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人工形态衍生：
广州高塔三角洲设计课程

Artificial Morphogenesis:
The Guangzhou Tower Delta Studio

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摘要 ……
在这篇文章中，我们以“广州高塔三角洲设计课程”为案例，来探讨为实现新城市聚落的生态发展所进行的全新参数化城市设计过程。传统的总体规划通常会基于自上而下的发展愿景，提出单一的、静态的设计“结果”（最好的情况下会提供几种可选择的中间状态），使得设计往往无法应对场地特定的微气候、地形以及文化条件。在一个终将变化的场地环境之中进行“静止”性的规划，这样的策略只能创造应对短期需求的低效规划，从长远来看则需要对其进行大量的设计重演过程。我们的实验性研究试图挑战传统的总体规划策略，利用一种自下而上、基于数据导向的策略，从而探索一种有机的设计过程，即针对建筑、城市/景观系统的新颖的形态衍生过程。该策略运用数字化运算来对特定场地上动态变化的环境特征进行解读，尝试运用参数化模拟来展现随时间而不断演变的多样化城市发展途径，并创造能够同时应对高环境性能和类型学创新两方面需求的景观及建筑形态。

关键词 ……
形态衍生；计算都市主义；数据导向设计；参数化类型学

Abstract ...
In this article we use the Guangzhou Tower Delta Studio as a case study to discuss novel parametric urban design processes for the ecological development of new urban settlements. Conventional master plans typically propose a single static 'end' condition (at best with a few intermediate phases) derived from top-down visions, often incapable of responding to site-specific microclimatic, topographical and cultural conditions. Frozen in an outmoded context, such strategies deliver ineffective planning in the short-term and require extensive recapitulation in the long-term. In our experimental research, we challenge traditional master plans and explore novel, morphogenetic processes for designing architecture and urban/landscape systems organically, by employing bottom-up, data-driven design strategies, consisting of a computational reading of the performative characteristics operating at a site, a parametric simulation of alternative urban developments over time, and a sculpting of landscape and building forms that address the simultaneous needs for environmental performance and typological invention.

Key words ...
Morphogenesis; Computational Urbanism; Data-driven Design; Parametric Typologies

有机城市项目

新数字技术的出现对建筑学思想以及城市设计具有两方面影响：其一是“转变”，即运用演算以及参数化技术替代传统的形态生成及设计产生过程；另一方面是“动态”，即摆脱建造环境是静止不变的错误认知，走向一种促进居住者与其周边环境之间动态互动关系的策略。

成立于2007年、隶属于瑞士联邦（洛桑）理工学院的“媒体与设计实验室”，是一个构建在建筑学院与计算机科学学院两者之间的研究平台，致力于探索上述的新数字技术对建筑学、城市设计以及景观设计等方面产生的多重影响。“计算都市主义”则是该实验室的研究重点之一。

自实验室成立后的5年间（2007–2012），我们在这个研究领域内开展了一系列名为“有机城市”的设计研究课程。我们运用借鉴于生物学领域的代码和算法（如植物生长算法），探寻能够应用于建筑及城市的新颖的形态生成过程。这一项目受到瑞士国家科学基金会的研究经费支持。

为了便于促进实验并建立起一套共享知识库，我们创建了一种被称为“anar.ch.”的开源对象导向式几何形状库[1]，为一系列研究设计课程提供基本的形状代码。设计师可以使用、调整或重组这些代码以实现参数化的建筑形态生成过程，使诸如环境、气候、结构或功能限制等外部环境参数能够影响并重塑建筑的最终体量形式。

“有机城市”系列设计研究课程创造了新颖的建筑及城市形式。从理念、精神以及形式语言等方面来说，我们对诸如摩天楼、中高层建筑和城市居住肌理的创新尝试，是对日本20世纪60年代的“新陈代谢运动”思想[2]以及约翰·法雷瑟早期的对于演变建筑学探索[3]的模仿与推广。图1展现了在佛罗伦萨建筑双年展上展出的4个由“anar.ch”库提供的算法及代码产生的有机形状摩天大楼设计[4]。

虽然“有机城市”系列设计研究课程所创造的不同尺度的项目拥有迷人的形式，它们作为最终的有机形式以及雕塑形态而言是有趣的，但是这一系列尝试也暴露了试图利用仿生代码来创造有效的城市生成方案所面临的挑战及其局限性。这其中有两点特别突出。首先，景观与建筑周边环境处在被动状态：我们如何能够将建筑周边景观以及一系列生态变量更好地融入设计过程，将其转变为能够积极引导设计过程的力量，而不仅仅作为用于矫正一个已有形态以及减轻设计缺陷的一系列被动的反应性约束？其次，传统建筑类型受到忽视：我们如何能够将现存的传统建筑类型学智慧积极融入参数化设计过程之中？这将能够创造一种宜居、宜人并充满意义的空间形式，与目前完全来源于生物学以及其他（非建筑）领域智慧的人工强制采用的有机形式截然不同。

为了应对如上两个挑战，我们于2012年发起了一个被称为“形态衍生”的系列设计研究课程，也就是本文的核心内容。在后文中，我们将首先勾画隐藏在“形态衍生”概念背后的想法，随后将通过介绍一个具体案例——广州高塔三角洲设计——来对“形态衍生”这一设计手法进行说明及讨论。

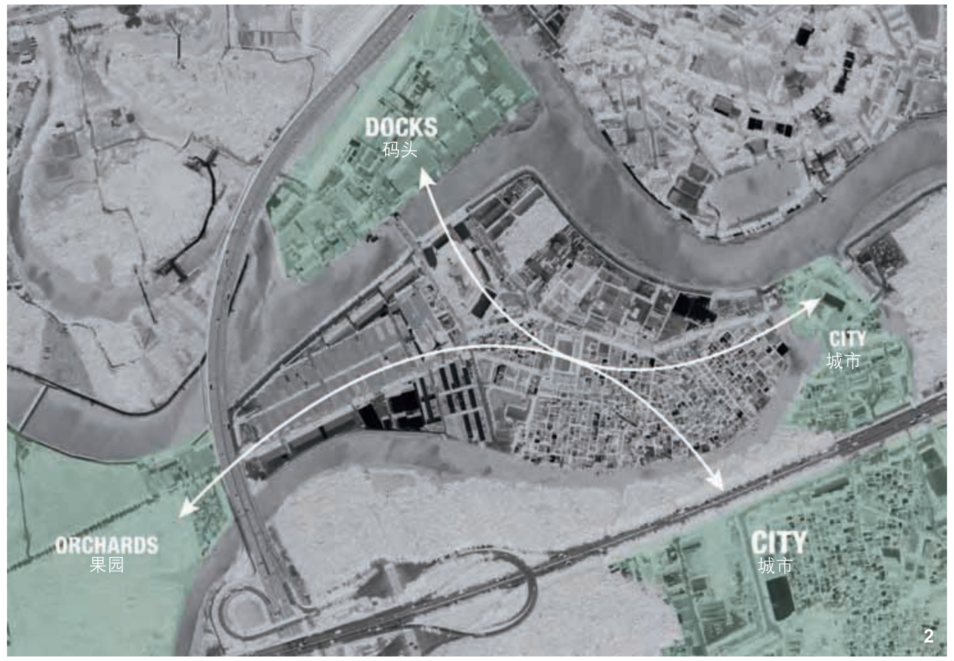
形态衍生

“形态衍生”设计课程的设立是出于发掘更加具有意义的形态生成过程。这一过程一方面融合了景观以及生态因素，另一方面则通过使用算法和参数化工具融合了类型学因素，并引入在建筑及城市设计中的“增长”概念。

为什么要采用“形态衍生”概念？达西·汤普森在1917年就已经意识到，在自然界中，形态的产生不可否认地与“生长”紧密相关[5]。计算机及其数字模拟潜力的出现重新唤起了人们对于“形态衍生”的兴趣，并将通过数字化生成过程模型进行尝试。我们使用“形态衍生”过程不但因为其拥有如同自然系统的包容不断增长的复杂性的能力，还因为其内在的能够包含从城市到建筑的尺度跨越性——例如，通过运用其尺度变化能力，当地的多样性约束因素能够被直接融入设计过程之中，并表现出能够应对周边环境变化的适应力。“形态衍生”过程考虑到设计的未来扩展性，意识到实际生成结果仅仅代表了一个长远发展过程中的短暂过渡阶段。因此，生成结果的形式失去了灵活性，而仅仅是一种对应当下一系列约束因素的空间表现形式。

我们利用新兴的亚洲城市作为“形态衍生”设计探索的案例。我们特别关注与中国快速城市化进程相关的种种问题，以及在规模和范围不断加速扩大的城市发展背景下，设计行业角色的不断扩展。我们没有选择被动地遵循自上而下的规划方式所设定的标准，而是试图探索一种自下而上的设计类型学，利用特定的参数化设计机制来组织其周围的城市结构。在“形态衍生”策略指导下产生的空间类型不再是一成不变、千篇一律的复制品，而是能积极适应各自所处的场地特征，比如场地的

1. “有机城市”设计课程成果——4个由几何代码生成的有机形态摩天楼（指导教师：杰弗里·黄教授；课程助理：纳撒尼尔·卒莱克、朱利恩·南布里尼、纪尧姆·拉贝尔；参与学生：奥利维尔·维斯穆勒、奥利维尔·伊莱热姆、治·莫泽修、阿尔贝托·菲奥里）。
1. Four organic skyscrapers from the "organicities" studio generated by geometric code (Instructor: Professor Jeffrey Huang; Assistants: Nathaniel Zuelzke, Julien Nembrini, Guillaume Labelle; Students: Olivier Wyssmueller, Olivier Ilegems, Osamu Moser, Alberto Fiore).



状况、景观及其综合环境条件。在人们对于在亚洲国家实行千篇一律的西方规划方式日益不满的情况下，这一策略试图提出新的解决方案。

在技术层面上，我们主要利用Grasshopper——一种可进行参数化建模的犀牛软件插件。Grasshopper可以将建模过程与视觉化、图解化、以及编程化的过程结合起来。我们选择运用Grasshopper软件不仅因为它能够产生多样的形式可能性，它同时还具有支持该设计课程整体概念框架的能力。通过遵循特定逻辑来管理众多的参数化变量，我们能够避免产生重复的解决方案，并在整个项目设计过程中保持高水平的概念严谨性。另一方面，Grasshopper还具有在设计过程中快速、准确地产生定量信息的能力，可以利用这些信息来强化设计理念，或是将设计决策的制定过程看成是动态的反馈系统。

广州高塔三角洲设计课程

为了更好地说明“形态衍生”策略，我们将在此介绍最近的一次设计课程——2013年春季广州设计课。该设计课程得到由俞孔坚教授指导的哈佛－北大平行设计课程的支持，其中包括场地数据提供、场地合作调研等方面。

设计场地位于中国广州市海珠区。该设计课程关注的是如何在具有高度生态敏感性的珠江三角洲冲积平原之上，运用构造及类型学手段建立一座城市高塔。海珠区是位于珠江三角洲的一个以其丰沃的果园及田地而著称的岛屿，这一冲积平原具有高度的生态多样性（图2）。

中国的第三大城市广州，为海珠区施加了巨大的发展压力，这使得该地区独特的生态环境及农业历史正在受到威胁。本次设计课的首要任务就是希望通过“形态衍生”策略创造一个能够应对这一精妙而脆弱的环境的综合功能高塔。

该设计课程沿着一个精心构建的序列发展——它遵循“形态衍生”逻辑并包括如下通过相叠加共同组成该项目的6个阶段：

（1）数据记录与地图呈现

我们首先进行了对现有场地生态、环境变量因素的数字化分析，例如地形、日照、风、水文、湿度，以及现有基础设施、气候条件、现有的建筑肌理等。这些数据被记录、索引，并被转化为以地图形式呈现的数据生成图（图3）。

（2）“涌现”的类型

数据驱动设计构想。在“形态衍生”过程中，景观环境中的参数变量将驱动着潜在空间类型的形成。我们将“类型”定义为一种灵活的、能够根据不同环境重新调整和反应的拓扑连接结构，而非一个固定的物体。

最初的设计构想将在这一阶段产生以表达设计者（们）的意图（图4）。

（3）图解与参数化

“图解”试图用一种正式的方式来说明各个设计元素之间的关系。这一过程不仅能够推动设计发展，同时能够使设计者的意图被他人所理解。“参数化”则需要设计者将前一步得到的“类型”变成一个定义了变量的参数化模型（图5）。

（4）“迭代”的偏离过程

在这一阶段，我们尝试通过检验不同的“实例”和多样的类型初始状态，来探索该参数化类型的多样变化。例如，空间体积与空间美学两者之间的关系在这一阶段得到研究。由同一参数化“类型”所产生的多样“实例”的性能，会在一个迭代反馈回路中被不断评估，并与最初特意设定的衡量标准进行对比（图6，7）。

（5）实例化和定型

这一阶段的目标是确定一个由参数化类型模型生成的特定“实例”，进一步设计并发展出足够的细节和规范以满足该设计课程对于一个完整的建筑方案在范围和规模上的要求。为适应该场地所进行的进一步形态塑造及裁减操作，能够使该方案回应周边环境存在的微变量（图8）。

（6）设计表达

最后，设计表达将回到由设计者向他人解释其所选择的参数化系统的逻辑，并运用批判性思维对由该系统生成的结果进行分析。这一阶段的成果包括诸如建筑图、图表、动画、计算机代码以及实体模型等一系列用于向他人讲解该设计项目的必要文件（图9）。

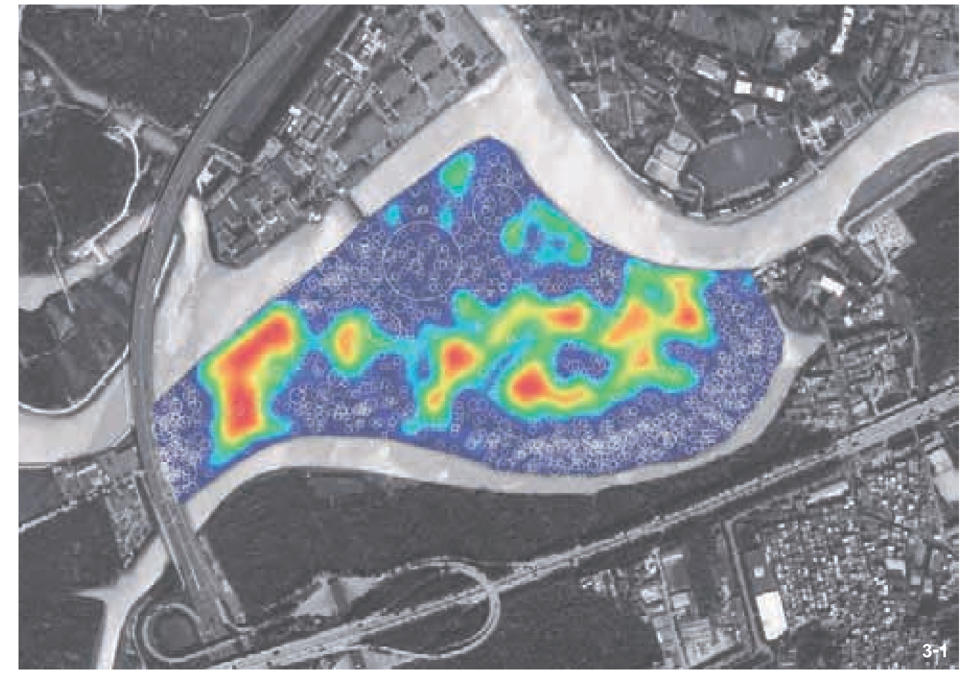
参数化类型学

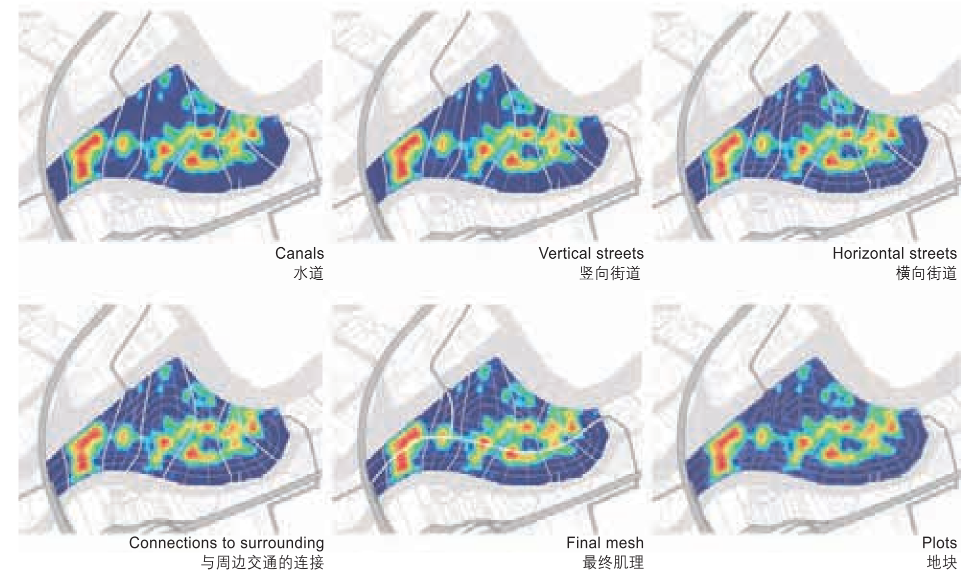
本次广州设计课程的一系列项目仅仅代表了我们对于“形态衍生”手法的初步尝试。通过这一课程我们逐渐开始思考这一手法面临的挑战及其应用范畴。而这些项目已经能够表达我们继续前进的方向，以及我们在之后的研究中将会关注的问题。

推动“形态衍生”策略的力量包括环境、生态数据以及其他一些参数变量——它们不仅仅是启动自下而上的、由景观环境驱动形态生成过程的客观基础，同时相比通常凭借主观直觉决定的形态生成过程，这样的方式更加清晰明确，即该策略能够为每一个项目提供客观的目标合理化过程，或被我们称为由数据导向的“形态衍生情节”。因此，参数设计中主观的形态决定策略在该研究中受到批判性质疑。[6]

然而，这种受到景观设计学“反规划”思想启发[7]，基于景观环境并由数据导向的设计过程，当被应用在建筑学以及城市设计领域时，需要回应“参数化类型学”这一概念。多样的类型场景以及伴随其产生的参数变量，会成为“形态衍生”策略中一种必要的“阻力”，它们将向传统的线性数据导向设计提出阻力与挑战，将其转变为前文所说的“迭代循环”过程。

通过反思本次广州设计课程的成果，我们意识到为实现景观导向与建筑类型学实





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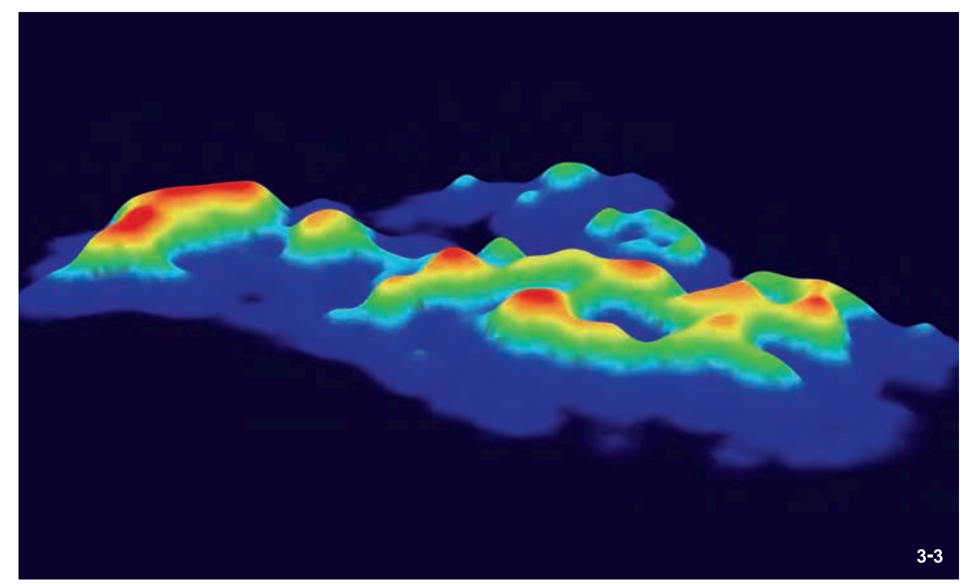
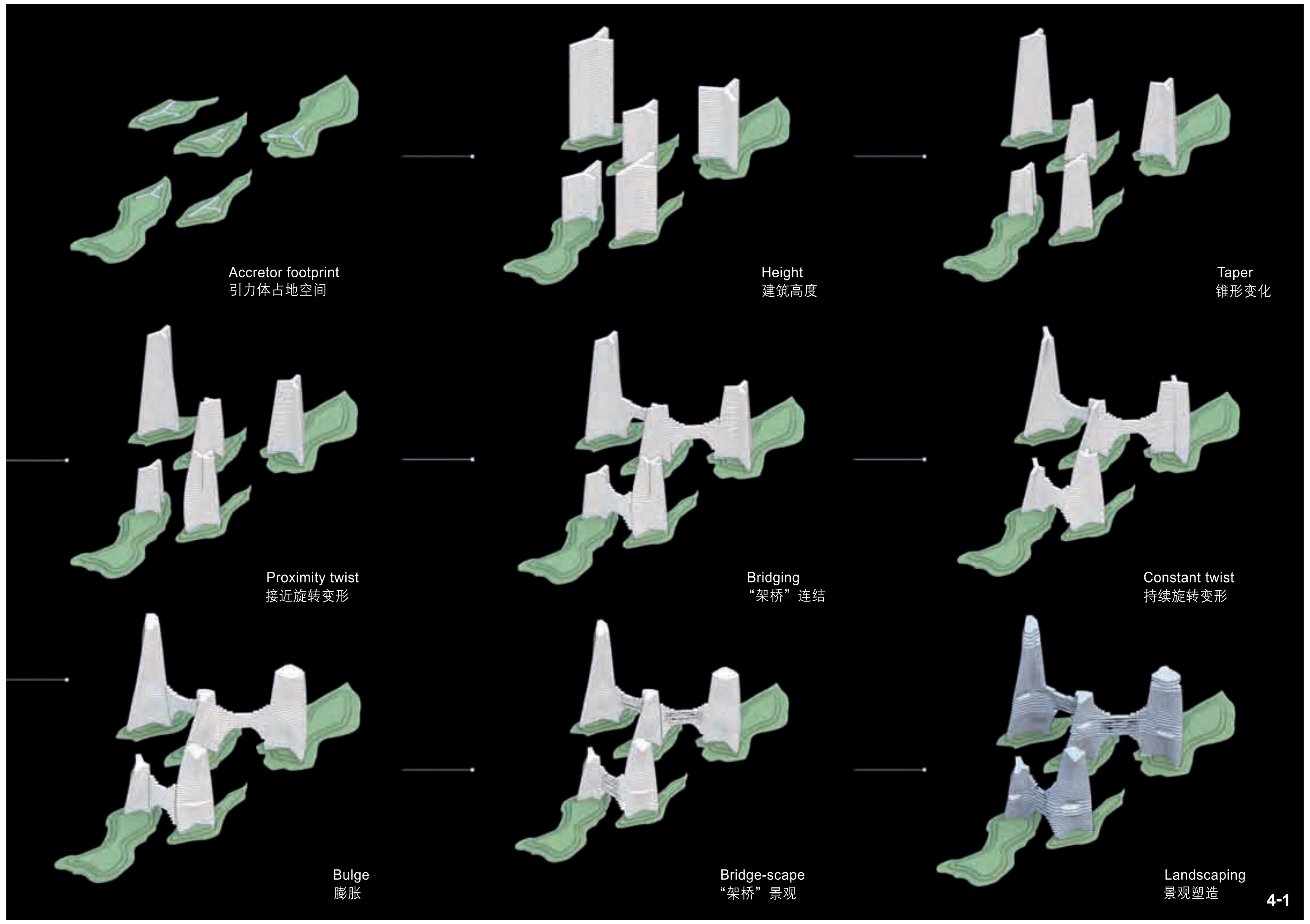


2. 设计场地周边环境（瑞士联邦理工学院“形态衍生”设计课程。指导教师：杰弗里·黄教授；课程助理：特雷弗·帕特、彼得·奥特纳；参与学生：杰拉尔德·格伯、乔纳斯·汉斯·如森博格。）
3. 数据记录与地图呈现。现有绿地被作为场地的生态驱动力。图3-1为密度地图，展现出了从非建设区（蓝色代表现有绿地区域以及推算的扩张量）到建设区密度的渐变（黄色到红色）；图3-2为城市肌理生成示意图；图3-3为控制的天际线高度示意图（瑞士联邦理工学院“形态衍生”设计课程。指导教师：杰弗里·黄教授；课程助理：特雷弗·帕特、彼得·奥特纳；参与学生：查尔斯·萨拉辛、肯·俊·崔博尼）。

2. The context of the site in the Haizhu District (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Gerald Gerber, Jonas Hans Reutherborg).
3. Indexing and Mapping. The existing green areas act as ecological site forces. Figure 3-1, the density map, translates the negative space (in blue, defined by existing green areas and their extrapolated expansion) into potential built density (yellow to red), generating the urban pattern (Fig. 3-2) and fixes a skyline (Fig. 3-3) (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Charles Sarasin and Ken Jun Triponez).



4-1

际需求之间的融合还有大量的工作需要完成。未来我们的研究将重点关注如下三个方面：

（1）参数化类型的来源

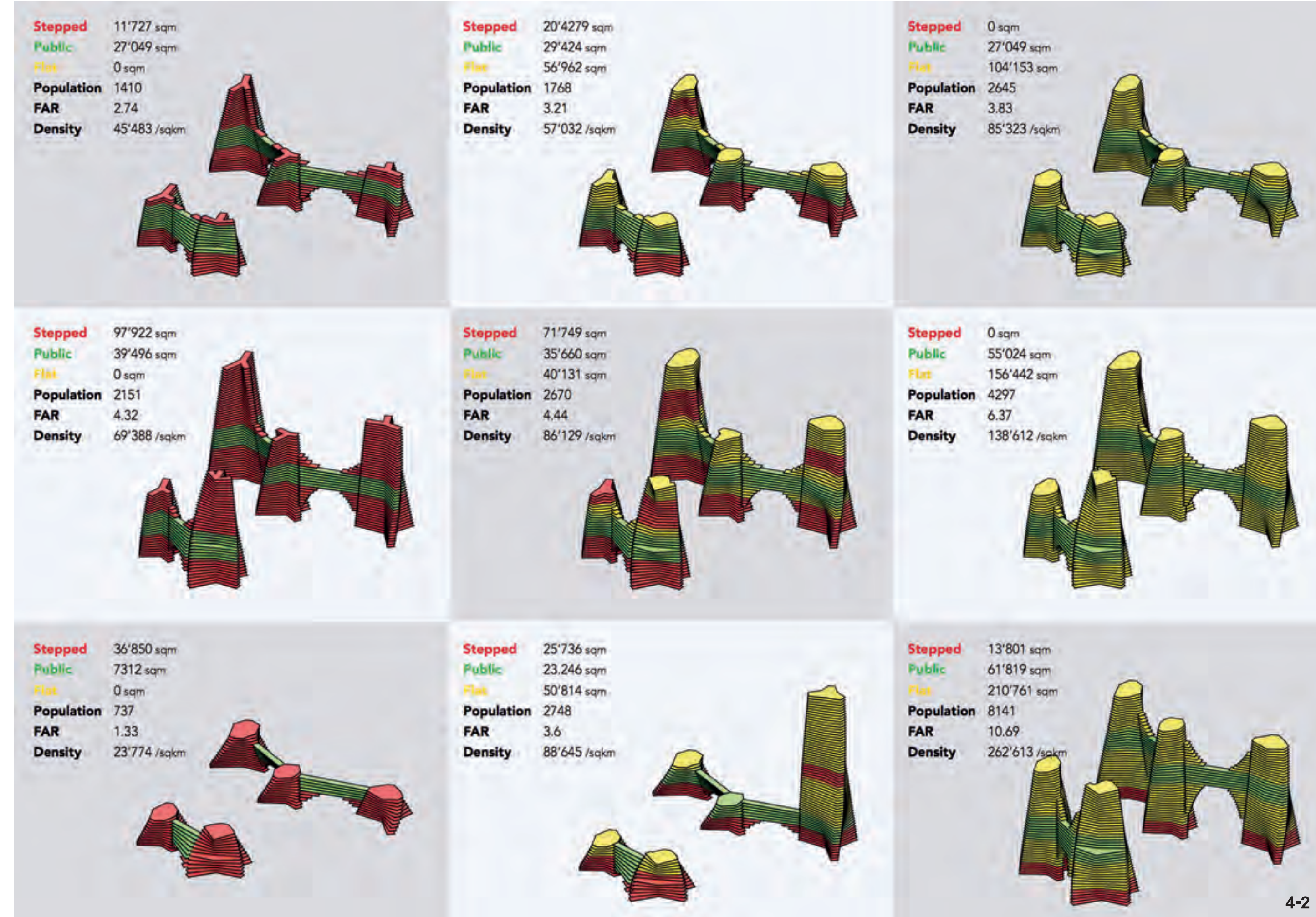
本次课程中的大部分项目都具有一个较强的景观驱动逻辑，关注于创造一个清晰的"形态衍生情节"，但是这些项目经常在结合建筑类型方面显得薄弱。在某些情况下，当遇到来自建筑原型的阻力时，会出现一个由景观逻辑向最终建筑形态生成的非理性、无说服力的逻辑跳跃。因此，在我们继续"形态衍生"研究的过程中，对参数化原型的来源仍有疑问：哪种原型可以作为发展城市肌理的基础？比如场地现有的城中村肌理这种源于当地的原型？或者是一种从诸如更大区域尺度甚至世界其他地方借鉴而来的原型？或者是否有可能在场地之上创造一种根据新的参数而产生的原型？

（2）参数化分析瘫痪

参数化模型能够为我们提供诸如容积率、密度、建筑能效等准确并可更新的数据，使我们能够实时评估每一提案的经济可行性。例如，一个项目的"形态衍生"过程可能需要依赖于改变经济效益来推广涉及新构造方式及生态推动力的创新方法。参数化工具会定量地展现某一提案中多个预景各自的利弊，这虽然能够从现实性出发为某一场景提供支持的论据，但同时限制了探讨其他更多空间形态和解决方案的可能性——因为初始参数总被认为是不可挑战的给定量。因此我们在研究过程中将提出的另一个问题是：我们如何能够使限制性变量更加流畅和更具可操作性，从而使一种连续的参数分析不会瘫痪而是能够形成一条有效的反馈回路。

（3）设计表达与参数类型学代码

"形态衍生"策略已将设计过程及其表达方式转变。除了传统的平面图、剖面图和模型之外，我们使用动画数字技术来解释所提出方案的系统灵活性，以及展现评价这些系统所依据的标准。在某些情况下，"形态衍生"研究还能产生新的代码以及数字化工具，这些可以共享给其他设计师并经过再次改造予以应用。因此，我们开始思考，这些新生成的代码是否可以成为类似于传统平面及剖面图的设计"产品"，甚至有一天能够取代它们？**LAF**



4-2

Stepped 梯台空间 Public 公共空间 Flat 平台空间 Population 人口 FAR 容积率 Density 密度

Organicities

The advent of new digital technologies has had a twofold impact on architectural thinking and urban design, transforming, on one hand, the processes for form generation and design production through algorithmic and parametric technologies, and, on the other hand, enabling an escape from the static fate of the built environment by facilitating dynamic interaction between inhabitants and their surrounding.

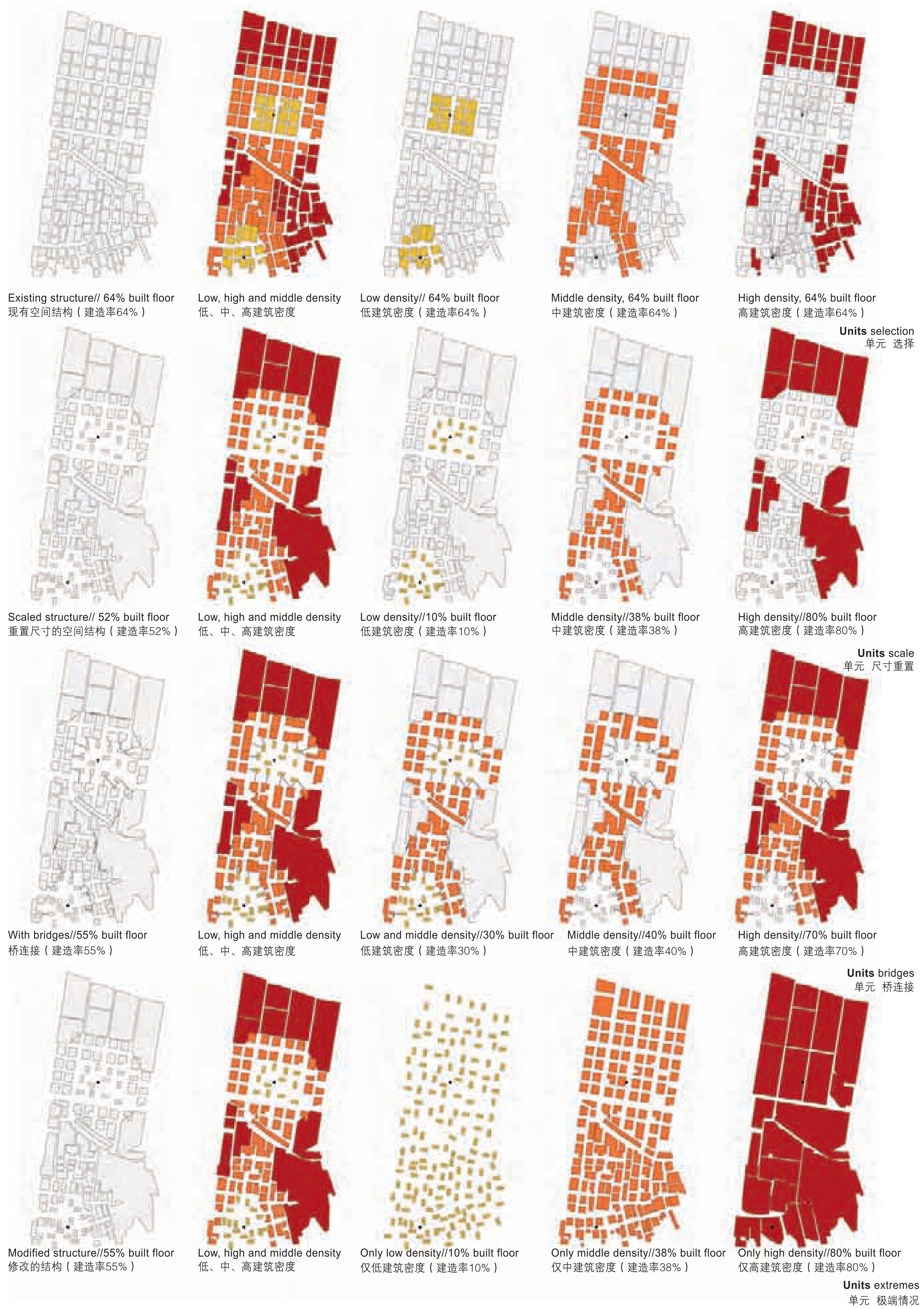
The Media × Design Lab, established in 2007 at the intersection of the school of architecture and the school of computer science at the EPFL in Lausanne, Switzerland in 2007, examines these effects of digitalization on architectural, urban and landscape design. One of the major research thrusts is in "computational urbanism".

Over our first five years, from 2007 ~ 2012, we conducted, within this research area, a series of design research studios entitled "Organicities" which explored the use of computer code and algorithms borrowed from biology (such as plant growth algorithms) to drive novel form-finding processes in architecture and urbanism. This work was sponsored by a research grant from the Swiss National Science Foundation.

In order to facilitate the experimentation and build a shared body of knowledge, we created an open-sourced object-oriented geometry library, called "anar.ch."[1]. This library "anar.ch" gave the research studios basic geometrical codes that designers could use, adapt, and combine to design architectural shapes parametrically, and let external parameters, such as environmental,

4. "涌现"的类型。景观参数在"形态衍生"过程中引导可能的建筑空间新类型的产生。参数化模型将根据形状、功能、人口、容积率、密度等因素来评价某一设计方案（瑞士联邦理工学院"形态衍生"设计课程。指导教师：杰弗里·黄教授；课程助理：特雷弗·帕特、彼得·奥特纳；参与学生：艾利克斯·萨迪赫）。

4. Emergent typologies. The landscape parameters drive the development of potential typologies in a morphogenetic process. The parametric model evaluates design solutions according to shape, program, population, FAR and density (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Student: Alex Sadeghi).



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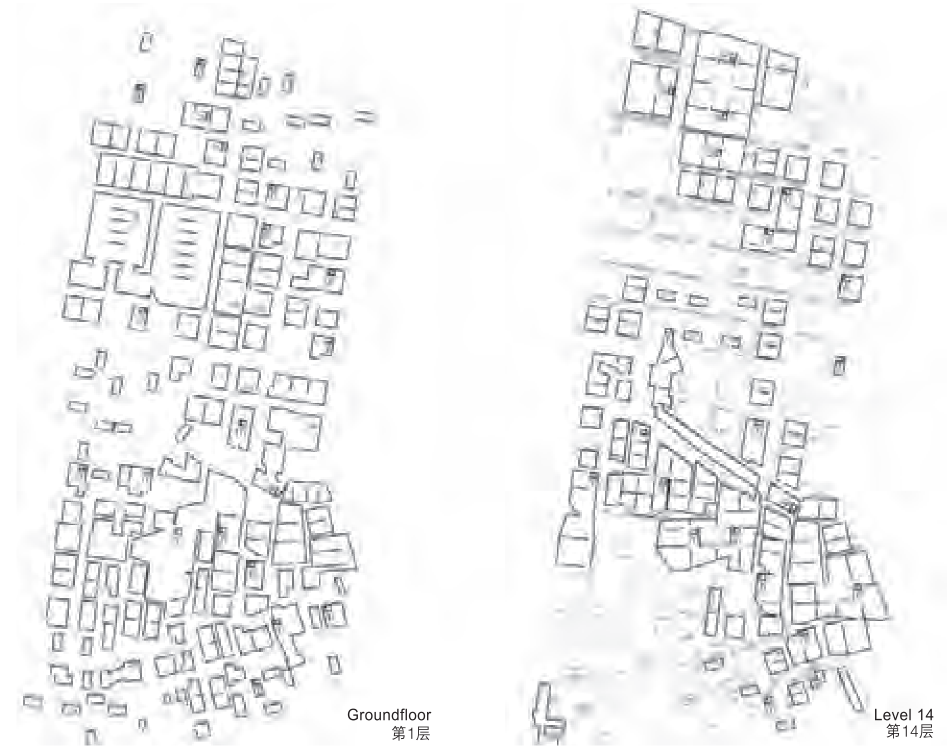

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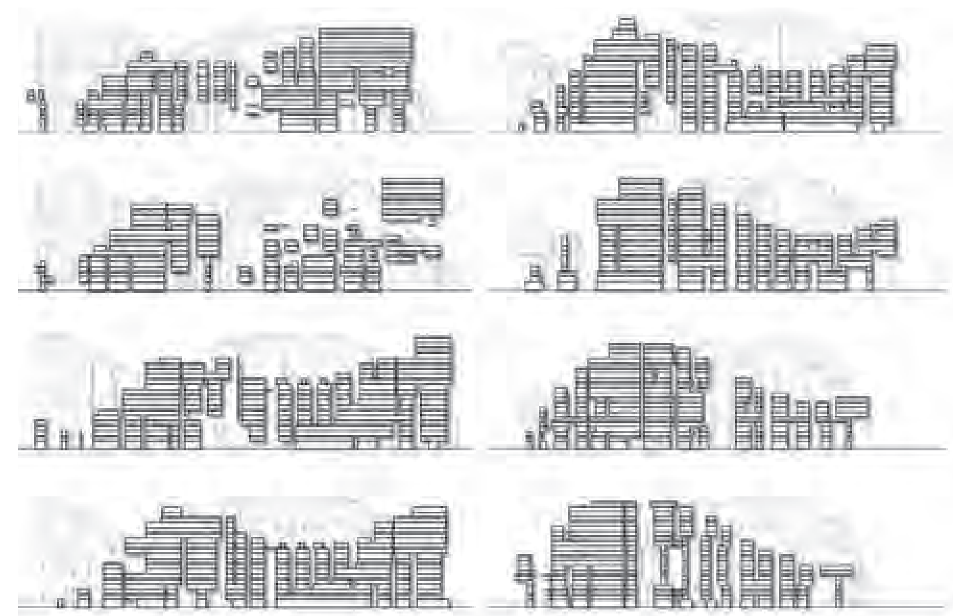


6-2

5. 图解与参数化。参数化定义首先指出了场地现有城中村的城市小广场，并在此基础上围绕广场置入了低、中、高三种密度的建筑类型。这些类型之间的平衡关系是变化的，并会根据居民的需求进行调整（瑞士联邦理工学院“形态衍生”设计课程。指导教师：杰弗里・黄教授；课程助理：特雷弗・帕特、彼得・奥特纳；参与学生：克里斯蒂娜・哈斯、珍娜・思嘉丽）。
6. “迭代”的偏离过程。参数生成实例的变化在平面及剖面上的反映（瑞士联邦理工学院“形态衍生”设计课程。指导教师：杰弗里・黄教授；课程助理：特雷弗・帕特、彼得・奥特纳；参与学生：克里斯蒂娜・哈斯、珍娜・思嘉丽）。

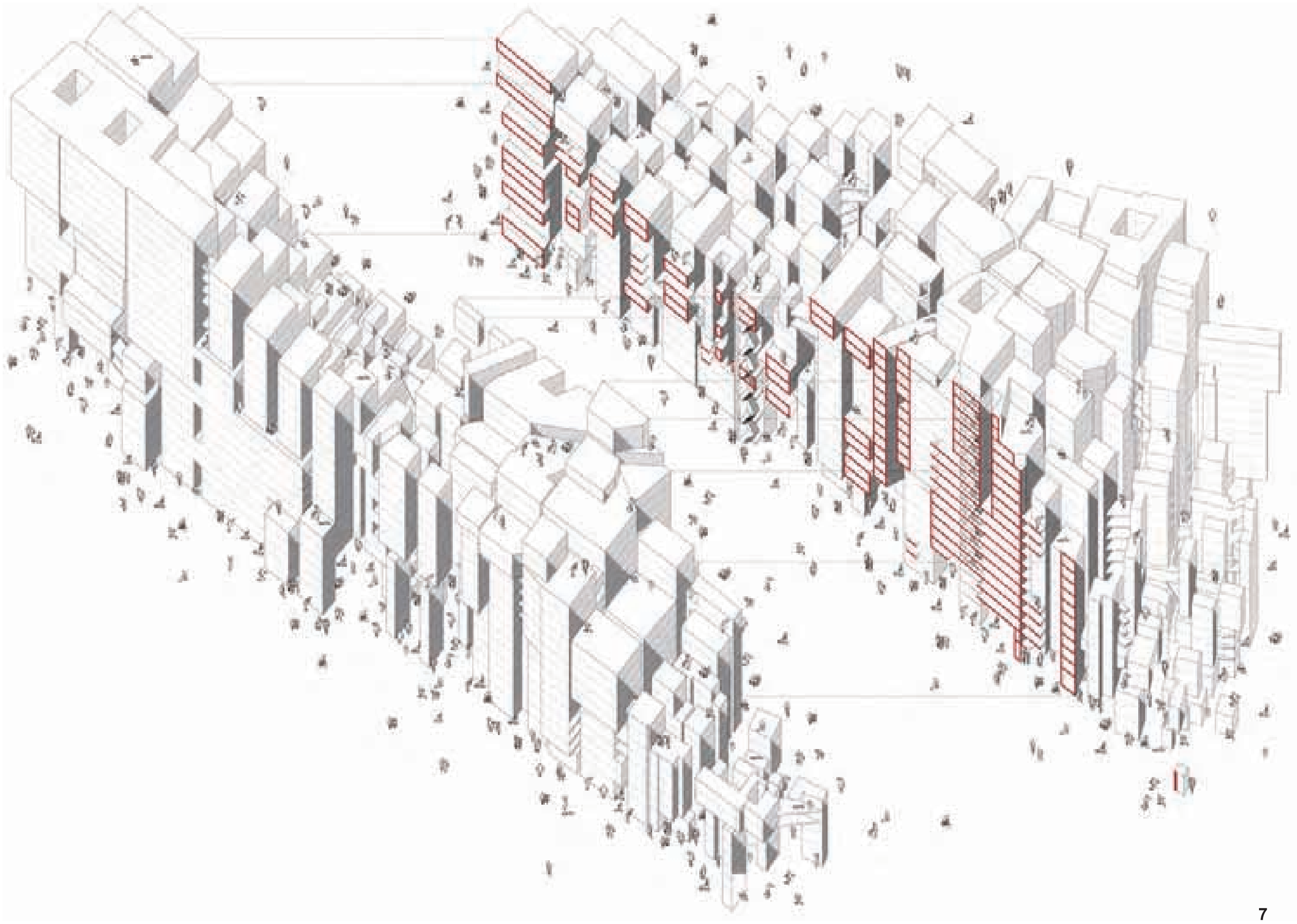
5. Diagramming and Parametrization. The parametric definition is first defining some urban plazas in the fabric of the existing urban village, and is building in a second step a mixture of low, middle and high density typologies around them. The balance between these typologies is variable and adapts according to the needs of the inhabitants (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Christina Haas, Jana Scharli).
6. Iterative Defamiliarization. Instances of the parametric variation in plan and section (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Christina Haas, Jana Scharli).

climatic, structural or programmatic constraints, act upon and deform the final volumetric forms.

The “Organicities” design studios produced novel architectural and urban forms, such as skyscrapers, middle rise buildings and urban housing fabric, which resemble and pay tribute to the philosophy, spirit and formal vocabulary of the Metabolism movement in Japan of the 1960s[2], and the early experiments with evolutionary architecture by John Frazer[3]. Figure 1 shows four sample organic shapes of skyscrapers that were generated with algorithms and codes from “anar.ch”, taken from an exhibition at the architecture biennale in Florence[4].

While the products and results at different scales of the Organicities studios were formally intriguing and interesting as final organic forms and sculptures in their own right, the experiments also exposed the challenges and limitations of using an approach driven by bio-inspired code for creating effective urbanism. In particular, two limitations became evident. The first is related to the passiveness of landscape and context. How can we better integrate external landscape and ecological parameters into the design process, so that they become proactive driver of the design rather than reactive constraints for correcting an already formulated design? The second relates to the neglect of traditional architectural typologies. Instead of artificially and forcefully adapting organic shapes derived from biology and other scientific (non-architectural) fields how can we activate the architectural knowledge embedded in existing architectural typologies within the design process, to create livable, desirable, meaningful space?

To address these two questions, we initiated in 2012 a new series of design research studios called “Morphogenesis” which we will present here as the heart of this



7

article. In the remainder of this article, we will first outline the ideas behind morphogenesis, and then present a concrete case study — the Guangzhou Tower Delta — to illustrate and discuss the approach.

Morphogenesis

The Morphogenesis studios were motivated by a desire to explore meaningful form generating processes that integrate landscape and ecological concerns on one hand, and typological concerns, on the other hand, through the use of algorithmic and parametric tools, introducing the notion of growth in architectural and urban design thinking.

Why morphogenesis? In nature, shape is undeniably linked with growth as already observed by d'Arcy Thompson in 1917[5]. As natural systems grow they enact increasing levels of complexity. The advent of computers with their simulation potential has revived an interest in morphogenesis through digital models of growth processes which are similarly able to coordinate complex systems. We use morphogenetic processes because of their intrinsic ability to encompass planning for a whole city as well as for the individual building, for example, their ability to scale, with the diversity of local constraints being directly translated into the designs, and presenting adaptability to change in context. Morphogenetic processes take into account future extensions in the design, the actual realization representing only a transitory state promised to further developments. Thus, the resulting form loses arbitrariness to become a spatial representation of the set of constraints enforced on the form.

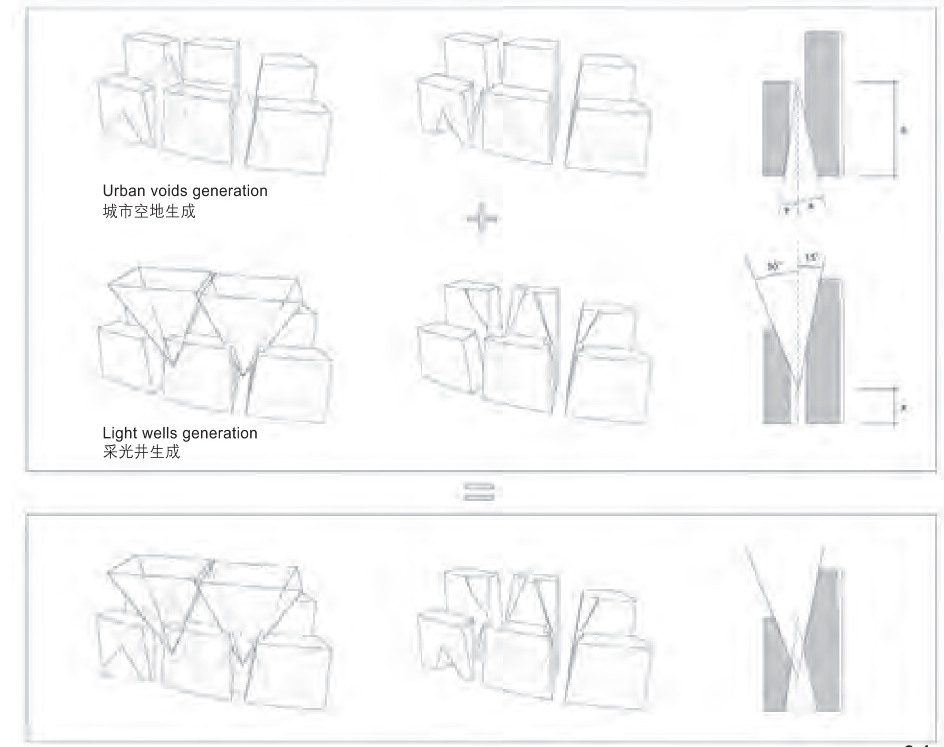
Our case studies for testing morphogenesis design are emerging Asian cities. We focus in particular on the problematic linked to the rapid urbanization in China, and the expanding role of our design professions that accompany developments of increased scale and scope with accelerated speed. Rather than passively following the criteria of a top-down planning, we are interested to develop bottom-up typologies which structure and inform the urban organization around them through the specific agency of parametric design. In a morphogenetic approach, these typologies are not static, identical copies, but adapt to their local situation: the conditions of their site, the landscape and their collective milieu. This approach complements the growing dissatisfaction with the imposition of unconsidered "cookie-cutter" Western planning in Asia.

Technically, we conducted the work using the parametric modeling software Grasshopper, a plug-in for Rhinoceros, which enables associative modeling through visual, or diagrammatic, programming. Grasshopper was chosen not only for the formal possibilities it enables but also for its ability to support the conceptual framework of the studio. The logical management of variation allowed us to avoid repetitive solutions and to maintain an equally high level of conceptual rigor across the entire project, to engage with that complexity rather than reducing it. An additional aspect was the ability to quickly and accurately produce quantitative information during the design process which could be used to strengthen the argument or inform the decision-making process as a feedback system.

Guangzhou Tower Delta Studio

To illustrate the morphogenesis approach, we describe our most recent studio, the Guangzhou studio, conducted in Spring 2013. The studio benefited from collaboration, data inputs from and a joint site visit with a parallel design studio offered at the Harvard Graduate School of Design and Peking University led by Professor Kongjian Yu.

Located in the Haizhu District, Guangzhou, China, the studio focused on the tectonic and typological implications of siting large urban towers in the ecologically sensitive flood-plain of the Pearl River Delta. The Haizhu District is an island in the Pearl River Delta known throughout China for



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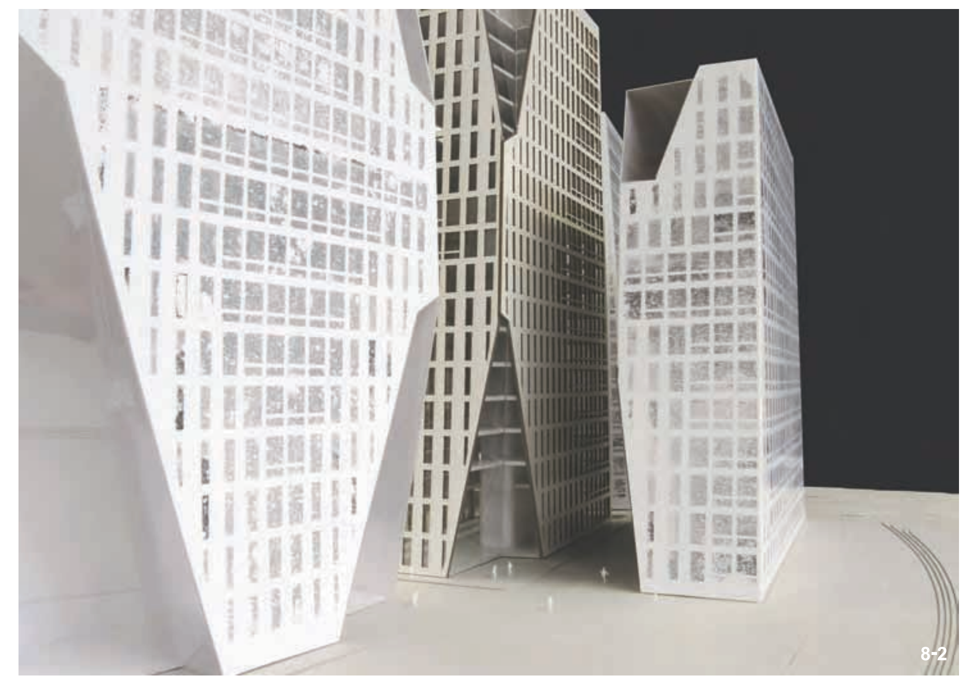

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7. 现有城中村的密度强化：一个参数生成实例的轴测图（瑞士联邦理工学院"形态衍生"设计课程。指导教师：杰弗里·黄教授；课程助理：特雷弗·帕特、彼得·奥特纳；参与学生：克里斯蒂娜·哈斯、珍娜·思嘉丽）。
8. 实例化和定型。为创造采光井及城市空地而进行的形态修剪。这种对建筑之间空间的塑造将形成一个建筑与街道之间的过渡区（瑞士联邦理工学院"形态衍生"设计课程。指导教师：杰弗里·黄教授；课程助理：特雷弗·帕特、彼得·奥特纳；参与学生：查尔斯·萨拉辛、肯·俊·崔博尼）。

7. Intensification of the existing urban village: Axonometric drawing of a parametric instance (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Christina Haas, Jana Scharli).
8. Instantiation and sculpting. Trimming process to bring light into the city and create urban voids. Sculpting of interstitial spaces that act as a transition zone between the buildings and the street (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Charles Sarasin, Ken Jun Triponez).

its fertile orchards and crop lands, and the diverse biotope of its flood-plain (Fig. 2). Guangzhou, China's third largest city has put tremendous pressure on the Haizhu district to develop, jeopardizing its unique ecology and agricultural history. The primary task of the studio was to morphogenetically develop mixed-use tower typologies that respond to the constraints of this delicate context.

The studio was structured in a deliberate sequence which followed the logic of morphogenesis, and consisted of six stages, which were additive, contributing to a single project throughout. The stages were:

(1) Indexing and Mapping

We began with a computational analysis of the ecological and contextual parameters of the existing landscape, such as topography, sun, wind, water, humidity, available infrastructure, climatic conditions, existing building fabric. This data is indexed and transformed into maps in the form of generative diagrams (Fig. 3).

(2) Emergent Typologies

Data drives the design hypothesis. The landscape parameters drive the development of potential typologies in a morphogenetic process. Typology as we are defining it does not suggest a fixed block but a flexible topology of connectivity which can reconfigure and react to different conditions. An initial design hypothesis is formulated that captures the author(s)' intentions (Fig. 4).

(3) Diagramming and Parametrization

Diagrams describe the relationships in a formal manner, both to further the design and to make it comprehensible to others. Parameterization require to take the typology definition and formalize its behavior as a parametric model (Fig. 5).

(4) Iterative Defamiliarization

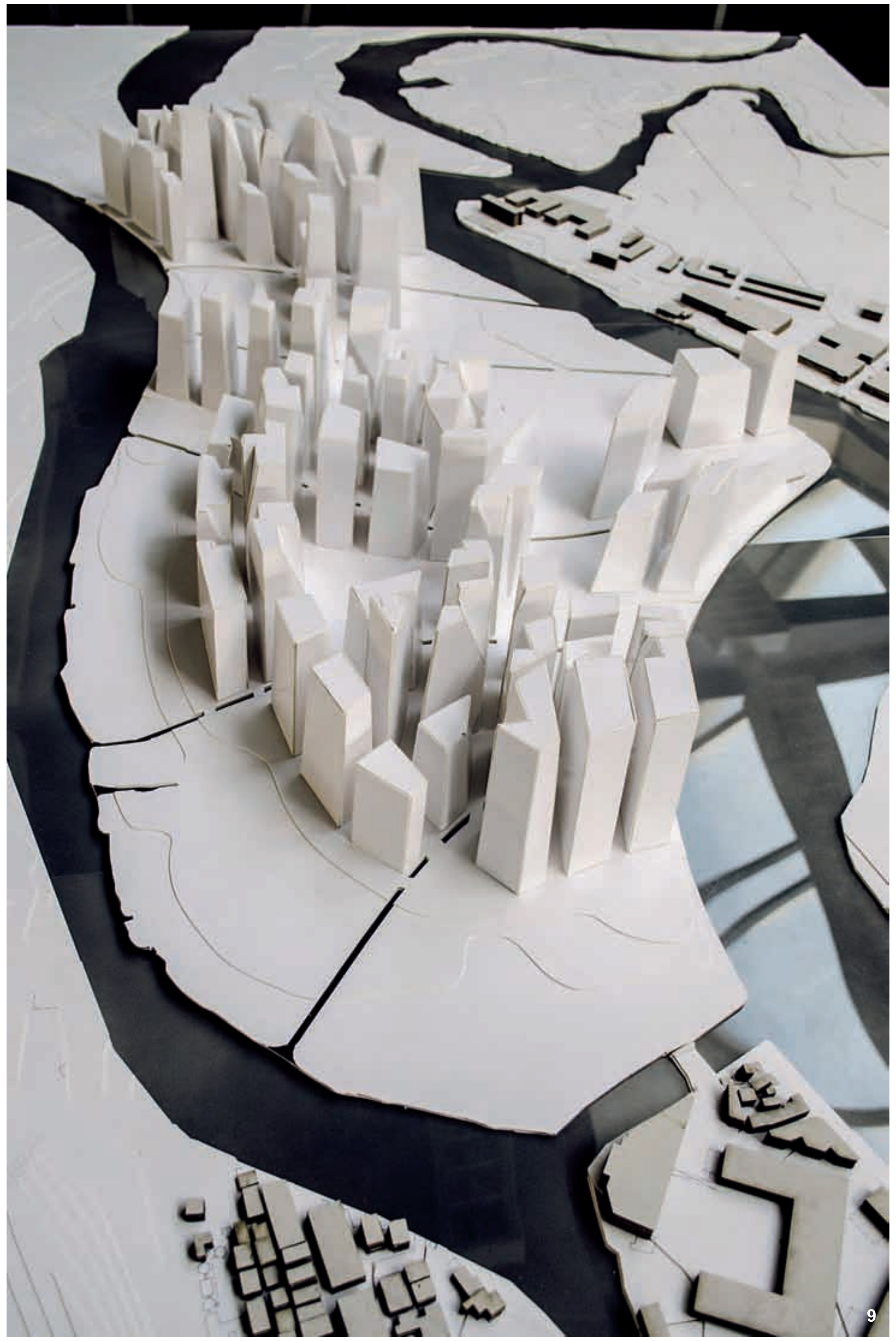
In this stage, we explore variations of the parametric typology by examining different instances and varying initial conditions. For example, volumetric and aesthetic relationships are investigated. Performances of the instances are continuously evaluated and measured against intentional criteria in an iterative feedback loop (Fig. 6, 7).

(5) Instantiation and Sculpting

The objective of this stage is to create particular instances of the parametric model and develop sufficient details and specifications for the scope and scale of the architectural proposal. Local sculpting and trimming operations are introduced to deform the architectural and urban form in order to respond to micro-contextual parameters (Fig. 8).

(6) Representation

Finally, Representation will return to the task of explaining the logic of a chosen system to others as well as analyzing the results critically. This stage produces all the documents necessary to explain the project, including drawings, diagrams, animations, computer code, physical models (Fig. 9).



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Parametric Typologies

The projects from this Guangzhou studio represent still very early examples of the morphogenetic experiments, and we are only beginning to understand what the challenges and implications of such an approach really are. Yet they are already indicative of the direction we are going and the issues that will be concerned.

The drivers for the morphogenesis approach are the environmental, ecological data and parameters which not only represent an objective basis for initiating a bottom-up, landscape driven form-finding process, but also making explicit the usually more intuitive form-finding stages of a design project, providing each project with objective rationalization, or what we call a data-driven "morphogenesis story". The notion of subjective authorship is thus critically called into question[6].

Yet this landscape-based, data-driven design process, which is inspired by a "negative" planning approach[7], needs to be confronted with positive typology when applied in an architectural or urban design context. Alternative typological scenarios and their subsequent parametric variations act as a kind of necessary "inertia" to provide resistance and challenge the linear, data-driven morphogenetic process, turning it into an iterative loop.

Reflecting on the outcome of the Guangzhou studio, we realize there is still enormous work to be done to link the landscape drivers with the demands put upon by the typological imperatives. Future work will thus address in particular the following three concerns:

(1) Origins of the Parametric Typologies

Most of the projects focused on a clean morphogenesis story, with a strong landscape driven logic, but often with weaknesses in the articulation of the typology. In some cases, an unconvincing, irrational jump could be observed from the landscape logic to the final building form when confronted with the inertia put forth by typology. Thus, a few questions remain concerning the origin of the typologies, as we continue with the morphogenesis experiments: What typologies should be used as a basis for growing the urban fabric? Is the local typology, for example, from the urban villages found on site, generative enough to be copied and intensified? Or should a "working" typology be imported from the larger region or other parts of the world? Or, is there an opportunity to invent completely new typologies based on new parameters?

(2) Parametric Analysis Paralysis

The parametric models furnished us with accurate and updatable data like floor-to-area ratio (FAR), density, and building efficiency, allowing us to evaluate the economic viability of each proposal in real time (Fig. 8). For example, the morphogenesis of a project may depend on leveraging economic benefits to promote innovative approaches to tectonics and responses to the ecological drivers. The parametric tools thereby revealed quantitatively the pros and cons of a flexible variety of scenarios, which certainly provide a certain realism to the protect proposals, but also limited the exploration space and possible solutions, as the initial, starting parameters were often considered as given and not challenged. The question thus will be: how to keep the constraints more fluid and manipulable, so that the continuous parametric analysis does not paralyze but rather foster a productive feedback loop.

(3) Representation and Code of Parametric Typologies

Design production and representation were transformed by the morphogenetic approach. In addition to the traditional plan, section and model, we used digital techniques of animation to explain not only the flexibility of proposed design systems, but also the criteria by which these systems may be evaluated. In certain cases a morphogenetic study resulted in the creation of a new code or digital tool, which could then be shared with and modified by future designers. Accordingly, we wonder if this newly created code could become as relevant a product as the traditional plan and section, and even replace them, as we move forward? **LAF**

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9. Representation: Physical Model of one of the final proposals (From Morphogenesis studio at EPFL. Instructor: Professor Jeffrey Huang; Assistants: Trevor Patt, Peter Ortner; Students: Charles Sarasin, Ken Jun Triponez).