

本文引用格式 / Please cite this article as:

Schlickman, E. (2019). Going Afield: Experimenting with Novel Tools and Technologies at the Periphery of Landscape Architecture. *Landscape Architecture Frontiers*, 7(2), 84-91. <https://doi.org/10.15302/J-LAF-20190208>

走向远方： 新工具与新技术 在景观设计领域的应用测试

GOING AFIELD: EXPERIMENTING WITH NOVEL TOOLS AND TECHNOLOGIES AT THE PERIPHERY OF LANDSCAPE ARCHITECTURE

1 序言

景观设计实践正处于急速转变之中，从业人员面临着更为棘手的问题、更大尺度的场地、更加激烈的竞争，以及愈发紧张的设计周期。为了应对这些复杂挑战，景观设计师的工具已不再囿于传统的图纸、绘图平行尺和绘图铅笔，一系列仍处于实验阶段的设备都逐渐为其所用（图1）。然而，由于目前众多的新兴技术最初并非是为建筑、工程和施工（AEC）行业而研发，因此不能简单地将它们直接引入并应用于设计过程之中。

在过去三年中，SWA集团XL研究与创新实验室（XL实验室）对无人驾驶飞行器、沉浸式环境技术和机器学习算法进行了缜密的评估，以更深入了解这些技术在景观设计领域的应用潜力。整个实验倾向

<https://doi.org/10.15302/J-LAF-20190208> 收稿时间 RECEIVED DATE / 2019-02-13 中图分类号 / TU984.11+3, TP181 文献标识码 / B



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摘要

如今，景观设计师在设计实践中正面临着前所未有的复杂挑战。为了更好地适应并应对这些问题，景观设计领域试图摆脱传统工具与设备的限制，引入源自其他行业的新兴工具。基于不断优化用户体验的硬件、更为直观的软件和逐渐降低的成本，越来越多的人能够有机会接触并使用这些工具。然而，多数新兴工具最初都是为其他领域的专业人士量身定制，因此并不能直接为设计领域所沿用。本文认为，唯有通过严谨的分析和评估，才能进一步将新兴技术应用于景观设计实践。通过剖析SWA集团XL研究与创新实验室就无人驾驶飞行器、沉浸式环境技术和机器学习算法这三种新兴工具的局限性所进行的实验和测试，本文试图厘清这些工具在设计行业的应用潜力。具体而言，本文概述了每种工具所涉及的技术，同时提供案例研究以判断其在景观设计实践中的应用前景，并依据实验结果列明每种工具的优势和局限，最终展望了这些工具在未来的应用可能。

关键词

工具；技术；设备；无人驾驶飞行器；虚拟实；混合现实；机器学习

ABSTRACT

Landscape architects are facing unprecedented challenges and complexities associated with design projects of today. To better adapt and evolve in light of these issues, the toolbox for the profession is currently expanding beyond traditional implements and devices to include emerging tools that have originated in other industries. The barriers to entry for these tools are continuously being lowered due to more user-friendly hardware, more intuitive software, and increased affordability, allowing them to get into the hands of more people. Yet, many of these emerging tools now available to professionals originated elsewhere and cannot be simply transferred over to the design world. This article argues that there is a need to critically evaluate and assess new technologies for use in landscape architectural practice. It unpacks how the XL Research and Innovation Lab at SWA Group has experimented with and tested the limitations of three new tools — unmanned aerial vehicles, immersive environment technologies, and machine learning algorithms — to better understand their potential for design. For each tool, the article provides an overview of its technology, a case study testing the technology for use in landscape architectural practice, a list of observed strengths and limitations, and a projected roadmap for future applications.

KEY WORDS

Tools; Technologies; Devices; Unmanned Aerial Vehicles; Virtual Reality; Mixed Reality; Machine Learning

翻译 王颖 张健

TRANSLATED BY WANG Ying Angus ZHANG

1. 一系列新兴技术的实际成本及其在设计过程中的运用
1. The observed level of investment and use within the design process of a selection of emerging technologies

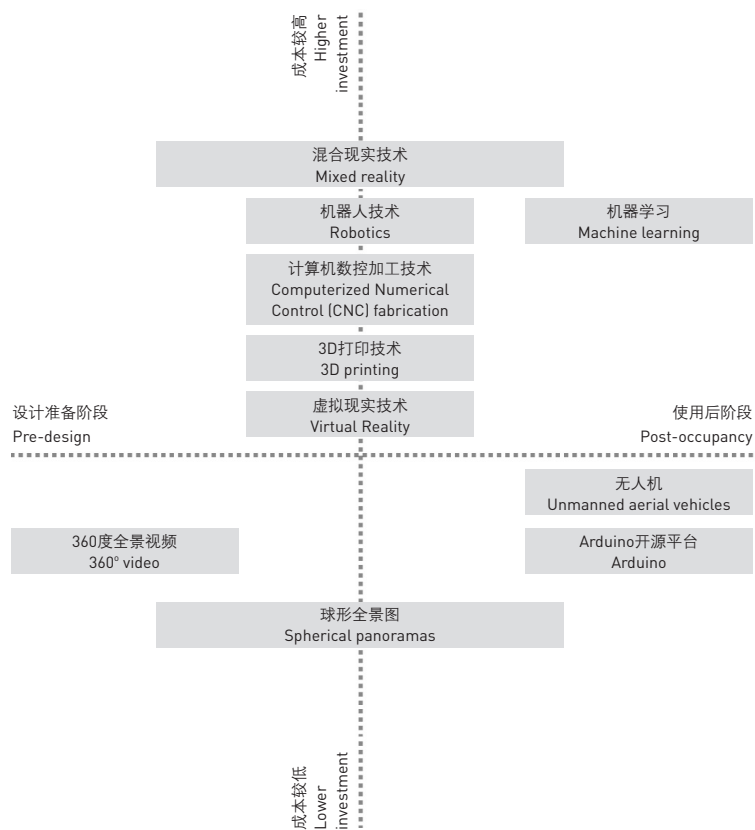
于采用更为客观理性的分析方法，而非过度乐观地为这些新兴工具大唱赞歌。实验室所做的是将这些工具放入一个“沙盒”之中，并试图破译它们。

为评估这些工具在设计领域的潜在价值，XL实验室主要聚焦于以下三个研究议题：1) 新技术如何改变我们对于空间的感知？它是否提供了某种观察景观的新视角？2) 技术的输出是否向我们提供了更多传统设计过程以外（如场地分析及建成后评估）的信息？3) 作为设计师，我们能否主动地参与技术研发，使其更好地服务于设计领域？不同领域能否建立合作并相互适应？

2 天空之眼

无人驾驶飞行器是指能够自主飞行或可被远程控制的飞行机器，通常被称为“无人机”。其在军事领域的运用历史悠久，可用于侦察和掠夺性演习。2015年前后，民用无人机的兴起将其推向了以娱乐功能为主的发展阶段。近几年，无人机的使用进一步扩展到了一些专业领域。具体就AEC行业而言，这一技术当前主要用于市场营销和商业宣传，而由无人机拍摄的高清图像和视频则通常用于展现项目建成后的效果。

为了探索无人机在景观设计领域更多可供实证分析的应用场景，XL实验室在纽约猎人角南部滨水公园的社会效益研究中引入了无人机



1 Introduction

The practice of landscape architecture is rapidly changing. Professionals are having to tackle bigger issues, larger sites, increased competition, and faster schedules. To deal with these complexities, the toolbox for landscape architects is expanding beyond traditional implements of vellum, parallel bars, and drafting pencils to include a spectrum of experimental devices (Fig. 1). Yet, many of the technologies that are currently on the horizon were not originally developed for the architecture, engineering, and construction (AEC) industry; thus, they cannot be simply adopted or streamlined into the design process.

Over the past three years, XL Research and Innovation Lab (XL Lab) at SWA Group has critically evaluated unmanned aerial vehicles (UAVs), immersive environment technologies, and machine learning algorithms, to better understand the potential for each of these technologies in landscape architecture. The approach, rather than being overly positive or celebratory, has instead been analytical. The lab simply puts the tools into a “sandbox” and tries to break them.

In assessing the potential value of these devices for design, XL Lab has focused on three primary research questions: 1) How does the new technology change our perception of space? Does it offer a new lens, or a new perspective, from which we can view the landscape? 2) Do the outputs from the technology make us more informed, not just during the traditional design process, but also during site analysis and post-construction evaluation? 3) Can we, as designers, be pro-active in the development of the technology to make it work for us? Is collaboration and adaptation possible?

2 Eye in the Sky

UAVs are flying machines that are either autonomous or remotely piloted. Commonly known as drones, UAVs have a long history of being employed in the military, for both reconnaissance and predatory exercises. In the mid-2010s, with the rise of civilian vehicles, a new wave emerged, focusing on recreational use. More recently, the use of UAVs has expanded into professional fields. For the AEC industry, specifically, the technology has been primarily employed for marketing and promotional purposes; high-quality imagery and video taken from the aircrafts are typically used to document a project post-construction.

In an effort to explore additional, more analytical uses of UAVs for the field of landscape architecture, XL Lab experimented with an aircraft as part of a social performance

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实验。该项目位于纽约长岛市东河沿岸，占地约4.5hm²。公园的使用后评估由美国景观设计基金会组织的“案例研究调查”计划牵头，该计划促成了学术研究人员与专业从业者评估建成项目的环境、社会和经济效益方面的密切合作^[1]。

实验团队一方面通过传统渠道收集数据——汇总来自个人、城市、州和联邦层级的数据，采访项目相关人员，以及绘制能够体现公园使用情况的图表（地面视角），同时借助无人机进行实地拍摄。采用空中视角进行记录与分析的初衷是通过拍摄公园的“社会快照”，呈现因地面视角盲区而无法观察到的使用情况。首先，无人机拍摄了一系列滨水区的静态图像，拼合之后的图像能够帮助团队了解东河沿岸的空间使用情况（图2）。此外，团队还拍摄了两组覆盖整座公园的



2 © Bill Tatham, SWA Group

study of Hunter's Point South, a 4.5-hectare waterfront park located along the East River in Long Island City, New York. The post-occupancy assessment for the park was performed through the Landscape Architecture Foundation's Case Study Investigation program, which pairs academic researchers with firm liaisons to evaluate the environmental, social, and economic benefits of built work^[1].

While the research team collected data through traditional channels — such as aggregating private, city, state, and federal data, interviewing project-related personnel, and tabulating and mapping park usage on the ground — the team also experimented with UAV footage. The overall goal of the aerial documentation and analysis was to reveal patterns not visible from the ground by providing a “social snapshot” of the park. First, the UAV took a series of still images of the waterfront which were stitched together to understand usage along the edge of the East River (Fig. 2). The team also conducted two fly-through videos that covered the entire park from end to end. This footage was intended for recording user behavior across the whole site at the same moment in time. The last piece of documentation involved hovering videos capturing localized pedestrian movement across portions of the park.

Using a UAV for the Hunter's Point South post-occupancy study proved to be a more affordable alternative to chartering a helicopter or Cessna to get the same shots. For example, the cost to charter a helicopter or Cessna for four hours could easily add up to over USD 5,000, whereas the full lifetime cost of a mid-range commercial drone is a quarter of that. The UAV also allowed the team to capture a wider swath of park at once, which significantly sped up the data collection process. For example, instead of a researcher spending thirty minutes in three different zones of the park to collect data on user behavior, one thirty-minute clip from above could capture the same amount of information. Furthermore, all of the outputs from the UAV were visually impressive and could be used not only for post-occupancy analytics but also for marketing and promotional purposes. As for limitations, the team quickly ran into a range of technical issues, from battery life to dealing with high-wind conditions. Privacy was also a major concern given the social focus of the study.

So what does the future hold for UAVs? Across a range of industries — including journalism, shipping, disaster management, search and rescue, healthcare, agriculture, and law enforcement — drones are already being tested for important professional applications. They fight forest fires, conduct maintenance inspections on aging infrastructure,

2. 无人机在猎人角南部滨水公园东河滨水区拍摄的静态图拼贴
3. 实验人员正在测试HTC Vive虚拟现实产品
2. The collage of a series of UAV stills of the East River waterfront of Hunter's Point South Park
3. Testing virtual reality with the HTC Vive

全景视频。这一连续式镜头旨在实时记录同一时刻整个场地中使用者的活动情况。最后，研究团队还使用空中悬停镜头捕捉了公园局部区域的行人动线。

事实证明，相比租用直升机或塞斯纳飞机来拍摄同等效果的图像，使用无人机更为实惠。就成本而言，租用一架直升机或塞斯纳飞机4小时即需支付至少5 000美元，而购买一台可以长期使用的中档商用无人机的费用仅为其四分之一。此外，在无人机的支持下，实验团队可即时拍摄更为广阔的公园区域，大大加快了数据收集的进程。例如，研究人员通常需要在公园的三个不同区域各花费30分钟来收集用户行为数据，而一段由无人机拍摄的30分钟视频即可捕获等量的信息。此外，无人机所拍摄的图像或视频往往极具视觉冲击力，因此不仅可以用于使用后评估，还可用于市场营销和商业宣传。实践证明，无人机的弊端主要在于其技术问题，例如续航时间短、风速过大影响飞行等。而考虑到该研究主要聚焦于社会公共空间，隐私保护也成为无人机使用过程中的主要问题之一。

那么，无人机具有怎样的发展前景？目前无人机已经在新闻报道、航运、灾害管理、搜寻和救援、医疗保健、农业及执法等众多领域的重要专业应用场景得到应用，如协助扑救森林火灾、对老化的基础设施进行维护检查、监控农业生产、强化建筑和规划的规范实施，甚至包括从激流中营救溺水者^[2]。随着对无人机研发投资的增加和实验测试的不断成熟，在实现机型更小、电池续航能力更强和机器人系统集成技术不断突破的基础上，无人机无疑将在AEC行业中发挥更大的功用，如空中城市运输和空中组装建造等。

3 戏剧式体验

沉浸式环境技术涵盖球形全景图、360度全景视频、虚拟现实和混合现实技术等一系列可输出相似感知结果的可视化工具。球形全景图由静态效果图拼接而成，可提供360度的观看视角。360度全景视频与之类似，不同之处在于其以球体形式记录真实的场所和事件，观众可

monitor agricultural production, enforce building and planning code, and even rescue drowning swimmers from dangerous rip tides^[2]. With increased investment and experimentation, on top of technological improvements such as the development of smaller aircrafts, longer battery lives, and integrated robotics, more powerful applications for the AEC industry will undoubtedly emerge, from aerial urban transportation to flight-assembled construction.

3 The Experience Theater

Immersive environment technologies is a term used to describe a range of visualization tools with similar perceptual outputs. Included in this group are spherical panoramas, 360° video, virtual reality (VR), and mixed reality (MR). Spherical panoramas are static renders that are stitched together so that the viewer can look around in 360 degrees. 360° video is similar but records real places and events in a spherical format, allowing the viewer to see all around while the video is running. VR creates a modeled and textured space that a person can move through virtually (Fig. 3). Lastly, MR, also known as augmented



以从播放的视频中观看360度的动态景象。而在虚拟现实技术所创建的具有特定结构与质感的模拟空间中，人们可实现虚拟化的移动（图3）。混合现实技术（又称增强现实技术）则主要将数字三维模型或动画叠加在真实存在的场所之上。尽管这些沉浸式环境技术起初主要用于游戏设计与体验，但目前其在AEC行业中的应用已越发令人瞩目。

在一项大型沉浸式环境研究中，XL实验室与其他设计团队合作，向项目利益相关方展示了众多虚拟空间^①。该设计项目位于加利福尼亚州圣何塞市，是一座为郡政府新建的城市园区，工期为20年。为了确定项目所需技术，团队首先从渲染程序中导出了该设计方案的球形全景图，而后通过应用程序将全景图加载到智能手机上，并将手机放入“谷歌纸盒”（一款简易虚拟现实眼镜）中，从而在待设计场地中建立起一个虚拟观测点，供项目经理、郡政府雇员、设施管理人员和大众体验虚拟的设计空间。

通过在面向利益相关方举办的活动中引入沉浸式环境技术，该项目的设计方案获得了更多的关注与反馈。相比扁平化的二维图纸（如平面图、剖面图和透视图），人们更愿意花费双倍时间在沉浸式可视化界面中体验设计方案。在某种程度上，这种与方案之间的交互使人们能够更快地判断自己的喜好及其依据。尽管如此，全景图像与图片浏览器的适配技术还远称不上完美，有机材质的视觉效果也并非十分逼真。同时，部分观众在沉浸式环境中容易迷失方向，从而影响体验效果。此外，运用了虚拟现实和混合现实技术的硬件往往造价昂贵且笨重，人们学会使用相应的软件也存在一定的难度。

目前，沉浸式环境技术主要作为互动工具应用于游戏、娱乐和新闻等行业之中。随着技术的不断完善，更加逼真的效果、更为直观的软件界面，以及更易操作、佩戴更为舒适的硬件都将一一实现，并可能开辟出更广阔的应用前景。对于AEC行业而言，这样的改进或能将沉浸式环境技术的应用延展至效果渲染和可视化处理之外，即融入更庞杂的设计和施工过程之中。例如，未来的设计师将可能在沉浸式环境中进行设计，并利用相关技术对建成环境中难以观测到的日照和使用者行为等因素进行拟真分析。沉浸式环境技术还可以提高施工效率和准确性，并协助完成使用后效果评估。

reality (AR), overlays digital 3D models or animations onto real world places. While originally developed for gaming, immersive environment technologies like these are gaining traction in the AEC industry.

As part of a larger study on immersive environments, XL Lab collaborated with a design team to show a series of virtual spaces to a group of project stakeholders^①. The design project, located in San Jose, California, was a new urban campus for county offices with a 20-year build-out period. To set up the technology for the event, the team first exported spherical panoramas of the design from a rendering program. The panoramas were then loaded onto smart phones using an app and the phones were placed into Google Cardboards. A viewing station was set up onsite, at the location of the proposed design, so that county project managers, county employees, facility managers, and members of the general public could experience the spaces.

By employing an immersive environment technology at a stakeholder event, the team was able to get more engagement with their proposed design, and, as a result, more feedback. People tended to spend twice as much time exploring the immersive visualizations when compared to flat, 2D drawings such as plans, sections, and perspectives. In a way, this increased accessibility allowed viewers to make faster decisions on what they liked, what they did not like, and why. That being said, the technical process for embedding the panorama into the viewer was far from seamless and the visual quality of organic material was not very realistic. Also, some of those viewing the immersive environment became disoriented, and instinctively looked away. In addition, with VR and MR, the hardware tends to be expensive and clunky and the software has a steep learning curve.

At this point, immersive environment technologies are primarily being used as communication tools in a range of industries including gaming, entertainment, and journalism. Technological improvements including more realistic representations, more intuitive software, and more user-friendly and comfortable hardware are on the horizon, though, which might open up more uses and applications. For the AEC sector, this might mean moving beyond rendering and visualization applications to embedding the technologies as part of the larger design and construction process. For example, in the future, it might be possible to actually design within these environments, and use the technologies for immersive analytics — to analyze aspects of the built environment that we cannot easily see such as daylight or human behavior. Immersive environment technologies might also increase construction efficiency and accuracy and help with the assessment of post-occupancy effects.

① 更多有关沉浸式环境的研究详见SWA集团官方网站。

① For more information on the study, please search for "Immersive Environments" on the official website of SWA Group.

② 更多有关该项研究的信息
详见SWA集团官方网站。

② For more information
on the study, please
search for "Plaza Life
Revisited" on the official
website of SWA Group.

4 深化设计

机器学习是人工智能的一个分支，它无需人类的特定指令即可通过算法执行任务。经过一系列数据训练，系统就能学会如何识别模式，并在最少干预的情况下实现自动化处理。一直以来，机器学习都与技术领域密切相关。人们日常使用的一系列应用（如虚拟个人助理、垃圾邮件过滤、产品推送和路况预测等），以及自动驾驶汽车等更大型的产品的研发，都离不开机器学习技术的支持。但其在AEC行业中起步相对较晚，因此实际应用较少。

为探索机器学习在景观设计领域的潜力，XL实验室将其应用到建成环境中，以更好地记录和分析空间中的人群分布情况。为此，XL实验室以威廉·H·怀特的《小城市空间的社会生活》中所谈及的场所为对象，专门设计了一项研究，期望在其出版40周年之际重新审视这一具有重要影响的作品^[3]。研究沿用但并未严格依据怀特原有项目的结构模式，同时融入了一些关键性的更新举措，意在一瞥当今公共空间的使用状况，探寻城市社会生活的新模式。以纽约市为例，研究重点关注了10个新近建成的公共或私有场地^②。除运用传统方法外，研究团队还外聘了一位数据科学顾问研发了一套机器学习算法来收集数据。团队收集了每个场地的录像片段作为机器学习的对象，并通过基于图像目标识别与跟踪的算法对录像中的人群空间分布进行识别，同时记录人们的行进轨迹。最终，借助机器学习技术生成的行人热力图可以揭示每个场地内不同区域人流量的大小（图4）。

借助机器学习技术，研究团队不再需要手动将10个场地的用户行为数据制成表格，因此节约了大量时间。尽管分析工作所耗费的大量计算能力降低了该算法处理录像数据的速度（例如，算法大约需要8小

4. 通过机器学习生成的热力图呈现了人们在“高层空间”广场的空间分布情况。

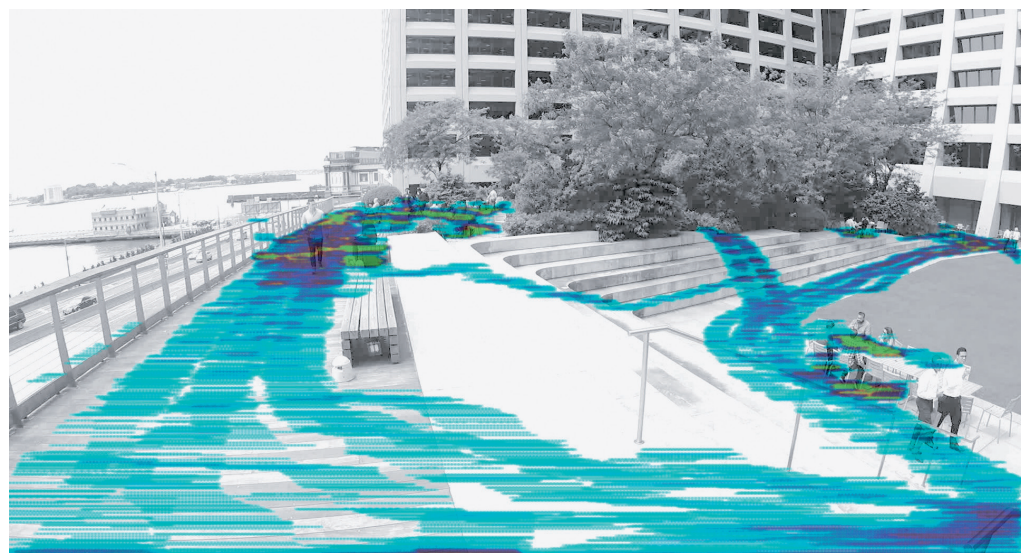
4. Heat map by machine learning showing the spatial distribution of people at Elevated Acre

4 Deep Design

Machine learning is a branch of artificial intelligence that uses algorithms to perform tasks without specific instructions from humans. Once trained with a series of data, the system learns how to identify patterns, creating an automated process with minimal intervention. Up until recently, machine learning has been primarily associated with the tech sector. It is the power behind a range of day-to-day applications such as virtual personal assistants, email filtering, product recommendations, and traffic mapping predictions, and it is also contributing to larger efforts like autonomous vehicles. For the AEC industry, applications in machine learning are scarce, given its relatively recent development.

Intrigued by its potential for the field of landscape architecture, XL Lab used machine learning to better document and understand the spatial distribution of people in built environment. To do this, the team designed a study that revisited the seminal work of William H. Whyte, 40 years after the publication of *The Social Life of Small Urban Spaces*^[3]. Loosely structured around Whyte's original project but with some key updates, the study was intended to identify new patterns of social life in cities by providing glimpses into how public spaces are used today. Using New York City as a laboratory, the study focused on 10 recently constructed publicly and privately owned sites^②. Data was collected both through traditional methodologies and a machine learning algorithm, which was developed with an external data science consultant. For the machine learning component, the team collected video footage of each site, and ran the footage through the algorithm. The algorithm, focused on object detection and tracking, was able to identify people in each space and recorded where they traveled. What ultimately resulted from the machine learning exercise was a series of pedestrian heat maps, indicating areas of low traffic to areas of high traffic within each site (Fig. 4).

In using machine learning for the study, the research team saved time as there was no need to manually tabulate user behavior data from the ten sites. The algorithm, while slow to process the footage given the large amount of computing power necessary for analysis, was able to run on its own, with minimal input from the team. For example, to count and produce a heat map for one hour of video footage, it took the algorithm roughly eight hours of processing. Furthermore, the resolution of the machine



时才能计算并生成一小时视频片段的热力图)，但其优势在于几乎不需要投入人力即可自动运行。此外，机器学习所用数据的分辨率非常高，而由算法生成的总结性图表既便于获取又易于理解。然而，尽管机器学习技术在此项目中发挥了强大功能，仍需专业技术人员来编写和运行软件。同时，算法偏差和普遍存在的隐私保护问题在该项目中也未能避免。

鉴于在隐私保护、高效计算能力和专业编码技术等方面还有较大的提升空间，机器学习在设计领域的发展和应用仍处于初级阶段。未来，如果该项技术能够被更多人接纳并掌握，那么其在景观设计领域的应用前景将不容小觑。例如，机器学习能够帮助设计师预测规划需求、能源消耗、维护需求，以及不同的参数化设计方案等。同时，设计师也能够从繁复的数据分析工作中解放出来，将更多的时间用于真正的设计。

learning data was extremely high and the algorithm produced a very accessible, easy-to-understand summary graphic. At the same time, while the machine learning technology was powerful in this application, it required a very specialized skillset to code and run the software. Also, in developing the project, the team ran into issues with algorithm bias and general privacy concerns.

Machine learning is still very much in nascent stages of development for the design world given concerns regarding privacy, high computing power, and specialized coding skills. In the future, though, if the technology is more widely accepted and accessible, there could be a number of new applications for the field of landscape architecture. For example, machine learning could help predict programming needs, energy usage, maintenance needs, and parametric design options, among others. The technology might also give designers more time to actually design by handling repetitive and data-heavy analytical work.

表1: 无人机、沉浸式环境技术和机器学习在设计领域的应用现状对比
Table 1: Comparison of the current status of UAVs, immersive environment technologies, and machine learning for use in design

技术类型 Technology	构成要素 Components	当前在AEC行业的应用 Current AEC application(s)	所适用的阶段 Phase of work	成本 Level of investment	优势 Strengths	不足 Limitations
无人机系统 Unmanned aerial system	运载工具、操控人员、通信系统 Vehicle, controller, communication system	市场营销和商业宣传 Marketing and promotion	建成后 Post-construction	适中 Medium	成本相对适中、数据采集范围广、视觉效果佳 Relatively affordable, wide data capture, visually impressive	续航能力差、抗风性能差、涉及隐私保护问题 Short battery life, hard to stabilize in wind, privacy concerns
球形全景图 Spherical panorama	可连接智能手机的耳机或计算机 Smartphone-integrated headset or computer	设计交流 Design communication	设计阶段 Design	低 Low	成本适中、沉浸式体验佳、有助于提高现有部分工作的效率 Affordable immersive experience, rendering part of existing workflow	体验效果一般 Limited experiential quality
360度全景视频 360° video	360度相机、可连接智能手机的耳机或计算机 360° camera, smartphone-integrated headset or computer	场地分析 Site analysis	设计准备阶段 Pre-design	低 Low	成本适中 Affordable	体验效果一般、需具备软件编辑技能 Limited experiential quality, software editing skills needed
虚拟现实 VR	可连接计算机的耳机、高性能计算机、手柄 Headset tethered to computer, powerful computer, wands	设计交流 Design communication	设计阶段 Design	适中 Medium	体验效果佳、可移动性强 Impressive experiential quality, able to move around environment	软件技术性要求高、易导致方向迷失、渲染效果不真实、成本高 Technical software, disorienting, unrealistic rendering, expensive
混合现实 MR	耳机、智能手机或平板电脑 Headset, smartphone, or tablet	设计交流 Design communication	设计阶段 Design	高 High	体验效果佳、可虚拟现实与现实之间转换 Impressive experiential quality, able to shift between VR and reality	软件技术性要求高、耳机笨重、成本高 Technical software, heavy / cumbersome headset, expensive
机器学习 Machine learning	摄像机、算法 Video camera, algorithm	数据收集 Data collection	使用后 Post-occupancy	高 High	耗时少、高分辨率/高准确度、输出结果易得 Time-saving, high resolution / accuracy, accessible output	需具备专业编码技能、存在算法偏差、涉及隐私保护问题 Specialized coding experience needed, algorithm bias, privacy concerns

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5 不断扩展的工具箱

应用无人机、沉浸式环境技术和机器学习等新兴技术的门槛正在不断降低（表1）。基于更易操作、穿戴更为舒适的硬件、更为直观的软件和逐渐降低的成本，越来越多的人能够有机会接触并使用这些技术，而技术的普及反过来又将推动实验和创新的进程以及全新应用领域的开拓。

这些工具势必会对AEC行业产生直接影响。面对气候和经济变化所带来的日益严峻的挑战，设计师可借助这些工具找到相应的适应、发展和应对方法。但是，鉴于这些工具最初并非是为设计行业量身定制，我们不能直接将其应用到设计实践中。在针对这些工具的分析研究中，XL实验室进行了缜密的评估，了解了它们的潜在优势和局限性，并试图探明设计师能否与研发人员合作来定制适用于设计工作的工具。我们希望通过“破译”这些来自其他领域的技术，设计师能够更加贴近真实的景观，而非远离它们。**LAF**

致谢

感谢托马斯·贝尔斯利、布莱恩·斯泰尔斯尼克、哈利·莫里森、舍拉·斯特朗和珍·索拉（SWA/Balsley景观设计事务所）；比尔·泰瑟姆（SWA集团）；安雅·多姆莱斯基（SWA集团XL实验室）；丽萨·杜罗歇尔和阿斯塔·辛格（宾夕法尼亚州立大学斯图克曼建筑与景观设计学院）对于本文及文内相关研究所做的贡献。本文所涉及的研究由SWA集团和美国景观设计基金会支持。

5 An Expanding Toolbox

The barriers to entry are being lowered for emerging technologies such as UAVs, immersive environment technologies, and machine learning (Table 1). The hardware is becoming more user-friendly and comfortable, the software is becoming more intuitive, and the technologies are becoming more affordable. As a result, these tools are getting into the hands of more people, a fact that is, in turn, increasing experimentation, innovation, and the development of new applications.

The potential for these tools to directly impact the AEC industry is substantial. In the future, these tools may give designers the ability to more easily adapt, evolve, and address increasing challenges associated with a changing climate and economy. Given the original applications of these tools, though, it is not possible to simply adopt them into practice. In taking an analytical approach to these tools, XL Lab has critically evaluated them, understood their potential strengths and limitations, and tested whether we, as designers, could help shape and tailor the tools for use in our work by collaborating with developers. The hope is that, in trying to “break” these technologies from afield, designers might actually get closer to the landscape rather than being further removed from it. **LAF**

ACKNOWLEDGEMENTS

The author would like to thank Thomas Balsley, Brian Staresnick, Hallie Morrison, Chella Strong, and Jen Saura from SWA / Balsley, Bill Tatham from SWA, Anya Domlesky from XL Lab at SWA, and Lisa DuRussel and Aastha Singh from Stuckeman School of Architecture and Landscape Architecture, Pennsylvania State University, for their input during the research and writing of this article. Studies included in the article were supported by SWA Group and the Landscape Architecture Foundation.

REFERENCES

- [1] Landscape Architecture Foundation. (2019, February 2). Hunter's Point South Waterfront Park Phase I. Landscape Performance Series. Retrieved from <https://www.landscapeperformance.org/case-study-briefs/hunters-point-south>
- [2] Barrett, B. (2016, January 8). Drones Aren't Just Toys Anymore. Wired Magazine. Retrieved from <https://www.wired.com/2016/01/drones-arent-just-toys-anymore/>
- [3] Whyte, W. H. (2001). *The Social Life of Small Urban Spaces*. New York: Project for Public Spaces.