

# 人工智能时代的设计

## DESIGN IN THE AGE OF ARTIFICIAL INTELLIGENCE

https://doi.org/10.15302/J-LAF-20180202 收稿时间 RECEIVED DATE / 2018-04-03 中图分类号 / TP18, TU98 文献标识码 / A

尼尔·林奇

建筑师、建筑理论家；欧洲高等学院数字化设计教授；同济大学高峰学科教授；佛罗里达国际大学客座教授；欧洲学院院士

Neil LEACH

Architect and Theorist; Professor of Digital Design at the European Graduate School; Gao Feng Professor at Tongji University; Visiting Professor at Florida International University; Member of European Academy  
20 Sunset Avenue, Apartment B, Venice, CA 90291, USA  
leachneil@gmail.com

### 摘要

人工智能在我们的生活中扮演着越来越重要的角色，但它会对设计专业带来何种影响？它会形成一种新的设计风格吗？或者，人工智能仅能辅助设计，还是会颠覆设计？通过定义不同形式的人工智能并展示三位设计师及团队的相关设计成果，本文试图对人工智能的潜力发起讨论。作者认为，人工智能不会创造新的设计风格；但其对设计过程影响深远。这或许将迫使我们反思许多广为设计界所接受的真理信条。某些传统术语（例如，“设计”这一概念以及对于“设计”这一行为的认识）可能会被“搜索”和“结果”等一批新术语所取代。更重要的是，对于“艺术天赋”的迷思可能也会被打破。本文并非意在指出人工智能强烈的“人工性”，而是旨在点明我们对人类智能的理解已深陷误区。

### 关键词

人工智能；人类智能；功能可见性；搜索；结果；艺术天赋

### ABSTRACT

Artificial Intelligence is playing an ever-increasing role in our lives, but what impacts might it have on the design professions? Will it introduce a new style? Or will it just help to improve the design process? Or will it have a completely different impact? This article attempts to offer an overview of the potential of Artificial Intelligence, defining the different forms of Artificial Intelligence, and illustrating its argument with the work of three designers. It argues that Artificial Intelligence will not generate a new style. However, it will have a radical input on the process of designing. It is also likely to force us to call into question many accepted beliefs within the design community. Certain traditional terms, such as the concept of a “design” and the very notion of “designing,” are likely to be replaced by a new lexicon that includes terms such as “searching” and “outcomes.” But, more importantly, the whole myth of the “artistic genius” is likely to be also called into question. What Artificial Intelligence tells us, as the paper concludes, is not how “artificial” Artificial Intelligence is, but rather how misguided our own understanding of human intelligence has been.

### KEY WORDS

Artificial Intelligence; Human Intelligence; Affordances; Searching; Outcomes; Artistic Genius

## 1 引言

尽管我们可能并未意识到，但人工智能（AI）已经成为我们日常生活的一部分。例如，AI帮助我们过滤互联网账户中的垃圾邮件、识别我们在“脸书”上的朋友、将我们发布在“照片墙”软件中的图像归类整理，大多数导航、流媒体和共享出行类应用程序也都以此为基础。然而，尽管如此，人们对AI的态度却大相径庭。对一些人来说，AI是“未来”的必要组成部分——一种必定会让生活更加便利的、不可或缺的辅助工具；而在另一些人的眼里——从已故的史蒂芬·霍金到埃隆·马斯克——AI则将对人类生存构成威胁。<sup>[1][2]</sup>这种论调并不是空穴来风。毕竟，既然AI已经具备超越人类智慧的能力——首先是国

整理、译 田乐

EDITED AND TRANSLATED BY Tina TIAN

① 举例来说，在“群体智能”的语境下，粘液霉菌所显现出的智力水平比粘液菌群的智力低得多。参见参考文献[3]。

① For example, in the case of “swarm intelligence,” the intelligence displayed by a slime mould is a considerably lower level form of intelligence compared to that of beings. See Ref. [3].

际象棋，现在又是围棋——那么放眼未来，AI毫无疑问拥有巨大的潜力，无论这对于人类来说是福是祸。不过，在本文中，笔者想打破一些关于AI的迷思，并试图探究其在设计领域的真正潜力。我们需要滤去围绕AI这一术语的“夸张成分”，以真正理解AI的实质。本文并不旨在对AI相关术语进行精确定义，而是意在简明地讨论这些术语之间的差异——虽然这种简明化的讨论在一定程度上也必然是粗浅的。

首先，AI并非人类智能，而是机械“智能”。对于此，我们必须明确的一点是，尽管在“人类智能”和“机械智能”这两个术语中都含有“智能”，但我们不能将两者等同起来。首先，AI只是一种对人类智能的**模仿或模拟**。此外，“智能”具有众多表现形式，但其含义及其所表示的智力水准却因使用场景的不同而千差万别。<sup>①[3]</sup>

其次，我们需要区分“强AI”（也称为“超级智能”和“广义AI”）和“弱AI”。强AI技术已经远远超出了人类的技术能力范围，但其目前仅出现在娱乐产业中。《终结者》系列电影中虚构的天网系统就是最好的例子。事实上，我们目前仍局限于一种相对保守的、所谓弱AI的阶段。正如其名，我们对于AI潜力的理解还是狭隘的、受限的，尽管普通大众往往会对AI盲目迷恋、崇拜，甚至不乏夸大和神化。不过，据《奇点迫近》一书的作者雷·库兹韦尔预测，到2029年，强AI的智能水平将比肩人类智能水平。<sup>[4]</sup>

再次，在弱AI中，我们或许应该对AI本身更为宽泛的范畴、“机器学习”和“深度学习”加以区分。我们可以将这三者看作类似于俄罗斯套娃或洋葱层的彼此嵌套的关系，因为深度学习是机器学习的一

## 1 Introduction

Artificial Intelligence (AI) is already very much part of our everyday lives, even though we might not realize it. For example, spam messages are filtered by AI in our internet accounts, friends on Facebook are identified by it, and our Instagram images are sorted by it, while most navigation, streaming, and ride-sharing apps are based on it. Yet there are many different attitudes to AI. For some it is a necessary part of “the future” — an indispensable aid that is sure to make life easier, while for others — from the late Stephen Hawking to Elon Musk — it poses an existential threat to human being.<sup>[1][2]</sup> This is understandable perhaps. After all, if AI already has the capacity to surpass the intelligence of human beings at games of first Chess and now Go, does it not promise huge potential for the future, both positive and negative? In this article, however, we wish to debunk some of the more outlandish myths surrounding AI, and try to ascertain its true potential in the field of design. We need to get beyond the “hype” that surrounds the term, and understand AI for what it actually is. Here we have insufficient space to define any of these terms to any great level of precision. Let us restrict ourselves, then, to a few brief — and necessarily superficial — distinctions.

Firstly, AI should be distinguished from the intelligence of human beings, and described as the “intelligence” of machines. Here we must sound our first note of warning: Although the same term “intelligence” is used for both human beings and machines, we must be careful not to equate the two. To begin with, AI merely *mimics* or *simulates* human intelligence. Moreover, there are many manifestations of “intelligence,” but the meaning of the term, as well as the level of intelligence, changes according to its respective context.<sup>①[3]</sup>

Secondly, we need to distinguish between “Artificial General Intelligence” — also known as “Superintelligence” and “General AI” — and “Narrow AI.” At present Artificial General Intelligence is well beyond the range of our technical capabilities, and only appears in the world of the entertainment industry. An example would be Skynet in the *Terminator* franchise, a pure fiction though. In fact we are still limited to a relatively modest realm of what is known as Narrow AI, which, as its name implies, is narrow and circumscribed in its potential, even though the general public tends to fetishize it and make it out to be more than it is. Nonetheless, it has been predicted by Ray Kurzweil, author of *The Singularity is Near*, that by 2029 we will have achieved a level of Artificial General Intelligence that will match the intelligence of human beings.<sup>[4]</sup>

Thirdly, within Narrow AI, we should perhaps distinguish between the broader category of AI itself, “Machine Learning,”

种，而机器学习又包含于AI。早期的弱AI主要基于在机器中设置人工编写的数据处理程序，是一种机械处理方法。需要格外强调的是，弱AI只能遵照为其编制的程序行事，而无法自主学习。与之相比，机器学习则更进一步，可以通过分析、处理大型数据集的方式进行自主学习。但是，机器学习仍然需要依赖人工编写的代码，以对其应做之事进行分类管理。深度学习则是近几年的研发成果，即机器可以绕过分类管理步骤，从而不需要任何形式的程序指令；其会依靠模仿人类大脑形式塑造的“神经网络”，针对某个特定的主题展开自主学习，并不断吸取和产生新的海量数据。例如，谷歌的“阿尔法狗”通过高效的自学习成为了围棋高手，能够击败人类最优秀的围棋选手，尽管它从未接收过任何关于如何落子的指令。同样地，“谷歌翻译”也通过其神经机器翻译系统进行深度学习，大大提高了在线翻译的准确度。

## 2 AI与设计风格

那么，AI可能对建筑设计、景观设计和城市设计领域产生何种影响？考虑到人们对于AI相关术语尚有诸多困惑，这种困惑很可能也会延伸到设计领域。例如，有人会认为AI将会激发一种全新的设计风格，正如帕特里克·舒马赫所言——尽管这在某种程度上是有争议的——在将数字化工具引入设计领域的过程中形成的“参数主义”，已在全球带动了一种新的建筑风格。<sup>[5][6]</sup>

针对这一问题，我们首先可以明确的是，AI本身不太可能在设计中引入新的风格，其中部分原因在于，就其本身而言，数字化工具不太可能在设计领域掀起全球性参数主义新风潮，因为没有什么工具会迫使设计师依从某种特定风格进行设计创作。毕竟，工具不能“控制”我们的行为，它们缺乏相关“机制”。为了理解工具带来的影响，我们必须审视它们的“功能可见性”——即利用这些工具，我们可以或难以完成哪些操作。<sup>②[7]-[9]</sup>比如，我们可以尝试用螺丝刀来钉钉子，但是若用锤子则会容易得多。因此，钉钉子的能力就是锤子的功能可见性。进而言之，相较于带有平行移动条的绘图板，一些计算工

and “Deep Learning.” These three can be seen to be nested within each other — somewhat like a series of Russian dolls, or layers in an onion — in that Deep Learning is part of Machine Learning that is itself part of AI. Early versions of Narrow AI dealt with machines that had to be programmed to deal with a set of data in a somewhat mechanistic way. The important point here is that the machine could only do what it is *programmed* to do, and could not learn for itself. By contrast, Machine Learning goes one step further, and uses large data sets in order to train itself. However, the Machine Learning still requires a code to be written for it to *classify* what it is expected to do. Deep Learning, however, refers to a more recent development whereby the machine is not programmed in any way, and bypasses the classification step. Instead, it teaches itself about a particular subject based on a form of “neural network” that mimics the human brain, and draws upon an even vaster quantity of data. For example, Google’s AlphaGo, which “learnt” to play Go to a level that it could beat the best human experts, effectively taught itself. It did not receive any instruction about any particular move. Equally Google Translate uses Deep Learning through its Neural Machine Translation system that has improved vastly the quality of online translation.

## 2 AI and Style

This raises the question as to what impacts AI might have on design in the fields of architecture, landscape architecture, and urbanism. Given the general level of confusion that surrounds the term, it is quite possible that this confusion might extend to the field of design. For example, some might imagine that AI will be responsible for a new “style” of design, much in the way that Patrik Schumacher has claimed, somewhat controversially, that “parametricism” is a new global style for architecture that emerges as a result of the introduction of certain digital tools into the design arena.<sup>[5][6]</sup>

Let us start by stating clearly that AI itself is unlikely to introduce a new style into design. This is in part for the same reason that digital tools are unlikely to be responsible — in and of themselves — for introducing parametricism as a new global style. No tool forces a designer to design according to a particular style. After all, tools do not “control” our actions. They have no “agency.” To understand the impact of tools, we have to see them in terms of their “affordances” — what operations we can or cannot perform with them.<sup>②[7]-[9]</sup> We can attempt to bang in a nail with a screw driver, for example, but it would be easier to do so with a hammer. The capacity of being used to bang in nails could therefore be said to be an

② 这一理论是指某一工具或物体所涉及的一组特定动作。例如，一个门把手可能会承受拉力（或推力），而绳子只可能承受拉力。这并不是说该工具或物体具有“引导”或“阻止”某些行为的机制或能力；它们只是“可提供”某些特定操作，即用户基于对该工具或物体的预先认知，必须承认应当这样操作。同样，所提供的操作也取决于执行者的能力。因此某些操作可能无法由那些没有一定身高或力量的人来实施。此外，特定的工具会提供特定的操作，但并不排除采用其他操作的可能。例如，如果我们手头没有锤子，也可以用螺丝刀来钉钉子，尽管效率较低。同样，用锯子切割木头比用锤子砸断木头更容易。功能可见性相关理论请参见参考文献[7]-[9]。

② This theory suggests that there is a particular set of actions afforded by a tool or an object. Thus a knob might afford pulling — or possibly pushing — while a cord might afford pulling. It is not that the tool or object has agency as such, or the capacity to “invite” or “prevent” certain actions. Rather it merely “affords” certain operations that it is incumbent on the user to recognize, dependent on pre-existing associations with that tool or object. Likewise those operations are also dependent upon our capacity to undertake them. Thus certain operations might not be afforded to those without the height or strength to perform them. Moreover, certain tools afford certain operations, but do not preclude others. For example, we could affix a nail with a screwdriver — albeit less efficiently — if we do not have a hammer at hand. Likewise it is easier to cut wood with a saw than a hammer. The theory of affordances was introduced by Refs. [7]-[9].

③ 该书是近年来在计算机运算领域饱受诟病的出版物之一。该书除了充斥着对文艺复兴及巴洛克时期无端的历史援引之外，并没有实质性地讨论计算机“设计”的本质——这也情有可原，因为该书作者是历史学家，而不是设计师或计算机专家。

④ 就设计理论而言，这反映了解释学和形态发生学之间的区别，其中解释学涉及对现有材料的解释，而形态发生学涉及新材料的生成。

⑤ 比如，GenJam是一种交互式遗传算法，能够学习爵士乐的即兴演奏。这与人类创作音乐的方式并不完全相同，尽管可以说人类在作曲时也会基于他们对背景题材的理解。

③ This is one of the most problematic books about computation, which has been published in recent years. Aside from the fact that it is peppered with gratuitous historical references to the Renaissance and the Baroque periods, it fails to engage substantively with the nature of computational “design,” which is understandable perhaps, given that the author is an historian, rather than a designer or computational expert.

④ In terms of theories of design, this echoes the distinction between hermeneutics and morphogenesis, whereas hermeneutics relates to interpretations of existing material, and morphogenesis relates to the generation of new material.

⑤ For instance, GenJam, short for Genetic Jammer, is an interactive genetic algorithm that is able to learn to improvise jazz. This is not quite the same as the way in which human beings generate music, although it could be said that humans also draw upon their knowledge of a background genre when composing.

具可以帮助我们更加容易地描绘曲线，但这些工具不会强制我们绘制曲线。这些计算工具并不能创造新的曲线样式，这也刚好反驳了舒马赫之于参数主义的论调。当然，在AI的背景下，某些操作会变得更加容易，并且由于新工具的功能可见性，可能会开辟一种全新的表达形式。例如，AI已经被用于一些结构优化软件，而随着这些软件使用率的提高，我们可能会看到越来越多能够有效表达某种结构的线形（如抛物线）出现。但AI并不会对最终的设计成果本身产生任何重大影响，尽管它可能对产生这种设计或结果的**过程**影响颇深。

诚然，当我们谈论大数据对设计过程的影响时，可能更多的是在探讨如何使设计过程更具效率，而非产生新的风格——尽管《第二次数字化风潮：设计超越智能》<sup>③</sup>的作者马里奥·卡普可能并不认同。<sup>[10]</sup>毕竟，大数据迄今为止最有效的功用之一，便是在如优步这样的互联网出行公司的应用。但是，我们发现优步平台中的汽车与普通汽车并无二致；它们**本来就是**普通的汽车，只是运营方式不同。可见，大数据不会宣扬任何特定的审美，而只是为我们提供更为有效的操作方式。

AI之所以不太可能引发新的设计风格的另一个原因是，广义而言，AI的主要工作范畴是“认知”和“解释”。当我们考虑AI带来的影响时，这也许是最重要的因素。例如，AI能够扫描声像资料并将其与更庞大的数据集相关联，因此它能够在脸上识别人脸、在照片墙上分类图像，或者识别音乐。如上操作可被视为对人类认知的“模仿”或“模拟”，但这些仍主要属于形式**解释**的范畴，而非形式**生成**。<sup>④</sup>当然，AI**有能力**生成形式，但这仍主要是基于对现有模式的认知，以及在这些模式的基础上对新形式的外延。<sup>⑤</sup>

### 3 当AI遇见设计

接下来我们将谈论AI对设计的**直接**和**间接**影响。显而易见，AI已在设计领域发挥着重要的**间接**作用。毕竟，如今还有多少项目能够完全脱离互联网，以及包括手机在内的设备呢？而脸书、照片墙等应用

affordance of the hammer. By extension, certain computational tools allow us to describe curves more easily than, say, in the days of parallel motion drawing boards. But these tools do not force us to draw curves. In themselves, computational tools are not responsible for the curvilinear forms that we associate with Schumacher’s discourse of “Parametricism.” Of course, in the context of AI, certain specific operations become easier, and a form of hegemonic expression might begin to emerge as a result of the affordances of the new tool. For example, AI is used in some structural optimization softwares, and we might expect to see a greater incidence of structurally efficient forms, such as parabolas, as a result of increased use of these softwares. But AI — in and of itself — is unlikely to have any significant impact on the final design itself, although it is likely to have a significant impact on the *process* of generating that design or outcome.

Indeed, if we look at the question of Big Data, for example, the impact on the design process is likely to be more a question of making the process of design more efficient, rather than producing a new style, despite what Mario Carpo might claim in his *The Second Digital Turn: Design Beyond Intelligence*.<sup>③[10]</sup> One of the most effective uses of Big Data, after all, has been the introduction of transport network companies, such as Uber. But if we look at Uber cars themselves, we will see that they look identical to ordinary cars, which is precisely because they *are* the same as ordinary cars. They just operate differently. Thus, Big Data does not promote any particular aesthetic. It simply allows us to operate in a more effective manner performing certain operations.

There is, however, a second reason why AI is unlikely to introduce a new style of design. Broadly speaking, AI deals mainly with questions of “cognition” and “interpretation.” This is perhaps the most important issue to be addressed when considering the impact of AI. For example, AI is able to scan visual and acoustic material, and relate it to a much larger data set. Hence it is able to “recognize” faces on Facebook and to categorize images on Instagram or identify music. In this it could be said to “mimic” or “simulate” human cognition, as noted above. Yet these operations belong largely to the realm of the *interpretation* of forms rather than the *generation* of forms.<sup>④</sup> Of course, AI *can* generate forms, but this is based largely on recognition of existing patterns and extrapolation of new forms based on those patterns.<sup>⑤</sup>

### 3 AI Meets Design

We can talk about the impact of AI on design in terms of both *direct* and *indirect* influences. Clearly AI has already

程序都或多或少地运用了AI，因此，在某种意义上，我们如今所做的任何设计都难免受到AI的间接影响。

此外，设计人员也开始直接将AI技术运用在他们的设计之中。贝纳兹·法拉希就是一位在交互设计领域积极探索的建筑设计师，她设计的名为“爱抚般的凝视”的交互服装使用了一种基于AI的面部追踪设备，能够对观者的视线做出回应。这种嵌入服装中的设备能够检测到注视它的观者的年龄、性别，以及视线方向。这些信息在经过处理后，会触发服装中的响应装置，利用形状记忆合金（SMA）或镍钛合金的受控发生改变机制，在观者的视线落点泛起波纹。法拉希还在另一个名为“白色月光”的互动服装上采用了基于AI的面部表情检测装置，其能够识别观者的悲伤、快乐、惊喜及愤怒等情绪（图1，2）。<sup>⑥</sup>

但是，AI如何直接对设计的实际过程产生影响？

### 3.1 渡边诚的AI建筑设计探索

渡边诚是探索将弱AI直接应用于建筑设计领域的先锋人物之一。在过去的24年中，他探索了一系列旨在利用AI进行设计的方法，在其

played a substantial *indirect* role in design. After all, how many projects are there being produced these days that do not involve the use of the internet, Facebook, Instagram, or devices such as the cellphone, all of which use AI? In some senses, then, there is nothing that we design these days that is not affected or influenced *indirectly* by AI.

Moreover, designers are beginning to incorporate AI technology directly into their designs. One example is Behnaz Farahi, an interactive designer trained as an architect who has used an AI-based facial tracking device in *Caress of the Gaze*, an interactive outfit that responds to the gaze of the onlooker. The device is embedded in the outfit and is capable of detecting the age and gender of the person looking and the direction of his / her gaze. This information is then processed and used to trigger a response in the outfit causing it to ripple where the gaze of the onlooker is directed, employing a mechanism based on Shape Memory Alloys (SMAs) or Nitinol. Farahi has also employed an AI-based facial expression detecting device in another interactive outfit, *Opale*, which is able to recognize the mood of the onlooker, whether it is sadness, happiness, surprise or anger (Fig. 1, 2).<sup>⑥</sup>

But how is AI influencing the actual process of design in a *direct* manner?

### 3.1 AI Tect by Makoto Sei Watanabe

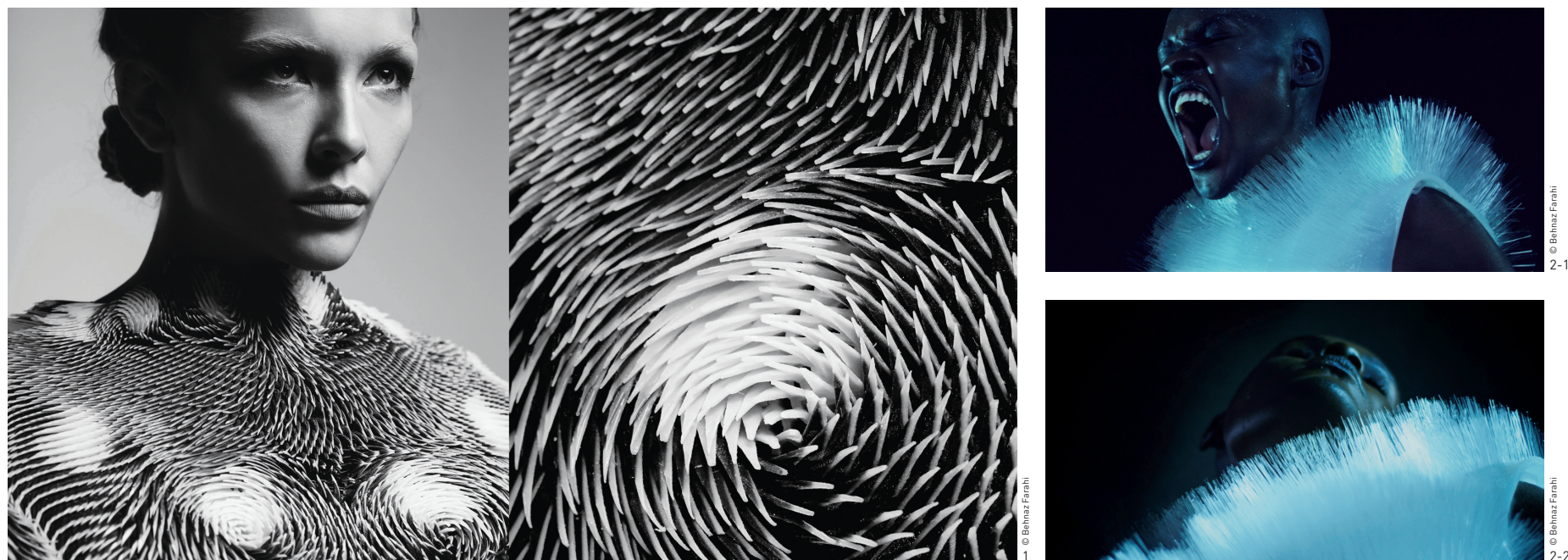
One of the first to explore the potential direct application of Narrow AI to the field of architectural design has been Makoto Sei Watanabe. Over the past 24 years, he has explored a range

⑥ 关于贝纳兹·法拉希的更多作品信息请访问 <http://behnazfarahi.com>。

⑥ More information about the works by Behnaz Farahi please visit <http://behnazfarahi.com>.

1. 爱抚般的凝视——一种使用了基于AI的视线追踪设备的交互服装（设计于2015年）。
2. 白色月光——一种使用了基于AI的面部表情检测装置的交互服装（设计于2016年）。
3. 渡边诚设计的新水侯站项目
4. 渡边诚运用“HandIn”技术设计的位于上海浦东的项目

1. Caress of the Gaze, interactive outfit with AI-based gaze detecting device, 2015.
2. Opale, interactive outfit with AI-based facial expression detecting device, 2016.
3. Shin-Minamata Mon Project by Makoto Sei Watanabe
4. HandIn Project for Pudong, Shanghai by Makoto Sei Watanabe



⑦ 使用“感应”一词是因为该程序产生了类似于物理电磁感应的效果。

⑦ The term “induction” was used because the program produced an effect that resembled the electromagnetic induction of physics.



© Makoto Sei Watanabe

发表的《AI建筑设计：AI能否进行设计？》一文中，渡边诚对AI在建筑设计中的成功运用进行了探讨。<sup>[11]</sup>

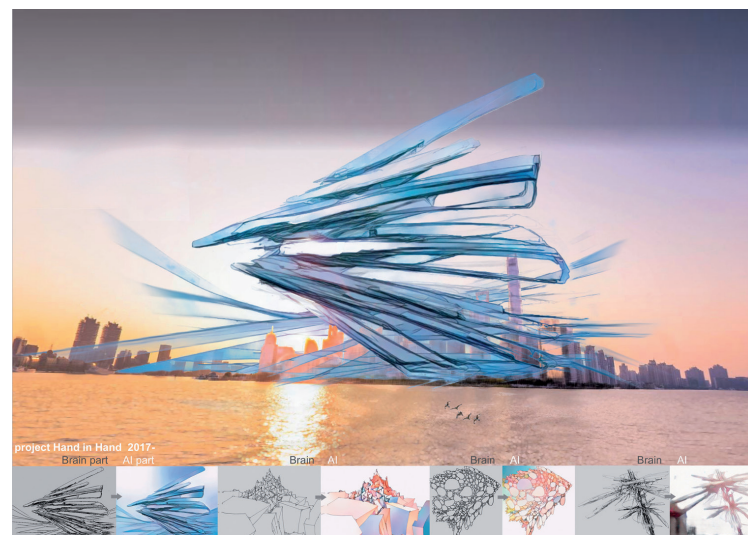
渡边于1994年开始涉足计算机生成设计，他将自己的方法称为“感应设计”。<sup>⑦</sup>已建成的为东京地铁系统设计的“网络框架”项目即采用了这一方法。渡边随后开始引入“算法设计”，这一方法于2001年前后在新水俣站项目的设计和建造中得以实践（图3）。这是一次以算法的形式将设计过程“外显化”的尝试。然而，渡边的感应设计和算法设计这两种方法的共同缺点是，它们很难为所生成的设计制定客观标准，因为从本质上说，这种判断是基于设计师的主观意识而产生的。因此，渡边认为两种方法都存在根本性的缺陷：“没有定义值就无法生成算法，进而也无法编写程序。因此，算法设计便也无从谈起”。<sup>[11]</sup>

接下来，渡边开始探索一种其称之为“AI设计”的方法。这种结合了神经网络和遗传算法的方法被用于筑波快线柏木园校园站的设计中。渡边将之视为“世界上首个满足了所有设计条件的、通过AI生成的建筑设计项目”。<sup>[11]</sup>但是，渡边仍对这项技术存疑，因为其视觉效果不甚理想，而他也不得不对项目设计进行了人工调整。

of approaches aimed at harnessing the potential of AI for design, and in his article “AI Tect: Can AI Make Designs?” he takes us on this personal journey, evaluating the success of this enterprise.<sup>[11]</sup>

Watanabe’s foray into the potential for generating designs computationally started in 1994 with what he describes as his “Induction Design” method.<sup>⑦</sup> This method generated a design that was actually built, Web Frame, for the Tokyo subway system. The next step was the introduction of “Algorithmic Design,” which began around 2001 and led to the design and construction of the Shin-Minamata Mon project (Fig. 3). This was an attempt to “externalize” the design process in the form of algorithms. For Watanabe, however, the drawback of both the Induction Design and Algorithmic Design methods is that it was difficult to establish objective standards about the designs they generated in that judgment is inherently subjective. Hence, for Watanabe, both approaches are fundamentally flawed: “Algorithms cannot be obtained without defined values, and programs cannot be written without algorithms. As a result, Algorithmic Design becomes impossible”.<sup>[11]</sup>

The next step for Watanabe was to develop an approach that embraced AI in what he referred to as “AI Design.” This consisted of a combination of neural networks and genetic algorithms that was used to generate the Tsukuba Express Kashiwanoha Campus Station, which Watanabe regards as “the first work of architecture in the world to use AI to generate architecture by meeting required conditions.”<sup>[11]</sup> Again, however, Watanabe was left unconvinced by the technique, as the visual results proved unsatisfactory, and he was forced to intervene and adjust the design manually.



© Makoto Sei Watanabe

渡边将这一系列实验统称为“AI”，包含“人工智能”和“建筑智能”两重含义。2017年，渡边开发了“HandIn”技术，其能够填充颜色并修改线条，但无法改变形式（图4）。在这种技术的运用过程中，设计者不会收到任何反馈，一切都是自动的。有别于在“黑箱”中近乎盲目的操作，该方法能够对操作趋势进行广泛追踪，因此渡边将其称为“灰色”操作。

对渡边来说，基于算法的设计方法比标准设计方法更加客观，因为后者通常更基于主观判断，例如经验和直觉。但是，这一过程往往属于“黑箱操作”，因为我们常常不知道算法的运行内容——或者它为什么这样做。从这个意义上说，这与基于建筑师直觉的传统设计方法中的“黑箱”并无二致，二者同样是模糊的、不透明的。随之而来的另一个问题是，我们倾向于在这个过程中进行人工干预。因此，“AI建筑设计”可能并不像所预期的那样客观。

最终，渡边认为，人类有其局限性，但机器也同样有局限性，如他所说——它们没有“想象力”：“在处理错综复杂的问题时，机器比人类更强，人们无法与其对抗。但人是唯一可以运用想象力创造不存在事物的物种，而机器却没有想象力。”<sup>⑧[11]</sup>

### 3.2 伊曼努尔·吴的感应设计机项目

另一位建筑师伊曼努尔·吴通过其“感应设计机”项目，以深度学习的方式探索了AI在城市设计中的应用。吴这样描述自己的项目：

Watanabe refers to this series of experiments collectively as “AI,” referring to both “Artificial Intelligence” and “Architectural Intelligence.” The series continued with the development of his “HandIn” technique, developed in 2017, which is capable of adding colors and modifying lines, but is incapable of changing forms (Fig. 4). With this technique there is no feedback and everything is automatic. Watanabe therefore refers to it as a “grey” operation, as opposed to one operating in a “black box,” but because it is possible to track broadly the tendencies of this operation.

By contrast, the use of algorithms, for Watanabe, offers a more objective approach to design than the standard approach, which would often rely on more subjective factors, such as experience and intuition. However, the process operates within a “black box,” because we often do not know what the algorithm is doing — or indeed why it is doing it. In this sense, it is no different to the “black box” of the traditional design approach, which is based on the *intuition* of the architect and is equally opaque. A further problem is that we tend to intervene manually in the process. As such, the “AI Tect” is not as objective as it might be.

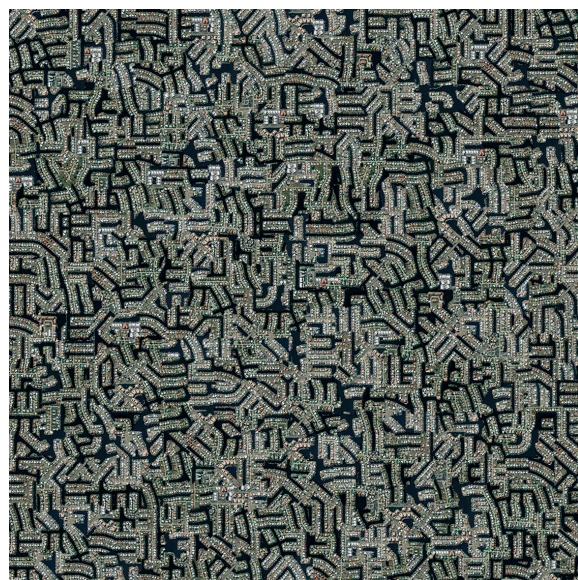
In the end, then, for Watanabe, human beings have their limitations, but machines also have their limitations, as — he claims — they cannot “dream”: “Machines are better than people at solving complex problems with many intertwined conditions. In that realm, people are no match for machines. But people are the only ones who can create an image that does not yet exist. Machines do not have dreams.”<sup>⑧[11]</sup>

⑧ 关于AI和人类智能之间的区别，渡边提出了一个有趣的问题：例如，在电影《银翼杀手》中，关键问题是如何区分人类和“复制人”。由哈里森·福特扮演的里克·戴克尔德（电影中一个负责追捕和杀害复制人的角色）是否也是一个复制人，仍是一个非常具有争议性的问题。

⑧ Watanabe raises an interesting question about the difference between AI and human intelligence, especially in the light of the movie *Blade Runner*, where the key challenge is how to tell the difference between humans and “replicants.” In fact what question left hanging in the air is whether Rick Deckard, played by Harrison Ford, who is charged with hunting down and killing replicants, is himself a replicant or not.

### 3.2 Inference Design Machine by Immanuel Goh

Immanuel Goh is another architect who has explored the



5. 伊曼努尔·吴设计的巴塞罗那“无限空间”项目
6. 伊曼努尔·吴设计的巴塞罗那“重组空间”项目
5. Infinite Series, Barcelona, by Immanuel Goh.
6. Recombinant Series, Barcelona, by Immanuel Goh.

“该项目试图将当前生成性/参数化建筑设计和城市设计中的显性规则脚本范式，转变为基于脚本化深度学习模型的隐性规则感应范式。该项目提出了一种新的重组方法来摆脱描述组合设计规则（即编程语言中的‘if-else’条件语句）的形式化限制，方法是通过深度神经网络训练，使其从容量最大化的设计数据集中学习参数化设计的相关系数。换言之，这个项目没有采用非数据驱动和手工编写脚本的方法，而是以数据驱动规则进行感应。”<sup>[12]</sup>

吴取得的成绩在于有效地创作出了一个能够从各种样本中感应出规则的设计生成器。换句话说，该系统能够识别模式的逻辑，然后根据这个可能会永久存在的逻辑来感应出一种更广泛的设计，正如安德里亚·班齐在《停不下来的城市》（1995）一书中讨论的那样。这将我们牢牢地限定在模式识别的领域，并且该系统似乎是在通过对现有模式进行复制而生成设计——而非完全脱离现有模式——直到新的逻辑能够有效地替代旧的逻辑。

吴还研发出了一种感应设计机的变体，即“重组设计机”。它能够两个完全不同的规划系统的逻辑结合起来。具体到吴的研究，其在“巴塞罗那扩建区”项目中的重复网格和佛罗里达州夏洛特公园中

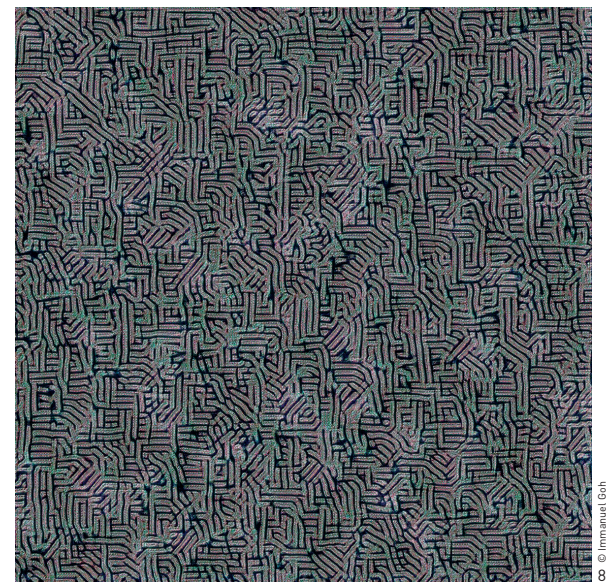
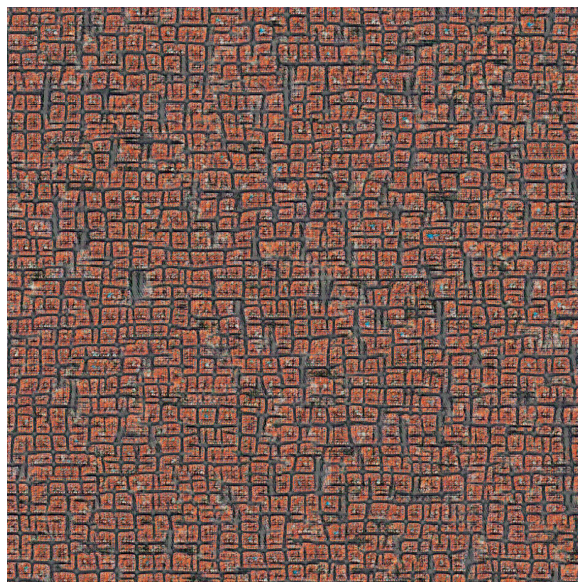
application of AI to urban design in the form of Deep Learning methods through his “Inference Design Machine” project. Goh describes his project as follows:

“The project seeks to shift the current paradigm of explicit rules-scripting in both generative / parametric architectural and urban design to one that is based on implicit inference of rules via scripted Deep Learning models. It proposes a new recombinant approach in overcoming the formalization limits of describing combinational design rules (‘if-else’) by training a deep neural network to learn parametric design correlations from a sufficiently sized design dataset instead. In other words, instead of a non-data driven and hand-craft scripting approach, here the data drives the inference of rules.”<sup>[12]</sup>

What Goh effectively produces is a design generator based on *inferred* rules drawn from a variety of samples. In other words, the system is capable of recognizing the logic of a pattern, and then extrapolating a broader design based on that logic that could potentially continue forever, much like Andrea Banzi’s *No-Stop City* (1995). This locates us firmly in the realm of pattern recognition, and would seem to infer that — far from generating forms that would stand out from the existing — the system only generates a replication of the existing, to the point that the new would be effectively *camouflaged* within the logic of the old.

A variation of the Inference Design Machine in Goh’s research is the “Recombinant Design Machine.” This is capable of combining the logics of two entirely different planning systems. In the case of Goh’s research, this is represented by the repetitive grid of the Eixample in Barcelona and the maze-like

7. 伊曼努尔·吴设计的佛罗里达州“无限空间”项目
8. 伊曼努尔·吴设计的佛罗里达州“重组空间”项目
  
7. Infinite Series, Florida, by Immanuel Goh.
8. Recombinant Series, Florida, by Immanuel Goh.





的迷宫式构造，是这一方法的典型代表。这种重组过程的确产生了新的形式语言，尽管我们清楚地知道这些新的形式语言完全源于两种不同系统的原始语言，因而并不是完全新颖的（图5-8）。

### 3.3 小库

当前在AI设计领域中最成熟的应用实例，是深圳一家新兴公司研发的AI建筑师“小库”。小库开发了一个基于网络的平台，支持从建筑设计到城市规划的各种尺度的AI运用。作为AI在设计领域最直接的应用，其目的是通过深度学习来简化设计流程，并使之更加高效、更富创造性：小库不仅能够在广泛的可能性中进行搜索，还可以在训练模型的基础上自动生成设计，并根据各种评估模型对设计结果进行评定和修正。尽管其生成的形式可能看起来并不新颖，但该过程是对于设计工作方式的一次真正意义上的变革。让我们再拿优步汽车举例：优步汽车本身可能与普通汽车并无二致，但与标准出租车相比，正是优步系统的运行优势使得该过程变得如此有趣。

前文中，我讨论了设计师在遗传算法背景下的角色转变：“在计算机的诸多潜力中，其作为搜索引擎的能力至关重要。那么，如果我们在‘设计’的背景下以搜索的逻辑来思考，倘若所有可能的解决方案均已存在，那么我们要做的将仅仅是定义一组约束条件并进行搜索，而后在得出的诸多结果中做出选择。这一假设可能会带来深远的影响，其不仅对建筑师/设计师关于‘设计天赋’的传统观念和艺术作品的独创性发出了挑战，同时还提出，如果说在‘设计’过程中仍存在任何创造性的话，那么这种创造性应首先体现在对特定问题的解决方案的条件限定上，其次体现在对筛选或评估这些方案的有效方法的研发上。”

configuration of Charlotte Park in Florida. This recombinant process does generate a new language of forms, although these new forms are clearly based entirely on the two different original languages of the systems from which they are derived, and therefore not novel in and of themselves (Fig. 5 ~ 8).

### 3.3 XKool

By far the most sophisticated application of AI to design, however, is the work of XKool, an AI startup in Shenzhen, China. XKool has developed a web-based platform for using AI across a range of scale from architectural design to urban planning. This is really the most direct of all applications of AI to the world of design, and its intention is to streamline the design process and make it more efficient and creative by using Deep Learning to not only search through a vast range of possibilities, but also automatically generate designs based on trained models, and then evaluate and return the outcomes from various evaluation models. Although the forms generated might not look so novel, what is truly revolutionary about this process is the way of working. To cite once more the example of the Uber car, the car itself might not look so different to an ordinary car, but it is the operating advantages of this system compared to that of a standard taxi that make the process so interesting.

Earlier I wrote about a shift in the role of the designer in the context of genetic algorithms: “Of the many potentialities afforded by the computer, one of the most significant is its capacity to operate as a search engine. If, then, we think through the logic of the search in the context of ‘design,’ what such an approach suggests is that if all possible solutions already

9. 运用小库原型设计的深圳湾生态科技城项目
  10. 将方案成果一键分享至智能手机，方便查看设计成果。
  11. 在小库智能设计云平台上可自由地切换建筑表皮
  12. 在小库智能设计云平台上进行实时规范检测
9. Shenzhen Bay TechCity Project by XKool
  10. One-click sharing of the project to any smartphone so as to view the results.
  11. Freely switching the architectural surface on XKool AI design cloud platform
  12. Performing normative detection in real-time on XKool AI design cloud platform

小库所做的工作之所以重要，是因为它将AI从结果搜索拓展到了结果生成和评估。通过小库的探索，我们如今得以瞥见将AI应用于设计领域的巨大潜力：其不仅可以作为优化和加速设计过程的有效工具，而且也对设计的本质提出了挑战（图9~13）。

#### 4 打破设计天赋的神话

直至今日，我们始终对设计师的“设计天赋”推崇备至。毕竟，根据渡边的说法，设计师超越机器之处，正是在于他/她拥有“想象力”。如果我们认同这一观点，那么我们必然会得到这样的结论：在机器拥有“想象力”之前，AI不可能与人类智能真正抗衡。但事实果真如此吗？这会不会是过时的思维方式呢？

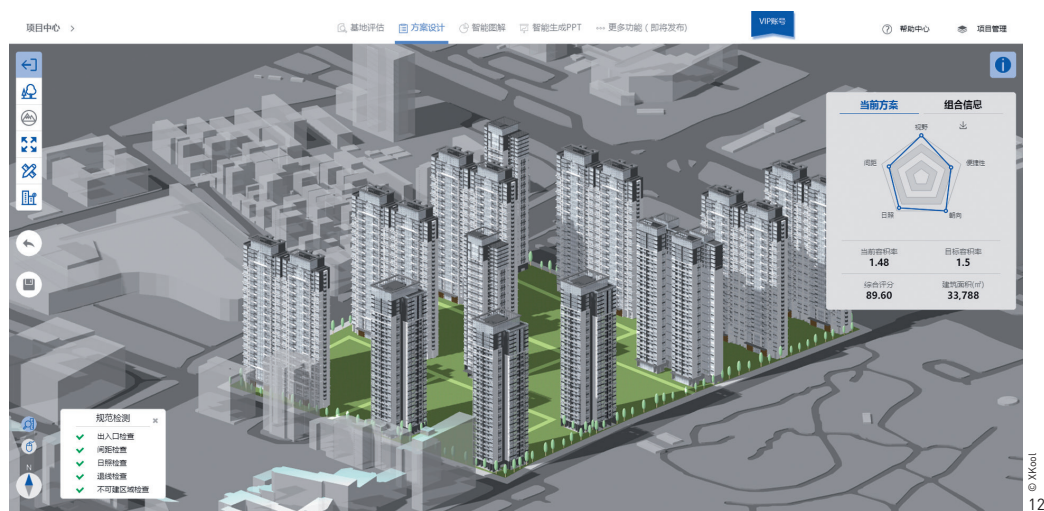
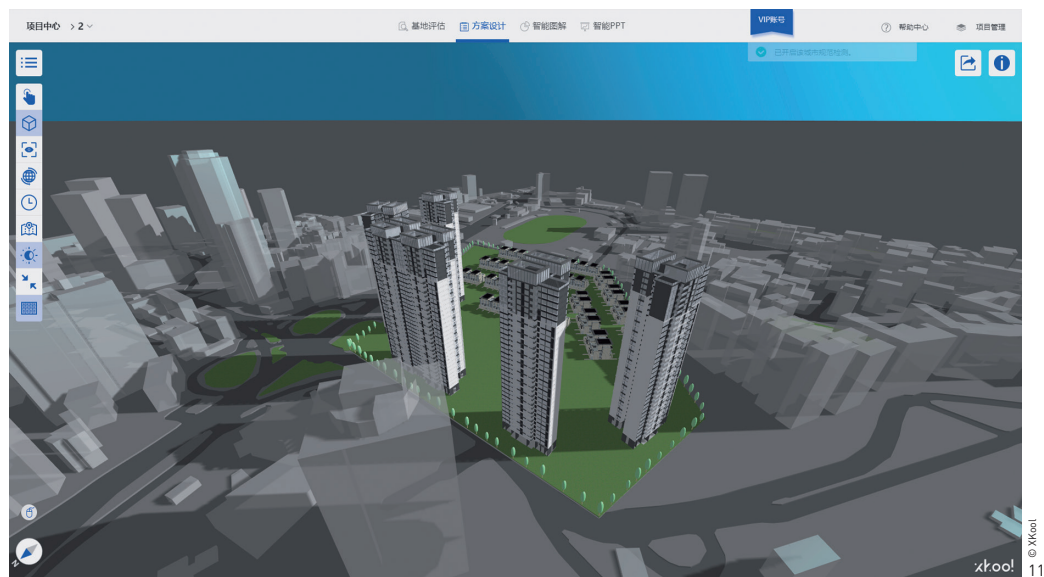
exist, it is simply a question of defining a set of constraints and conducting a search, and then selecting one of the many outcomes. The potential implications of this are far reaching. Not only does it challenge the traditional notion of the ‘genius’ of the architect / designer and the originality of the work of art, but it also suggests that if there is still any creativity in the ‘design’ process, it should lie, firstly, in defining the constraints that generate the range of possible solutions to a problem, and secondly, in developing an effective method of filtering or evaluating them.”

What makes the work of XKool so significant is that they have extended this principle so that AI not only searches for outcomes, but also generates and evaluates those outcomes. Through the work of XKool we can therefore begin to glimpse the extraordinary potential of the application of AI to the world of design. Not only can it be an effective tool for optimizing and speeding up the design process, but it also calls into question the very nature of design itself (Fig. 9 ~ 13).

#### 4 Debunking the Myth of the Genius

Up until now we have placed great faith in the “genius” of the designer. After all, according to Watanabe, it is precisely the capacity for a designer to “dream” that sets him / her apart from a machine. If so, we would have to conclude that until such time as a machine can “dream,” AI cannot be any real match for human intelligence. But is this really the case? And is this not old fashioned way of thinking?

Here I want to introduce a somewhat iconoclastic notion. I want to suggest that with the advent of computation we need to radically rethink what it is to “design,” and to even question whether we can still use this term any more. Let me start with a simple question: how exactly do we take photographs in an age of the digital camera, and is it any different to the way that we used to operate with a manual camera? Let me offer a brief — and necessarily superficial — overview of how I see the shift. In the old days of manual photography, a photographer would carefully set up the camera for the *ideal* shot. In the age of digital photography, we take a burst of many — perhaps even over a hundred — *sample* shots. Then we review them carefully, and decide which one of the many shots to select, often using post-production techniques — available on our smartphones and other computational devices — to edit and refine this selected shot. Let us call this a process of “sampling.” It is no longer a question of the genius photographer setting up the ideal shot, but rather of reviewing an array of possible sample outcomes, and then selecting and enhancing the best of them.



在本文中，笔者想要介绍一个略显反传统的概念：随着计算的出现，我们需要从根本上重新思考“设计”是什么，甚至质疑我们是否还能继续使用这一术语。让我们从一个简单的问题开始：在数码相机时代，我们拍摄照片的方式与之前用手动相机操作的方式有何不同？我对这种转变的一点简单（可能难免粗浅）的看法是，在过去手动摄影时，摄影师会仔细调试相机，以求拍摄到**理想的**照片。在当今数码时代，我们会尽情按动快门，拍下许多张，甚或上百张照片，然后我们仔细地从中**挑选**出满意的一张，并通常使用后期制作技术（这些技术已可在我们的智能手机或其他计算设备上实现）来编辑和优化这张选中的照片，我们可将此称为“选样”过程。这不再是天才摄影师调试理想拍摄参数的问题，而是在一系列潜在的结果样本中挑选出最好的一个并进行优化。

除了这种新的摄影方法和我们在计算时代处理设计的方式之外，还有一些问题值得我们关注。的确，计算最重要的贡献之一是拓宽了可能的结果的**范围**。这让我想起几年前在伦敦建筑联盟学院参加的一次评审活动。一名学生在介绍他的作品时，指出自己已经探索了6种不同的可能性。另一名学生在进行作品介绍时也指出，其使用计算机推演了所有可能的几百个结果，尽管其中大部分都存在一定程度的雷同，但他还是将它们全部呈现了出来。对此我的观点是：我们经常利用计算来拓展我们以前可能不曾考虑过的可能性。从这个意义上讲，计算机运算提供了一种拓展可能性范围的技术。与数码摄影一样，我们并不需要在设计之前便清晰地理解理想的设计是什么样的，而只需生成一系列可能的样本结果，并在其中挑选出最佳。

因此，我们必然需要重新思考我们所使用的术语。既然单一的设计结果被一系列潜在的样本选项所取代，我们是否更应将它们称为“结果”？既然产生这些样本选项的过程不再是基于单一的设计结果，而是基于一系列这样的“结果”，我们是否应该将这一过程称为“搜索”，而非“设计”？至此，设计师自然也仅仅成为了这个过程发起者，而相较于传统意义上的设计，此过程中的“设计”则更像是一个结果。

## 5 结论

在AI时代，设计过程正在发生着显而易见的转变。然而，这其中的关键问题是，我们是否可以继续使用“设计”这一术语，因为在这一过程中实际发生的是对现有模式的识别或定义，从而进行进一步推演。尽管渡边诚似乎没有完全认识到这一点，但显然吴已非常清楚这种转变。正如其所言，“这种转变表明未来设计师担任的角色将不仅是输入设计数据的管理员，还包括构建深度/机器学习模型的程序员。”<sup>[12]</sup>

由此带来的影响将是惊人的。这不仅表明渡边提出的“想象力”问题如今已不再那么重要——我们不再依赖原本主流的“设计”过

Now, there are certain parallels that could be drawn between this new approach to photography and the way that we approach design in our age of computation. Indeed one of the key contributions of computation has been to open up the *range* of possible outcomes. Here I am reminded of a review that I attended at the Architectural Association (AA) School of Architecture in London a few years ago. One student presented his work, and noted that he had explored a range of 6 different options. The next student then presented his work, and noted that he had run all the possible outcomes through a computer, producing several hundred outcomes, most of which were somewhat similar, but nonetheless he presented them all. My point is this: often we use computation to open up possibilities that we might otherwise not previously have thought about. Computation, in this sense, offers a technique for expanding the range of possibilities. As with digital photography, it is not about having a clear sense of the ideal design ahead of time, but rather of generating a range of possible sample outcomes, and filtering them to select the best.

As a corollary to this, however, we need to rethink the terminology that we use. If the notion of a singular design is being replaced by a range of potential sample options, should we not refer to them as “outcomes”? And if the process of generating these sample options is based not on the generation of a singular design, but on an array of such “outcomes,” should we not call this process one of “searching” rather than “designing”? Surely the designer here is merely the instigator of a process, and the “design” is more of an outcome than a design in the traditional sense.

## 5 Conclusion

In the age of AI, it is clear that the design process is being transformed. The key question here, however, is whether we can still use the term “design” any more, when what is effectively happening is that an existing pattern is being recognized or defined, and then extrapolated further. Even though Watanabe does not seem to acknowledge this, it is clear that Goh is very much aware of this shift. As he notes, “This shift suggests that the designer of the future would take on the role of both a curator of design data input, as well as a programmer architecting the design of Deep / Machine Learning models.”<sup>[12]</sup>

The implications of this are startling. Not only does it suggest that the issue of “dreaming” raised by Watanabe is now not so relevant in that we no longer rely on the same processes of “designing” that were popular in the past and therefore machines do not need to learn to “dream.” But it also suggests

13. 小库智能设计云平台网站首页
13. The login page of XKool AI design cloud platform

程，因此机器也不需要学习如何拥有“想象力”。这还说明，如果已经存在一个囊括所有可能的解决方案的范围，那么我们需要做的仅是进行正确的“搜索”。这不再是关于设计师利用其“设计天赋”来“创造”新方案，而是从一系列现有的可能选择中挑选最佳方案。从这个角度来看，我们也可以质疑渡边的“人是唯一可以创造不存在事物的物种”这一观点，因为正如AI带给我们的启示那样，所有的待选结果皆已存在。<sup>[11]</sup>

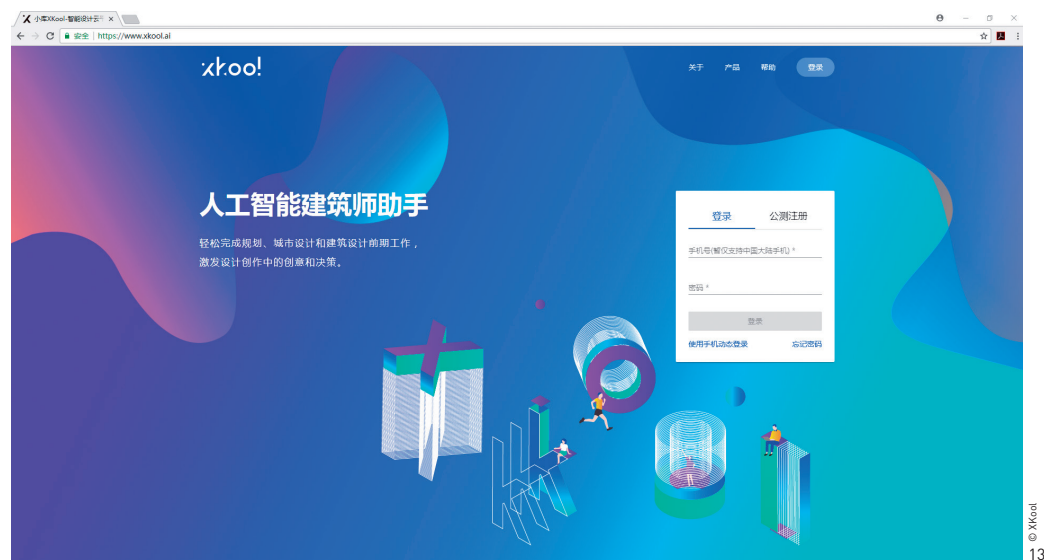
换言之，这些假设将引导我们直面一个不可避免的结论：我们不仅不必等待AI赶超人类智能，而且也已经发现AI在任何设计搜索过程中找寻可能“结果”的能力均已远远超过人类。这意味着，AI对于传统意义上的设计并不一定会做出太多贡献，但其可能会颠覆我们沿用了多个世纪的设计过程的本质。

因此，这似乎意味着天才设计师的概念实际上可能只是一个迷思。那么，我们是否应该摒弃对于设计天赋的推崇，并开始重新思考世界的本质？我们或许会发现此结论中最令人震惊的一点是，AI带给我们的真正教训可能并不在于AI本身具有怎样的“人工性”，而是人们长久以来所推崇的人类智慧中的“设计天赋”竟也是“人工性”的——我们被深深地误导了。**LAF**

that if the range of all possible solutions are already out there, it is merely a question of conducting the right “search.” It is not about the designer “inventing” some new proposals by drawing upon his / her “genius,” but rather of selecting the best solution from a range of existing possible options. From this perspective, we can also challenge Watanabe’s claim that “people are the only ones who can create an image that does not yet exist,” in that — as we have learnt from AI — all images already exist.<sup>[11]</sup>

In other words, we now arrive at the inescapable conclusion that not only do we not need to wait for AI to catch up with human intelligence, but also that AI is already far more efficient than human intelligence in searching for the range of possible “outcomes” in any “design” search process. It means that AI does not necessarily add much to “design” in the traditional sense. However, it might have a significant impact in reconfiguring the very nature of the design process as it has been bequeathed to us over the centuries.

As a result, what this would seem to imply is that the notion of the “genius” designer might actually be something of a myth. Are we not in a position, then, where we can abandon the notion of the genius designer, and begin to understand the world for what it actually is? Perhaps, then, the most startling aspect of this conclusion is that the real lesson of AI might not be how “artificial” AI is, but rather how “artificial” — and fundamentally misguided — was our previous perception of the “genius” of human intelligence. **LAF**



## REFERENCES

- [1] Gibbs, S. (2014, October 27). Elon Musk: Artificial Intelligence is Our Biggest Existential Threat. The Guardian. Retrieved from <https://www.theguardian.com/technology/2014/oct/27/elon-musk-artificial-intelligence-ai-biggest-existential-threat>
- [2] Jones, R. C. (2014, December 2). Stephen Hawking Warns Artificial Intelligence Could End Mankind. BBC News. Retrieved from <http://www.bbc.com/news/technology-30290540>
- [3] Leach, N., & Snooks, R. (Eds.). (2017). Swarm Intelligence: Architectures of Multi-Agent Systems. Shanghai: Tongji University Press.
- [4] Kurzweil, R. (2005). The Singularity is Near: When Humans Transcend Biology. New York: The Penguin Group.
- [5] Schumacher, P. (2017). Parametricism: A New Global Style for Architecture and Urban Design. In N. Leach, & F. Yuan (Eds.), Computational Design (pp. 29-42). Shanghai: Tongji University Press.
- [6] Pisca, N. (2017). Forget Parametricism. In N. Leach, & F. Yuan (Eds.), Computational Design (pp. 43-48). Shanghai: Tongji University Press.
- [7] Gibson, J. J. (1977). The Theory of Affordances. In R. Shaw, & J. Bransford (Eds.), Perceiving, Acting, and Knowing (pp. 67-82). New Jersey: Lawrence Erlbaum Associates.
- [8] Gibson, J. J. (1977). The Theory of Affordances. In J. J. Gibson (Ed.), The Ecological Approach to Visual Perception (pp. 127-137). Boston: Houghton Mifflin.
- [9] Gibson, E. J., & Pick, A. D. (2000). An Ecological Approach to Perceptual Learning and Development. New York: Oxford University Press.
- [10] Carpo, M. (2017). The Second Digital Turn: Design Beyond Intelligence. Cambridge, MA: The MIT Press.
- [11] Watanabe, M. S. (2017). AI Tect: Can AI Make Designs? In N. Leach, & F. Yuan (Eds.), Computational Design (pp. 69-78). Shanghai: Tongji University Press.
- [12] Koh, I. (2017). Inference Design Machine and “Infinite” and “Recombinant” Series. In N. Leach, & F. Yuan (Eds.), Computational Design (pp. 291-296). Shanghai: Tongji University Press.