. 37.
26. Lars Spuybroek, Machining Architecture, London: Thames and Hudson, 2004.
27. Spuybroek, Machining Architecture, p. 9.
28. Spuybroek, Machining Architecture, p. 10.
29. Perhaps in Le Corbusier we could even see that sense of desire sublimated or masked within the realm of the mathematical - the logic of 'sensed' mathematics.
30. Among others Francois Roche is deeply influenced by the 'bachelor machine', and his selection of Architects' works for ABB2010 'Machinic Processes' reflect this influence.
31. Donna Haraway, 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century,' in Simians, Cyborgs and Women: The Reinvention of Nature, New York: Routledge, 1991, pp.149-181.
32. For a critique of Heidegger's approach to technology, see Neil Leach, 'Forget Heidegger' in Neil Leach (ed.), Designing for A Digital World, London: Wiley, 2002. Clearly, we need to include human beings within the category of machinic in order to understand the complex relationships that structure human existence. As Félix Guattari comments on the subject of technology: 'Far from apprehending a univocal truth of Being through techné, as Heideggerian ontology would have it, it is a plurality of beings as machines that give themselves to us once we acquire the pathic or cartographic means of access to them.' Félix Guattari, 'Machinic Heterogenesis' in Verena Andermatt Conley (ed.), Rethinking Technologies, Minneapolis: University of Minnesota Press, 1993, p. 26.
33. On the potential for design to foster a sense of 'sensuous correspondence', see Neil Leach, Camouflage, Camb., MA.: MIT, 2006.

参数化过程设计 / The Parametric Design Process

对于建筑设计方法的研究，几十年来似乎处于停滞的状态，但是，建筑设计方法本身却有了根本性的变化，这一变化最显著的特点就在于“由重视结果的设计转变为重视过程的设计”。上世纪 60 年代开始的关于建筑设计方法的研究，最为关注的是建筑设计的流程，它是建筑师作为创作主体进行建筑设计所遵循的步骤，流程和步骤是作为客体而存在的，它是为建筑师获得设计结果服务的，因而，无论设计方法本身，还是这些研究，均重视作为结果的建筑设计或方法。

但近二十年来，显而易见，设计方法已转变为重视设计过程的设计及控制，这种新的设计法更重视设计过程的主观能动性及直接性，坚信通过把握动态的设计过程，设计结果定能自然浮现，实际上建筑设计方法从自上而下转变为自下而上的设计方法。这一转变具有其复杂的社会、科学、哲学及技术背景。

过程设计

上述设计方法的变化与两种哲学思想有着密切的关系。

其一是“过程思想”。20 世纪 20 年代，英国著名学者 A・N・怀特海（1861-1947 年）在他的著作《过程与实在》中首先系统地阐述了“过程哲学”的思想，之后查尔斯・哈茨霍恩，以及小约翰・B・科布又发展了这一思想。“过程”代表着正在发生着的动态新生活动，过程体现为转变和新生。转变即一种现实个体（又称“经验机遇”）向另外一个现实个体的转化，它构成了暂时性，因为每一个现实个体都是一些转瞬即逝的事件，灭亡就意味着转向下一事件；新生则意味着生成具体，它构成了永恒性，因为在新生的过程中没有时间，每一个瞬间都是崭新的，都是“现在”，在这个意义上，它又是永恒的。

另一哲学思想是“生成”。德勒兹在《生成》一文中曾经指出，“生成”总是逃避在场性的“现在”，因为它不能被固化成一种空间性的先后秩序（过去 / 将来），在某个特定的时点，它既在又不在，这里根本没有可以独立地分隔开来的在场和不在场，二者总是已经在互动和转换的游戏之中了。“生成”是一个运动过程，它不是由事物的状态决定的，它不提出“你将生成什么”的问题，因此也不涉及模仿与再现。生成是对固化的理论和学说的瓦解，由于任何系统都是内在异质的、多元化的，因此它的存在状态必然是开放的、时空统一的。维特根斯坦认为，生成的结果就是形成无数处于时空边缘、“家族相似”、但不能“类同化”的“事件”，而系统就在这种关联的拓展和重组中穿越不同的层次、不断改变自身的性质，而根本无法固定在某个特定的领域之内。

“过程”的概念建立在自然机体论基础之上，自然机体论认为自然是活的生命有机体，而“过程”是在更加抽象的形而上学层面上对“自然是活的生命有机体”观点的解析，因而，“过程”概念用于建筑设计法其实是把建筑设计过程看成生命的有机发展过程；而“生成”的概念实际上是对动态的阐述，把事物的产生及其历时性特征展现出来，因而对建筑设计法的影响在于把设计过程看成动态连续进化发展的过程，设计的结果只不过是这一过

The study of architectural design methodology seems to have been stagnant for decades, but the methodology itself has changed fundamentally. The most significant characteristic of this change has been the shift from an interest in the resultant design to an interest in the design process itself. In the 1960s the architect was perceived as an individual creative genius, and, although processes and procedures existed, most attention was focused on the actual results of the architectural design or method.

In the past two decades, however, design methodologies have been transformed into the control of the design process, and this new design method is more concerned with the architects' role within the design process and the belief that good design can emerge from a dynamic process. In this sense, design methodology has changed from a top-down to a bottom-up approach. This shift has a complex social, scientific, philosophical and technical background.

The Design Process

The shift is related to two philosophical concepts. One is 'process', first elaborated systematically by the famous British scholar, Alfred North Whitehead (1861-1947), in his book Process and Reality in the 1920s. Charles Hartshorne and John B. Cobb Jr. further developed the concept. 'Process' represents dynamics, and consists of two components: 'concrescence' and 'transition'. 'Concrescence' is the predominant path from a particular existent to a new existent, while 'transition' leaves the new existent as an 'original element'. Every moment of 'concrescence' is totally new, and reveals 'objective immortality'.

The other philosophical concept is 'becoming' from Gilles Deleuze. In his article. Control and Becoming, 'becoming' always avoids the potential of 'presence', because it cannot be solidified into a spatial order (past/future). At any particular point of time, there is no independently separated presence and absence. Both are interactive and are locked together in a mechanism of reciprocal presupposition. 'Becoming' is a movement, and is not determined by the status of objects. It does not ask 'what are you going to be', so it does not involve imitation and reproduction. 'Becoming' is the collapse of static theory. Because all systems are inherently heterogeneous and diverse, their existence must be open and unified with space. Ludwig Wittgenstein believes that the production of 'becoming' is the formation of events, with 'family resemblance', but no 'class assimilation'. It operates across different levels in this expansion and reorganization of the association, changing its nature, but simply cannot be fixed in a particular domain.

The concept of 'process' is based on the ideology of the organism, and is a further elaboration of the conclusion 'nature is an organism', but in a more abstract metaphysical way. So when we apply the concept of 'process' to architecture, we actually view architecture as an organism. On the other hand, the concept of 'becoming' is an elaboration of dynamism, showing the characteristics of producing objects. Its impact on architectural design is that we can view design as an evolutionary process, and the result of the design process as just a temporary moment or 'event'. The direct impact of 'process' and 'becoming' on architectural design is that design has been turned into a concern for 'processes' and 'becomings' instead of 'results'. Design has changed into a process in search of an open system.

This design method has been adopted by many architects. For example, Rem Koolhaas conducts studies on social issues, and Herzog & de Meuron analyze the logic of phenomena related to specific projects. As Alejandro Zaera Polo always points out, design is now a process rather than a static image, and the designer no longer relies on traditional forms of representation or invention using sketches, but rather waits for the design to 'emerge'.

程的瞬间暂时性的“事件”。“过程”及“生成”的概念对于建筑设计方法的直接影响是将作为“结果”的建筑设计转化为了作为“过程”及“生成”的建筑设计，将寻求确定解答的设计流程转化为了寻求开放系统的设计过程。

这种设计法已经被众多的建筑师所使用。莱姆·库哈斯通过对社会问题的研究过程来进行建筑设计；赫尔佐格通过对与具体项目相关的现象逻辑的分析过程来进行设计；FOA 建筑事务所的 Alejandro Zaera Polo 就曾经讲到：“我们在设计中引入了连续的发展过程，而不仅仅是一种形式、一个图像，我们让其生长，等待设计的浮现，而不再拘泥于传统模式的再现或是从草图引出的发明。”

尽管不少建筑师已运用了“过程设计”的方法进行建筑设计，但是，他们停留在人为操作的境地，设计过程的生命有机特性及动态连续复杂性要求更高智能的技术来解析及把握，仅靠人工操作已远远不能掌控。因而，计算机技术及其参数化平台成为“过程设计”的有力工具。

计算机参数化设计

参数化设计实际上就是要找到一种关系或称规则，用这一关系或规则来模拟影响建筑设计的某些主要因素表现出的行为或现象（这里把影响建筑设计的因素看作参（变）量或参数），进而用计算机语言描述关系或规则，形成软件参数模型，然后通过软件技术输入参量及变量数据信息并转化成图形，这个图形就是设计的雏形。

软件参数模型给建筑设计带来了灵活性，可以满足设计过程生命有机特性及动态连续复杂性的要求，当设计的条件或设计想法改变的时候，可以修改软件参数模型得到新的结果，当变量的大小值改变的时候，在已有参数模型上，改变输入信息就可得到新的结果，这样，设计结果就变得可控。

另一方面，影响建筑设计的因素除了主要的因素外还有其他因素，当通过软件参数模型得到设计的雏形后，可以根据其他因素的影响，进一步调整雏形，得到更高程度上满足设计要求的设计结果。

与人工操作的过程设计相比，计算机参数化设计实际上提供了一个抽象的造型机器，它可以让设计过程反反复复不断反馈，可以输入不同条件得到多个结果，可以对设计结果进行多次修正，这是人工操作做不到的。

参数化设计过程中的规则及描述规则的语言、软件参数模型、参量及变量、以及生成的形体都是显形可见的，与传统的设计过程相比，再也不是人脑黑箱生形的不可见过程，相反，它是逻辑化可控的科学设计过程。

参数化过程设计的关键环节

1. 设计要求信息的数据化

设计要求是设计的起点，包含了人的活动行为对建筑的要求，以及周边环境对设计的要求。对场地进行直观调查可有助于我们准确了解周边环境特征，而对未来建筑使用者进行访谈，观察相似功能建筑中使用者的活动行为等方法可获得更可靠的设计信息；但对于参数化设计来说，对周边环境特征及人的活动行为的数字化描述是最为关键的工作，因为这些数字化的信息将是建筑形态生成的基础。

Although many architects have applied the concept of 'process' to architectural design, their tools remain largely manual. The dynamism and complexity of process-based design requires intelligent tools, so computer technologies and parametric tools now offer a powerful support for this approach.

Digital Parametric Design

The role of parametric design is actually to find certain relations or rules, to simulate the behavior of main performance factors (parameters) in architecture, to use computer language to describe these relations or rules, to build up a digital model, and to import the parameters to create the design prototype.

Parametric modeling brings flexibility to architectural design and meets the demands of architectural dynamics and continuous complexity. When the initial design conditions change, the design results also change. When values of parameters vary, the model varies. Design becomes controllable.

On the other hand, there are always additional factors that affect architectural design. The design prototype can be adjusted by inputting those factors into the computer.

Compared to the traditional manual process of design, computer-aided parametric design actually provides an abstract prototype machine for architects, which allows repeated experimentation within the design process experimenting. When you input a number of different initial conditions, different results are generated, and may be adjusted based on the feedback of results. This cannot be done using traditional manual operations.

The parametric design process, including the description of rules, and the generation of a digital parametric model, with its parameters, variables, and final form, is a transparent operation. Compared to the traditional design process, it no longer operates within a black box. Instead it has become a logical, controllable, scientific design process.

Steps in the Parametric Design Process

1. Design Program Information

The design process begins with the gathering of program information, including the constraints of human activities within a building space and surrounding environments. The investigation of the site can help us understand exactly the features of the existing environment, and interviews with potential users and observations of users' activities in similar buildings can help us access more reliable design information. But in terms of parametric design, the most important input for architects will be the digital description of existing environment and people's behaviors, which will be the foundation for the generation of architectural form.

2. The Establishment of Parametric Relations

Architectural design is a complex process. When we start the design process on the computer, we first need to find out the main factors influencing the design, and usually simulate these factors or behaviors using certain relations or rules. For example, in an Urban Planning Exhibition Hall, the city model is usually in the center, and visitors walk around the model first and then visit other exhibition halls. Such doughnut-like flow can be seen as the main factor in the design. Doughnut-like space defines the basic relations of architecture, and the dimension of the model, the height of the space, size of the flow, number of nearby exhibition halls and so on, can be seen as parameters determining the relations of the doughnut. Once we have this knowledge, we have established the basic parametric relations.

3. Parametric Modeling

Once we have the basic design parameters and their parametric relations, we can use computer language

2. 设计参数关系的建立

建筑设计是一复杂系统，影响设计的因素众多，在计算机参数化设计时，往往首先找到影响设计的某些主要因素表现出来的行为或现象，并用某种关系或规则来模拟这些行为或现象的特征，比如中国城市规划展览馆建筑中，往往以城市总体模型为中心，参观者通常首先环绕总体模型参观，之后再参观周边的其他展厅，这一像面包圈一样的人流参观动线可以被看成影响设计的主要因素，这里，面包圈可以作为设计的基本关系，而中心模型的尺寸，建筑空间的高低，人流量的大小，周边展厅的数量及大小等可被看成决定面包圈这一关系的参数。但我们有了这些认识，我们就有了基本的设计参数关系。

3. 计算机软件参数模型的建立

当有了基本的设计参数关系，我们就要用计算机语言描述参数关系，形成软件参数模型。软件参数模型的建立可通过不同的途径，比如，使用已有软件菜单，如 Rhino 软件里的放样操作；也可使用已有的参数化设计软件，如 DP、GC、Grasshopper 等建立形态参数模型；或利用已有软件的脚本语言的描述实现参数关系的图形可视化，如 MAYA 里的 MEL 语言或 Rhino 里的 Rhinoscripting 等；当然我们也可在操作系统平台上编写程序生成符合要求的图形。当我们给软件参数模型各变量输入一定的值的时候，就得到设计雏形，当改变输入值时，可得到新的设计雏形。

4. 设计雏形的进化

从设计要求的某些主要因素得到的设计雏形一般只解决了建筑设计这一复杂系统的主要矛盾，许多其他因素也应该对设计结果产生作用，以便最终设计成果能最大程度地满足使用者活动行为的要求，并与环境相适应。这样，设计雏形还需在其他因素的作用下进化，正因为设计雏形是在参数化软件条件下的图形，所以它可以接受其他的软件程序操作，从而发生形态优化变形并发展到令人满意的设计结果。

5. 最终设计形体的参数化结构系统及构造逻辑

建筑设计这一复杂系统的各种因素的综合作用通常导致最终设计形体是一不规则的非线性体，仅仅满足于此是不够的，因为这一非线性形体如果没有结构系统及构造逻辑的支持是没有说服力的，也就是说设计还没完成，进一步考虑设计的基本结构系统及构造逻辑可以打开通向该建筑的构件加工及实际建造的通道。参数化的设计对确立建筑形体的结构系统及构造逻辑十分有利，我们可以研究计算机软件生成非线性形体时的内在逻辑，显示这一建构系统并可把它用来作为实际建造的基本结构系统；我们也可以在软件内根据形体的应力分布进行分块并研究单元体之间的连接构造，以这种方法作为基本结构系统；也可以首先研究某种自然界生物的结构关系并把它用来作为非线性体的基本结构系统，等等诸如此类的结构关系也是当今建筑师及结构工程师乐于探索的对象。构造逻辑是指在大的结构系统下，有限尺寸的分块材料如何被连接到一起，联系的关系应该与结构逻辑具有连续性。

6. 设计成果的测试与反馈

参数化过程设计的终极目标是要获得最高程度满足使用要求的设计结

to describe those parametric relations. A parametric model can be built using different approaches - by using existing software, such as Rhino, and existing parametric software applications, such as Digital Project, Generative Components, Grasshopper and other established parametric models, and existing scripting languages embedded in software, such as Maya Embedded Language in Maya, Rhinoscript in Rhino and so on. Of course, we can also write our own programs. When we input certain values into the parametric model, we obtain the design prototype, which varies as the values change.

4. The Evolution of the Design Prototype

The design prototype is developed according to certain principal constraints, that usually resolve the constraints within the architectural design. However, as architectural design is a complex system, some other factors many affect the final design results. Hence, the design prototype needs to evolve driven by other factors. Because the prototype is developed by parametric tools, it can be easily modified and optimized using other software.

5. The Parametric Structural System and Detailing of the Final Form

A combination of factors within the complex system of architectural design usually leads to an irregular non-linear form. But no non-linear form is convincing without a logical structural system and coherent detailing system. To some extent, then, the design is not complete without them. Further consideration of the basic structure system and detailing system can open the door to the actual logic of building construction. Parametric design tools are very useful for establishing the structure and detailing system, and we can study the software program's internal logic for generating an architectural form as the basis for the structural system in the actual construction; we can also study the connection between the components in the non-linear form based using certain kinds of mechanical analysis, such as stress distribution, and to use that information to inform the detailing; we can also introduce an initial biological study of natural structures, which some architects and engineers use as case studies. The structural and detailing systems relate individual components of limited size within a global system according to its own internal logic.

6. Testing and feedback of design results

The ultimate goal of the Parametric Design Process is to obtain the results to satisfy the design constraints. Although the logic of the process can guarantee this to a large extent, it is still necessary to test whether the design meets those constraints. Currently we can only rely on a limited range of testing techniques, such as Ecotech or self-programmed software to test the design, and the feedback the results into the design using parametric tools, perfecting the design by adjusting parameters.

From above discussion we can conclude that the parametric design process takes the following steps: 1. The process starts with an understanding of human beings and their environment; 2. The design is generated by controlling the process; 3. Based on the design process following the logic of causal efficacy we can obtain the results corresponding to the starting point of the design; 4. Further study of the structural and detailing logic ensures that the design can be constructed.

Xu Weiguo