

树的时代

AGE OF THE TREE



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摘要

自人类出现伊始，我们与生态环境——或者更具体地说，与树——之间的联系，一直是关乎人类生存与传统的核心问题。而随着近几个世纪的工业化、城镇化、无序拓张，以及技术的兴起，这种人与树木之间的核心的共生关系已不复存在。一种新的趋势随即形成，许多发达国家，甚至是发展中国家更加重视人类建筑领域中技术和环境的发展，而对大自然每天无偿提供给我们的便利置若罔闻。

面对极端的环境、日益紧张的城市状况和不断削弱的人与自然之间的联系，重新遍植树木是一种最为简单有效且适用于城市的补救途径。

我们正在进入一个新的“树的时代”。在此背景下，我们必须将树视为新兴城市的重要元素之一，重新审视人与树的关系。简而言之，打造一个健康、强健、成熟的林冠体系，应当成为未来所有开发的重点，且绝无例外。我们今日的共同努力必将造福于子孙后代。

关键词

树；城市；城市冠层；森林；自然

ABSTRACT

Throughout the history of human existence, the connection to ecology and — more specifically trees — has been central to human survival and tradition. But over several recent centuries of industrialization, urbanization, sprawl and the rise of technology, this central and symbiotic relationship has been lost. A trend has been established in which much of the developed — and developing — world now places a greater emphasis on the technologies and environment of the built realm and less upon the natural amenities provided to us for free every day.

The single most effective — and urban — remedy for extreme environments, increasingly stressful urban conditions and declining connection between humans and nature is the reemergence of the tree.

We are entering a new “Age of the Tree” where we must reconsider our relationship to the tree, as one of the focal elements in this emerging urban reality. Simply stated, creating a healthy, robust and mature tree canopy must become a critical focal point for all future development — without exception. Our future generations will thank us as they reap tremendous dividends for our collective efforts today.

KEY WORDS

Trees; City; Urban Canopy; Forest; Nature

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1. 树叶中的叶绿体
2. 棉白杨树枝横切面

1. Chloroplasts in a leaf
2. Cross section of a cottonwood tree branch

树的生长奇迹

一棵树的生命源于距其1.5亿千米的地方——太阳。太阳每天都向地球表面输送充足的太阳能，以驱动地球上所有自然现象正常运行。尽管拥有这一不可思议的礼物，人类至今尚未完全了解如何有效利用这种每天都无偿馈赠于我们的能量。但树木早已掌握了利用这些馈赠的方式。

1648年，比利时科学家扬·巴普蒂斯塔·范·海尔蒙特在一个装有90kg干土的种植盆中种下一棵2.2kg重的柳树。此后5年间，除了水之外，他没有向盆中添加任何其他物质；5年后，他发现柳树的重量已达77kg，而盆中土壤重量只减少了56.7g。

他的逻辑推论是：“木材、树皮和树根所增加的74.8kg重量完全来自于水。”^[1]当然，那时他并不知道大气中的元素也助力了树的生长。但无论如何，这次实验都是人类对树的神奇生长奇迹的初次洞悉——这些向四周伸展的美丽形态并非仅仅通过吸收地面中的物质所形成，而是由各种元素与化合物——例如水及来自大气中的CO₂——经过复杂的化学作用而形成。

这一过程的核心在于光合作用。在进行光合作用时，太阳能与由叶片上气孔吸收的CO₂和由根系吸入的水发生反应，即光照触发了叶绿体中的反应，使分子分解并转化为糖和O₂。而后，过量的O₂被释放到大气中，C和H元素则被转化为葡萄糖，并最终转化为纤维素，即组成树皮、树枝和树根的结构单元。

树叶被设计为一种天然的高效能量吸收工具：平而薄的叶面具有很大的比表面积，

可确保叶片吸收能量的效果达到最佳。它们扁平的叶形可以顺应风和雨的走向。大多数植物的叶子都会定期掉落再生长，以替换掉那些被磨损或啃噬的老叶。

我们可以根据树枝构成的美丽形态来辨别树的种类，但这些树枝更重要的作用是向外伸展以最大限度地增加叶片受光面积，通过光合作用增加树木产能及其释放O₂和固碳的能力。

树干不仅能够使树木在各种情况下具有韧性和稳定性，还能在外树皮之下基于一种复杂的、增压的维管系统组织，通过木质部和韧皮部为整株树木输送水、营养物质和纤维素。

树的根系则充当它的锚，由树干根部向地下伸展，形成与地上的冠幅一样的宽度，以尽可能地汲取水和矿物质。每条根的表面均覆盖着数千根根毛，以最大程度地吸收养分和水分。

与现代人类以消费为主的生活方式相

反，生长在我们星球上的三万亿棵树木^[2]只需消耗一小部分的太阳能即可产生O₂、固碳、生长、繁殖^[3]。它们的生长、生产和生存是一项关于效率、进化和美的不可思议的壮举，自然界中的任何故事都无法与之媲美。

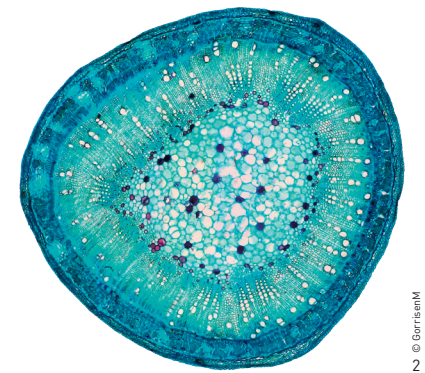
人与树的关系

我们的祖先对树的奇迹有着另一种更为崇敬的理解。树是无数人类群体的人类学文化的重要组成部分，触及其行为标准、价值观和传统的核心。这其中最精髓的部分均含有一个相同的观念——树是应当受到敬重的元素。

北美洲原住民与树有着深厚的联系，树不仅为他们提供日常所需的庇护、食物和导引，更在精神和信仰层面融入他们的生活。他们充分利用大量松树、柳树、山毛榉和板栗树所能提供的所有物料，享受着土地之上的森林所提供的裨益。但同时他们也意识



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到，对于他们来说，对树的保护即意味着自身和后代生命的延续，因而选择以更谨慎的方式来利用这份馈赠，使森林继续成长，以造福后世子孙。

核桃树、松树、山核桃以及其他树种为人们提供各种坚果，以作为全年的食物。由橡果制成的橡果粉是北加利福尼亚州各部落的主食。而纽约州北部的“阿迪朗达克”部落得名于易洛魁语，意为“吃树皮的人”，因为那里的人习惯啃食树皮。但他们一般只剥除外层树皮，以避免树木死亡。

美洲原住民使用的大多数药材，均来源于树叶、树皮或树的其他部位。柳皮茶中含有水杨酸，可用于退烧和缓解疼痛；从种植山毛榉的树坑中收集到的水可用于治疗皮肤炎症，煮熟后的山毛榉叶可制备烧伤膏剂；白松和红侧柏可治疗呼吸系统疾病，而枫糖浆则是可以促进消化的甜食。

树也向人们提供实用材料，如用于制作狩猎弓箭的橡木和用作房屋框架的红侧柏——其因具备耐用性、防虫性及独特气味而备受青睐。剥下的桦树皮可像木瓦一样用于建造屋顶。甚至连树根也被用于编织盛物篮^[4]。

美洲原住民竭其所能地避免伐木，他们更乐于以可持续的方式“采收”树木的不同部分。而当迫不得已要砍伐整株树或一些树枝时，他们会精心准备一场仪式，确保砍伐时心中满含敬重，以示伐木乃出于必要，而非随意为之。

美洲原住民也会通过赋予树某种象征，与其建立强烈的精神联系，如“和平之树”、“神圣的橡树”等。在人类历史长河

中，诸如此类赋予树木以含义特殊的精神身份和象征意义的行为在许多群体中都曾出现过。

其中一个例子，是佛教和印度教对菩提树的尊崇。在印度菩提伽耶的摩珂菩提寺中，屹立着被敬若世界上最富精神内涵的圣菩提树。据说，佛陀本人曾坐在最初的菩提树下静坐冥想七日，直至悟道成佛。人们在那里修建了一座神殿，那里从此成为了世界各地的佛教徒最重要的朝圣地点。尽管最初的那棵菩提树早已枯亡，但据说场地中后续出现的每棵菩提树都由其繁殖而来，包括现在那株繁茂的圣菩提树。事实上，这棵树的树苗还被移植到印度的舍卫城和金奈、斯里兰卡的阿努拉德普勒，以及夏威夷的檀香山，并分别成为了当地的神圣之所。

不同文化背景的人们均通过简单地沉浸于自然环境之中，寻得了启迪、精神疗愈和放松。20世纪80年代，人们创造了一种名为“森林浴（Shinrin-yoku）”的放松方法，其充分利用了位于日本密集都市环境周围的茂密森林。森林浴是指在森林或葱郁的自然环境中散步或徘徊的行为。这种活动背后的理论依据是，通过简单地将自己沉浸于自然，即可缓解压力、修复细胞，并获得许多其他健康功效。这种做法需要完全沉浸于自然，其不断发展演变成为一种趋势，引领着遍及全球的“森林治疗”中步行活动的展开。

人类和树木的繁衍遵循同一套自然法则，即使是在生物学和生理学层面，二者之间也存在着固有的联系。这种联系也成为许多学术研究和文献的主题。中国的《内经图》（又名《内景图》）将人体内部的运作与星座及诸如地球、山脉、河流、树等自然

元素联系起来。当我们观察一张现代医学的支气管造影照片，会发现其清楚地显示出人类血管和支气管系统与树的根系系统的相似性。

在这个星球上，人类是自然的一个组成部分。我们由地球所提供的C、O、H、N、Ca、P等元素组成，同时也依赖它们而生存。我们的食物是由自然生产而成的，我们的肺呼吸着地球大气层中的空气。我们因而存在，而非置身其外。

建造疏离了人与树之间的关系

虽然人类历史只占地球史的极小部分，但人类千百年来的活动对自然造成了与自身存在时间极不相称的巨大影响。栖息地、生态环境、野生动植物均见证了人类的专横手段对自然和树的影响。

在过去的一个世纪里，人类清除了大量的森林以建造居所。而在不那么遥远的过去，人们伐木仅是为了利用砍下的木材在其原位置建造遮蔽结构。但现在，我们已不再遵照一处树群对应一处居所的比例关系来进行建造。新的开发模式清除了森林，代之以钢或玻璃材质的垂直构筑物，和以沥青和混凝土铺就的四通八达的道路。但我们却从未认真尝试如何进行叶绿素生产或固氮来抵消这些足迹。森林砍伐已成为造成温室效应加剧的第二大人为因素，由此所导致的温室气体排放量占总排放量的6%~17%。^[5]我们让地球陷入了失衡。

建筑技术的进步使我们免受极端自然环境的损害，为我们提供极度舒适的住所，并

3. 菩提伽耶摩诃菩提寺中的圣菩提树，据说佛陀本人曾在该树下悟道成佛

3. The Sacred Peepul Tree at the Mahabodhi Temple in Bodh Gaya, under which Buddha was said to have reached enlightenment

使我们能够建得更高、更轻便、更高效。这些进步大大提高了我们日常生活的舒适度，也使我们忽视了自然环境无偿提供的恩惠，转而过分偏爱建筑材料和工程解决方案。可最终，我们无法通过工程技术塑造出一个与地球相平衡的弹性未来。我们需要重新调整人与自然的关系，以实现更高层次的可持续发展。

在寻求将树和植被引入城市的实践中，我们的设计方案往往不能使这些自然元素生长成熟并发挥其全部的生物潜力。无论是土量过少或填土种类不当的树坑，还是无支撑的路面铺装体系造成的土壤紧实，亦或是糟糕的树种选择——许多城市中的树木都未能得到足够的机会去生存和茁壮成长。城市行道树的平均寿命为7~20年，仅仅占最佳生长



条件下的树木预期寿命中的很小一段。凭借更多的思考和精益的设计，我们可以保障对城市树种的投入能够使其生长成熟，并确保我们的后代能够享受到它们带来的益处。

我们的城市环境为了满足快速交通和信息传播的需求，变得高压且极端，我们失去了与鸟类的联系，失去了藏身于大树冠之下的舒适，也失去了在漫长的午间漫步时享受到的和煦阳光。逾百项研究表明，在绿地中亲近自然远比置身没有树木和植被的都市更有助于减轻压力。^[6]我们的心理健康将取决于我们正在为自己打造的环境，是时候去为我们在城市中生理和心理的双重舒适而设计了！

重新校准这些现时的问题尚在我们的能力范畴之内。事实上，仅需一代人的时间，我们的城市就可能变得与我们今日所感完全不同。尽管许多技术进步导致我们忽视了自然的馈赠，但我们的设计能力（包括材料科学的进步）也使我们能够运用新的、激动人心的（也或许是必要的）方式将自然融入我们的生活。

前路——重新确立树在都市社会中的重要地位

如今，我们必须换一种方式来利用树的馈赠。在一个愈发都市化的世界中，树提供遮蔽和食物的功能不再那么重要，新兴科学正在试图进一步架高林冠，建造垂直森林，并将其作为最有效的单体元素，用于缓解城市热岛效应，加强雨水的调蓄和滞留，舒缓压力并改善人体舒适度，提高社区认同感及地产价值，同时为野生动植物营造栖息地。

如果我们认同人类能够并且应该优先考虑将城市森林作为城市区域更为重要的组成元素，那么以下几条建议将改变我们对城市的描述，葱郁、绿色、生机勃勃的城市环境将无处不在。

在城市森林中种植多样化的树种

大自然既是美的创造者，也是无情的破坏者——这一点在上世纪就已被屡屡见证。在疾病、虫害或天气变化等极端条件下，所有树种都易受到影响。单一栽培作物或由单一树种组成的植物群落则更加容易遭到破坏。

康涅狄格州的纽黑文市设立于1638年，是美国第一批在城市规划背景下建造的城市，随后也创建了全美首个公共植树项目。由于城市中种植的绝大多数树木为美国榆（*Ulmus americana*），纽黑文也被称为“榆树城”。20世纪20年代，来自荷兰的木材运输船将携带着榆树枯萎病致病真菌的榆树皮甲虫带到了纽约，迅速引发了对美国东北部乃至中西部榆树的大肆破坏，其覆盖范围从纽约蔓延至新英格兰、底特律、芝加哥乃至更远的区域。而在纽黑兰，真菌更是无缝传播，轻而易举地摧毁了一度被成熟的美国榆覆盖的整条街道、整座公园和社区。截至1990年，这场“荷兰榆病”摧毁了美国大约75%的美国榆，其中底特律、芝加哥和其他主要城市的美国榆树群落惨遭灭绝，死亡树木总数达6 000万棵^[7]。

而今，美国又遭到白蜡窄吉丁虫的侵袭，这场灾害逐渐席卷了东北部和中西部地区，已造成大约6 000万棵白蜡树死亡，是美

国近一个世纪以来第二次大规模单一树种受害的瘟疫，且已成为美国现代历史上对树木影响最大的瘟疫。

要确保我们未来对“城市树冠”的投资不至于演变为又一场灾难性事件，最好的方法是构建具有高耐性和精心设计的物种多样性的新型城市森林。沿街道、公园和整个社区种植多种形状、规格、习性和美学特质相似的树种，将确保我们的城区既美丽又富有弹性，让子孙后代能够享受其中。但这并不意味着每条街道都应该像一座植物园或拥有不同树木的“大杂烩”。每条街道都可以包含具有相似习性和树冠特征的树种，同时通过不同季节的美学特征、树皮纹理、分枝结构，以及多样的昆虫、鸟类及动物栖息地类型来增添趣味性。我们很少在自然界中观察到单一作物在一片土地上长期延续，又如何能指望其在城市街道和开放空间中生生不息？

将树作为城市（绿色）基础设施

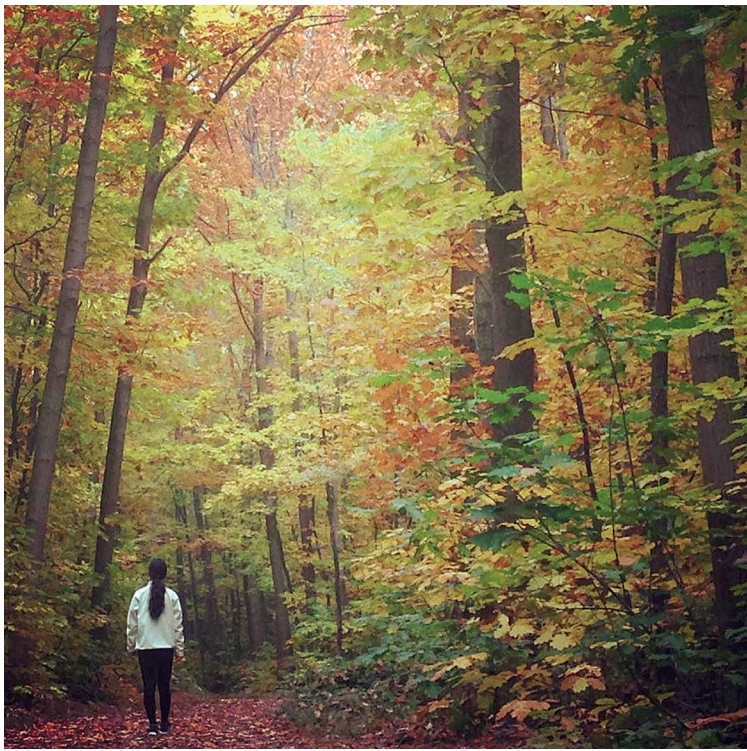
让我们回想一下，在过去十年里，日趋严格的雨洪法规对新项目和新社区的设计、材料选择和营销产生了哪些影响。各大城市通过颁布条例强调绿色基础设施的优先性，以实现水源保护、回用、持留和下渗回含水层。这些条例迫使人们在每个新建项目的开发、设计和工程建造过程中都要探索创新性的解决方案。如今我们也已取得了显著的成果：雨水成为了各大开发项目的焦点，水不仅是项目形式的决定因素，也是重要的绩效指标；水资源的有效利用逐渐成为开发商用于开拓市场的优势，且所有公建项目都已对其有明文要求。

试想，假如我们的城市和社区开发更进一步，采用更为严格的设计规范以要求更高的树木覆盖率，从而可以减缓雨水下渗，提供怡人的绿化视野，并全天有效调节周围环境的温度。例如，如果一座城市60%的土地被建筑覆盖，却需要至少50%的绿化率，这将带来多少设计机会。如此一来，人们将转变对场地中树的看法——它们不再是项目收尾时的附加点缀物，而是自设计初始就至关重要的景观基础设施系统中的一部分。

毫无疑问，绿树成荫的场地和空中花园将会陆续涌现，对场地高品质原生树木的保护将被每个项目纳入考量。也许我们还将看到更为创新的方法将树木应用于建筑，比如由斯蒂法诺·博埃里设计并于2014年落成的米兰“垂直森林”大厦^[8]。我们可以设想，在未来几年内，森林建筑和森林城市街区将成为新常态，将我们的城市从由钢和玻璃等人造材料主导的空间完全转变为合金与纤维素和谐共存的美丽城区。设计垂直城市森林的专业人员将取代高楼擦窗工，成为城市中常见的身影。统一设计的建筑群可以营造微气候和适应季候特征的植物群落，并为特定的野生动植物打造栖息地。所有人都能欣赏到这样的景观，而非像原来的社区公园一样，只能被所属的高价房产所独享。而也许最重要的是，我们的建筑表皮将持续不断地净化空气、固碳和吸收热量。

收集数据以推进城市冠层计划及建立搜索引擎

城市规范和开发标准的制定标志着转型过程的启动，而数据和详细规划的成果则能够激励对于城市冠层的政府投资和市民管理。



4. © Sarah Hareidson

近日，纽约市实施了一项前所未有的城市森林数据收集计划，名为“TreesCount!”。

2015年，该项目共召集了2 300名当地志愿者，记录了逾684 038棵城市树木的信息，涵盖215个种类。每棵树的物种、规格、健康状况、位置和特征均被记录在交互式在线数据库中，且各有一个ID号码。通过数据解析，可以得到显示每棵树在应对雨洪、太阳曝晒和去除污染物等方面效益的一系列参数。TreesCount!为每棵记录在册的树标定“生态价值”（以美元计）。整体效益可以根据各

4. 在德国波恩市附近的克顿福斯特大森林中进行森林浴

4. Forest bathing in the Kottenforst, a large forest adjacent to the German city of Bonn

① 请登录<https://tree-map.nycgovparks.org/> 了解关于纽约城市街道树种地图的更多信息。

个独立区域的树种、规格及其产生的效益而细分。^①基于对附近的大冠层树种的规格、间距、品种和健康状况等的分析，可以更为详细地了解某地块的房地产增值潜力。

在线数据库对公众开放，可方便市民们对整个城市范围内的树木信息进行交互式搜索，上报单株树出现的问题，查看养护报告，在自己的社区内认领喜爱的树或是加入树木养护团体，从而了解更多关于这些树种的情况，并在第一时间知晓问题所在。

最终，TreesCount!及其他类似工具可提高人们对城市冠层的环境价值的认识，引导我们成为城市森林的“管家”，并调动数百万当地行动者共同努力，以减缓全球变暖及其对气候变化的负面影响。

项目伊始即与专家展开合作

树的生长依赖于由空气、水和土壤共同组成的适宜环境。因此，我们为城市树种创造的地下自然条件与地上可见的条件同等甚至更为重要。景观设计师、苗圃专业人员、树艺师、土壤学家，以及当地的其他专家，应在每个项目伊始即参与到协同设计工作中，以确保我们最初的投入可以转化为成熟而繁茂的城市冠层。

在设计建成区域的地下环境时，为了确保其在高度建成环境下茁壮生长，需将协同研究中的以下几个方面纳入考量：

- 树木长成时，其规格将达到多少？
- 树木长成所需的最低土量是多少？
- 在树木所处特定位置何种土壤（成分）最利于其生长？
- 哪些方法能够避免人行道和广场所在

区域下方的土壤板结？

- 如何确保水被根系吸收？
- 基础设施将建在哪里，这些系统如何与树共存？

备有这些问题的答案，设计人员将可以确定如何帮助树木在城市环境中蓬勃生长，并带来有竞争力的经济效益和生活质量。随着开发前期对树木投资的增加，投资者们也将获得更加丰厚的回报。也许，到了那个时候，城市林冠体系这一通常被用在项目最后的装点因素，也将成为每个城市项目中的首要考量因素。

以树为中心的未来城市

上述建议为我们打造更适宜当下条件且顺应自然的城市环境提出了现实的、可实施的策略。然而，为了实现这些策略，我们必须反问自己：作为人——无论在生物或心理层面均与自然不可分割的人类——我们究竟想要居住在什么样的环境里？我们对当前世界中高度活跃的城市是否满意和拥护？亦或是，我们是否还想要更好的，与自然环境更加平衡的世界——一个更环保、更繁茂、充满各种生命的世界？

想象一下，当你正行走在城市中的某条街道，汽车从身旁呼啸而过，喇叭声不绝于耳；高音广播播报高架列车靠站；城市公交车尖刺的刹车声和远处手提电钻钻入水泥的巨大声响混作一片，而施工人员只能以更大的音量互相喊话；当你经过快餐店时，店外的排气口正把浓重的油烟吐泄到人行道上。这些都是世界各地的城市每天上演的场景，

数以百万计的我们时常扮演旁观者，甚或参与其中。我们的环境正诱导人们戴上耳机、低头行走，并逐渐与社会隔离。

现在让我们退后一步，想象同样的环境，但加上额外的一层，它由整齐排列于每一条街道的成熟壮观的树冠组成。树干间的节奏打破了网格化路网的单调延伸，不仅提供即时的视觉效果，同时将行人与喧闹的机动车隔离。树冠吸收了大部分通常回荡在城市街道的声音。微风拂来，空气中飘散着树叶、树芽和树皮的新鲜气味，嘤嘤鸟鸣更是此起彼伏。昆虫在眼前来去自如，让头顶的空间瞬时生机盎然，召唤行人摘掉耳机，吸引他们用所有的感官来感受周边的环境和他人。

而使我们沉浸其中、组成这新的城市禅意的每一棵树，正在为城市提供多项无价的服务：吸收和减缓流向超负荷的雨洪基础设施的雨水；提供荫蔽，让行人感觉更加凉爽；降低建筑能耗；最大限度地减少城市热岛效应；在最需要的地方过滤掉碳元素并释放O₂，以净化空气；为我们所有的城市、城镇和社区提供鲜活、自由呼吸的基础设施。如果我们能够重新将树视为我们日常生活、精神世界和基本生存中不可或缺的一部分，如上所述的环境完全可能成为现实，并无处不在。

“最佳的种树时机是20年前，而次佳的时机则是现在。”

——非洲谚语^[9]

树的时代已然来临。**LAF**

The Productive Splendor of the Tree

The life of a tree begins 93 million miles from the place where it eventually grows, at the Sun. Each day, the sun powers the entirety of natural phenomena on our planet by delivering an abundance of solar energy to the earth's surface. Despite this incredible gift, humans have yet to fully understand how to efficiently use the endowment of energy delivered to us, for free, every day. But trees have known how to use this energy.

In 1648, the Belgian scientist Jan Baptista van Helmont planted a five-pound willow in a pot containing 200 pounds of dry soil. Over a five-year period, he added nothing to the pot with the exception of water and after five years, he weighed the willow again, finding it now weighed 169 pounds while the soil weighed only two ounces less.

His logical conclusion was “164 pounds of wood, bark and roots arose out of water only.”^[1] Of course, he was not aware that elements in the atmosphere were also contributing to the growth of the tree. This experiment was, however, the first insight into the incredible productive splendor of the tree, that the beautiful forms that grow all around us do not grow only by absorbing material from the ground. Rather they are generated through complex chemical processes utilizing elements and compounds such as water and carbon dioxide that fall from the sky.

At the heart of this story is the process of photosynthesis. During photosynthesis, sunlight energy reacts with carbon dioxide taken in through the stomata of the leaves and water brought in through the roots, triggering a reaction in the chloroplasts that disassembles the molecules, converting them into sugars and oxygen. The excess oxygen is then released into the atmosphere while carbon and hydrogen are transformed into glucose, and eventually cellulose, the building blocks that become the bark, branches and roots of the tree.

The leaves of a tree are naturally engineered to be incredibly efficient energy absorption tools: flat and thin, with a high surface to mass ratio which ensures that the ratio of energy potential to the mass of the leaf is optimal. Their flat profile yields to wind and rain and most plants replace their leaves periodically as the old ones become damaged or eaten.

The beautiful branching gives a tree its distinguished form, but is primarily a tool to reach out wide to maximize the exposure of leaves to the sun and increase the potential of the tree to produce energy, release oxygen and sequester carbon through photosynthesis.

The trunk provides strength and stability in all conditions yet, beneath the outer bark, employs a complex, pressurized vascular system of tissues that moves water, nutrients and cellulose



5. 《内经图》，以中国画的形式呈现出人体内的景观脉络
6. 1976-2016年的40年间，珠江三角洲经历的城镇化过程
7. 改革大道，一条由各类树木的树冠覆盖的墨西哥城主干道。

5. The *Neijing Tu*, a Chinese illustration of the inner landscape of the human body
6. The urbanization of the Pearl River Delta over 40 years, between 1976 and 2016
7. El Paseo de la Reforma, a major avenue in Mexico City with a diverse tree canopy.



throughout the entire tree via the xylem and the phloem.

The roots of the tree serve as its anchor, spreading underground from the trunk as wide as the canopy above to grab as much water and minerals as possible. Each root is covered with thousands of root hairs to maximize the absorptive surface area.

As opposed to the consumption based lifestyle of modern humans, the three-trillion trees growing on our planet^[2] consume only a fraction of the sun's energy to produce oxygen, sequester carbon, grow in stature and reproduce^[3]. Their growth, production and survival is an incredible feat of efficiency, evolution and beauty that rivals any story contained in nature.

Human Relationships with Trees

Our ancestors understood the splendor of the tree in a different, more reverential way. The tree was an integral part of the anthropology of countless groups, central to their norms, values and traditions. The best of these have all shared one common notion: the tree as an element to be respected.

The Native Americans of North America enjoyed a deep connection with the trees, depending on them for shelter, nourishment, navigation, spirituality and many facets of everyday life. To be clear, they enjoyed an advantageous relationship with the forests of their lands, utilizing all that the vast stands of

Pine, Willow, Beech and Chestnut had to offer. However, they recognized that for them, the preservation of the trees meant life and therefore utilized the gifts in a sensitive way enabling them to grow on as a gift to future generations.

Walnut, Pine, Pecan and others provided year-round nourishment in the form of their nuts. Flour made from the acorns of Oaks was a staple for the tribes of Northern California. In upstate New York, the “Adirondack” tribe derived its name from the Iroquois word for “bark eaters” due to their habit for consuming Pine bark, which they did by stripping the bark so as not to kill the tree.

Most medicinal remedies of Native Americans were derived from the leaves, bark and other parts of the tree. Willow Bark Tea contained salicylic acid and was used to bring down fever and relieve pain. Water collected in the hollows of the Beech Tree was used to treat skin problems and its boiled leaves were used to make a salve for burns. White pine and Red Cedar was used for respiratory ailments and Maple Syrup was a sweet offering for digestive troubles.

Practical elements also came from the trees, such as Oak bows for hunting and Red Cedar frames for houses, favored because of its durability, resistance to insects and unique smell. Tree bark was stripped from Birch trees and used like shingles for roofing. Even the tree roots were used to weave basket for carrying objects.^[4]

At all costs, the Native Americans avoided cutting down trees, preferring to harvest different parts of the tree in sustainable ways. When they did cut down trees or branches, elaborate rituals were performed to ensure that the practice of felling trees was done respectfully, out of necessity and not haphazardly.

Native Americans also enjoyed a strong spiritual connection to the trees bestowing identity to them such as “The Tree of Peace” and “The Sacred Oak” amongst many others. This assignment of spiritual identity and symbolism to trees of special significance has been shared by many groups throughout the history of human existence.

One such example is the honor paid to the Peepul Tree (*Ficus religiosa*) in the Buddhist and Hindu religions. At the Mahabodhi Temple in Bodh Gaya, India sits what is likely the most spiritually recognized tree in the world, the Sacred Peepul Tree. It is said that Buddha seated himself beneath the original Peepul Tree growing at the site and meditated for seven days without moving until he had attained perfect enlightenment. Afterwards, a shrine was constructed there and has since been the most important pilgrimage site for Buddhists worldwide. Though the original tree has long since died, each successive tree at the site is said to be propagated from the original, including the magnificent specimen growing there today. In fact, saplings of the Sacred Peepul Tree have

been transported and planted in Sravasti and Chennai in India; Anuradhapura, Sri Lanka and Honolulu, Hawaii. All have become sacred sites in their own right.

People of all cultures have also found enlightenment, spiritual healing and relaxation by the act of simply engulfing themselves in natural settings. In the 1980s, Shinrin-yoku, a relaxation technique was developed to take advantage of the lush forests located near the dense urban environments of Japan. Shinrin-yoku, translated to “forest bathing,” is the act of walking or lingering in the forest or lush natural environments. The thought behind this practice is that by simply engulfing oneself in nature, stress recovery, cell recovery and many other health benefits are obtained. The practice requires complete immersion and has evolved such guides that are now leading participants on “Forest Therapy” walks throughout the globe.

Created by the same laws governing nature, the connection between humans and the trees is inherent even in our biology and physiology. This has been the subject of much scholarly study and documentation. The *Neijing Tu* or “*Chart of the Inner Warp*” is a Chinese depiction associating the inner workings of the human body with the constellations and natural elements of our planet, mountains, rivers — and trees. Or consider a modern medical Bronchogram, which clearly demonstrates the likeness the human



8. “荷兰榆病”发生前后的厄巴纳市伊利诺伊大学的步行大道

8. The University of Illinois broadwalk in Urbana before and after the onset of Dutch Elm Disease

vascular and bronchial system shares with the root system of a tree.

As humans on this planet, we are an integral part of nature. We are made up of and rely on the elements given to us by the earth: carbon, oxygen, hydrogen, nitrogen, calcium and phosphorus. Our food is generated by its natural processes, our lungs breath the air of its atmosphere. We exist because of it, not outside of it.

Building Away from Trees

Yet, human activity has over the centuries and millennia created a disproportionately large effect on nature when considering that we occupy only a small part of this cycle. Habitat, ecologies and wildlife have all seen the impacts of our domineering approach to nature, and to the trees.

Over the past century, humans have cleared massive tracts of forests to build settlements. Whereas in the not so distant past the trees cut down were used to build shelter in their place, we are no longer building with this 1:1 relationship in mind. Our new development patterns clear forests and replace them with vertical structures of steel and glass, and connective passageways of asphalt and concrete, without any serious effort to replace the footprint of chlorophyll production or carbon sequestration. Deforestation is the second largest human-caused source of carbon dioxide to the atmosphere, ranging between 6

percent and 17 percent of annual global greenhouse gas emissions.^[5] We have thrown the planet’s equilibrium into a tailspin.

Advancements in building technologies have insulated us from natural extremes, providing incredibly comfortable dwellings and allowing us to build taller, lighter and more efficiently. While these advancements have drastically improved our everyday comfort, we have also begun to favor built materials and engineered solutions over the free benefits that our natural environment provides. Ultimately, we cannot engineer ourselves into a resilient future in balance with the planet. We are in need of a realignment with nature to achieve the next level of sustainability.

Where we have sought to incorporate trees and vegetation into our cities, we have often provided solutions that do not allow these natural elements to reach maturity and perform to their biological potentials. Whether it be providing tree pits with too little or inappropriate soil, allowing soil compaction beneath unsupported pavement systems or simply selecting the wrong tree, many urban trees have not been given a sporting chance to survive, and thrive. The average life of an urban street tree is somewhere between seven and twenty years, a mere fraction of the life expectancy of one planted in optimal conditions. With a bit more thought, and design savvy, we can ensure that the investments made in urban trees are able

to grow to maturity, ensuring that the next generations will enjoy the benefits.

Our urban environments have also become high-stress and extreme places focused on rapid transportation and information on-demand. We have lost the connection to the birds, to the comfort of a large tree canopy billowing overhead, to the warmth of the sunshine on a long mid-day stroll. Over 100 studies have shown that stress reduction benefits are achieved by spending time in green areas, as opposed to urban areas that do not contain trees and vegetation.^[6] Our mental health depends on the environments we are now creating for ourselves. It is time for us to design for both physical and psychological comfort in the city.

A recalibration of these present-day issues is not beyond our current abilities. In fact, in just one generation our cities will be completely different than the way experience them today. For although many of our technological advancements have contributed to our straying from the gifts of nature, our design capabilities, including advancements in material science, also allow us to integrate nature into our lives in new, exciting and one could argue vital ways.

The Way Forward — Re-prioritizing Trees in Urban Societies

We must now utilize the gifts of trees in different ways. In an increasingly urbanized world, they have become less

critical for shelter and nourishment. Emerging science is elevating large canopy trees and vertical forests as the single most successful element that cities can incorporate to relieve urban heat island effect, enhance stormwater retention and delay, recover stress and enhance human comfort, while improving neighborhood identity, property value and habitat for wildlife.

If we agree that humans can, and should prioritize the urban forest as a more prominent element in urban places, below are several suggestions to begin shifting the narrative toward lush, green and living city environments everywhere.

Plant Diverse Urban Forests

As we have witnessed countless times over the last century, mother nature is both a beautiful creator, and a merciless destructor. Whether it be disease, pests or changes in weather, all species of trees are susceptible under these extreme circumstances. Monocultures, or plant communities made up of the same species of tree, are particularly susceptible to destruction.

Founded in 1638, New Haven, Connecticut was incorporated as one of the first city plans in America and subsequently created the first public tree planting program in the country. Planting an overwhelming majority of American Elms (*Ulmus americana*), the town earned the nickname of “The Elm City.” Until the 1920s, the Elm Bark Beetle, carrying the fungal agent *Ophiostoma*

ulmi, was transported to New York via lumber shipments from the Netherlands. Quickly it began wreaking havoc on the Elm Trees planted throughout the Northeastern and Midwestern United States, spreading from New York to New England, Detroit, Chicago and beyond. In New Haven, the fungus was able to spread seamlessly, destroying entire streets, parks and neighborhoods once full of mature American Elms. By 1990, Dutch Elm Disease had destroyed approximately 75% of the American Elm Trees in the US, devastating entire districts of Detroit, Chicago and other major cities and killing close to 60 million trees^[7].

Currently, the United States is again under siege. The Emerald Ash Borer is gradually spreading throughout the Northeast and Midwest and has killed approximately 60 million Ash Trees in its wake. This second plague in one century has decimated another American monoculture and is now the largest pestilence to affect American trees in modern history.

The best way to ensure that our future investments in the urban canopy do not fall to catastrophic events is to plant hardy new urban forests with a calculated diversity. Incorporating several species of trees of similar form, scale, habit and aesthetic qualities along streets, in parks and throughout neighborhoods will ensure that our urban areas are both beautiful and resilient, allowing future generations

to enjoy them. This does not mean that every street should be an arboretum, or a mishmash of dissimilar trees, rather each street can both incorporate trees of a similar habit and canopy, that also add interest via varied seasonal aesthetics, bark texture, branching structure and insect, bird and animal habitat possibilities. Rarely do we see monocultures exist in nature for long periods of time, why should we expect our urban streets and open spaces to behave differently?

Classify Trees as Urban (Green) Infrastructure

Consider for a moment the impact that more stringent stormwater regulations have had on the design, materials and marketing perception of

9. 由斯蒂法诺·博埃里设计的米兰“垂直森林”大厦是迄今为止最成功的垂直森林建筑。
9. The Bosco Verticale by Stefano Boeri is the most successful vertical forest built to date.

① Please visit <https://tree-map.nycgovparks.org/> to learn more information about the New York City Street Tree Map.



new projects and communities over the past ten years. Regulations that prioritize green infrastructure to conserve, re-use, hold and return water to the aquifers have been established in major cities, forcing the development, design and engineering communities to incorporate innovative solutions into every project. The results have been substantial. Stormwater is now a focal point of every major development project and water is often a defining element in the form and performance metrics of projects. Water efficiency is being used to create market advantages for developers and being required for all public buildings.

Imagine if cities and the development community took this next step, committing to more stringent design codes that required a high percentage of tree cover on-site or on-building to slow water infiltration, provide vegetated views for all and reduce ambient temperatures throughout the 24-hour day. For instance, imagine the design opportunities that would be created if a city required 50% tree canopy coverage on sites where 60% building coverage is allowed. Immediately, the attitude towards trees on the site would shift, from being a tacked-on item that finishes off a project to an integral landscape infrastructure system conceived as part of the design genesis.

It is not out of the question that we would begin to see heavily treed sites, treed terraces in the sky and the preservation of existing quality trees

as part of every project. Perhaps we would begin to see more creative ways of using trees in architecture, such as Milan’s Bosco Verticale by Stefano Boeri, completed in 2014^[8]. Within years, we could conceive that forested buildings and urban blocks would become the new normal, completely transforming our cities from spaces dominated by man-made materials like steel and glass to places where a harmony between the strength of alloy and cellulose forms a beautiful urban realm. Vertical urban forestry professionals would take the place of window washers. Groups of buildings designed in concert would create microclimates and synergistic plant communities of seasonal interest and specific wildlife habitats. Views of the landscape would be available to all, not just for those high-priced units across from the parks. And perhaps most importantly of all, the surfaces of our buildings would continuously clean the air, sequester carbon and absorb heat.

Gather Data to Inform Urban Canopy Plans and Dashboards

While city codes and development standards can begin the process of transformation, data and detailed planning efforts must galvanize the commitment of a city and its citizens to the stewardship of the urban canopy.

Recently, New York City has undertaken an incredible urban forest data collection program, called TreesCount!. In 2015, the program

assembled 2,300 local volunteers to document over 684,038 individual city trees consisting of 215 species. The species, size, health, location and attributes of each individual tree were then loaded into an interactive online database and assigned a unique ID number. By interpreting this data, a series of values were then assigned for each tree’s impacts on stormwater, solar exposure and pollutant removal. TreesCount! has assigned an “Ecological Value,” in dollars, to each tree documented. Overall benefits are also broken down by species, size and benefits achieved in individual boroughs.^① Further analysis may also lead to a more informed understanding of potential increases to real estate values based upon the size, spacing, species and health of large, proximally located canopy trees.

The online database is accessible to the public, allowing citizens to search interactively throughout the city, report problems with individual trees, view maintenance reports and assign favorite trees or tree care groups in their own neighborhoods to learn more about them or be notified when issues arise.

Eventually, TreesCount! and other tools like it can bring a deeper awareness to the environmental value of the urban canopy, allowing us all to become stewards of the city forest and mobilizing millions of local actors in the effort to curtail global warming and its negative impacts on climate change.

Collaborate with the Experts at Project Inception

Trees' growth is dependent on the right combination of air, water and soil. Therefore, the conditions that we create for urban trees beneath the surface are just as important, if not more so, as those visible above ground. Landscape architects, nursery professionals, arborists, soil scientists and other experts specific to the region should partake in a collaborative design exercise at the inception of every project to ensure that our initial investments result in mature and lush urban canopies.

As part of this collaborative investigation, several aspects must be accounted for when designing the below ground environment of built up areas:

- How large will the tree be when it reaches maturity?
- How much soil volume is necessary for the tree to reach maturity?
- What type (composition) of soil is optimal for the tree in its specific location?
- What methods can prevent soil compaction from sidewalks and plazas above?
- How does water reach the trees roots?
- Where will infrastructure be located and how can these systems co-exist with the trees?

Armed with these answers, design professionals can identify the methods needed to help trees thrive and make powerful economic and quality of life

arguments to advocate for increased investment up front that will pay off down the road. Perhaps then the urban canopy, that which is often the last element considered, will become a primary consideration and formative element of every project in the city.

The Tree-centric Cities of the Future

The aforementioned suggestions identify realistic and attainable strategies that can help to bring our urban places more in line with a nature that suits our present condition. However, all of these strategies are predicated on some very important questions that we must each ask of ourselves: What kind of environment do we as humans — biologically and psychologically inseparable from nature — want to inhabit? Are we satisfied and encouraged with the current hyper-active cities of this world? Or do we find ourselves wishing for more, a world more in balance with our environment — something greener, more lush and full of life of all varieties?

Imagine for a moment that you are walking down a city street. Hear the cars whizz by, the horns honking intermittently, a loudspeaker announces that the elevated train has reached a stop, the brakes of a city bus squeal and somewhere in the distance a jackhammer pounds away at the concrete, with operators shouting instructions at each other. The exhaust vent from a fast-food

restaurant spews deep fried smells out to the sidewalk as you pass by. These are the scenes that play out every day in the cities of the world, with millions of us playing the part of bystanders and often, participants. It is an environment that beckons for headphones, head-down walking and social isolation.

Now step back and imagine the same environment, but with an additional layer. A layer of mature and stately canopy trees lining each street in the city. The rhythm of the trucks breaking the monotonous stretches of gridded roadway, providing immediate visual interest while separating pedestrians from the whirring automobiles. The canopies of the trees absorbing much of the sound that normally echoes in the the urban street. When the wind billows, it wafts the fresh scent of leaves, buds and bark. The sound of birds singing and chirping is ever-present. Insects flutter in and out of view, activating the space immediately overhead and beckoning pedestrians to remove their headsets, engage all of their senses and interact with their environment, and other people, as they move through the city.

Every single tree that engulfs us to create this new urban zen is performing multiple invaluable services for the city: capturing and slowing water bound for an overburdened stormwater infrastructure; providing shade to keep us cool; reducing building energy costs and minimizing urban heat island effect;

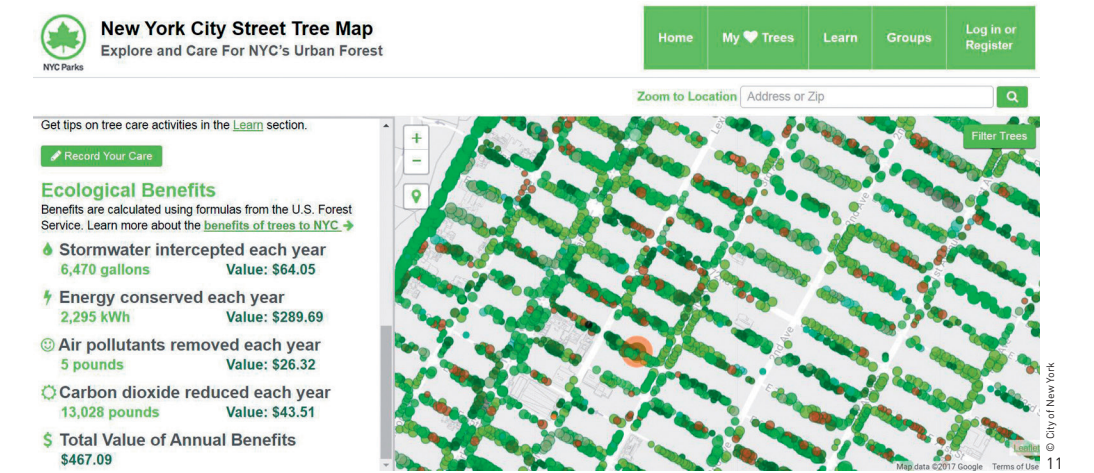
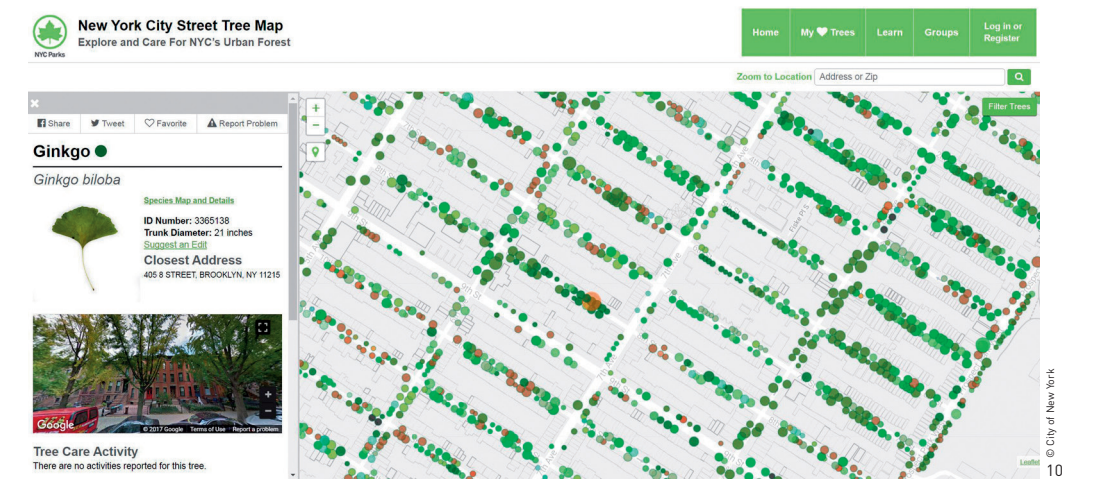
filtering in carbon and releasing oxygen to clean the air in the places it is needed the most; providing living and breathing infrastructure for all our cities, towns and communities. This is an environment that is completely possible everywhere, if we once again prioritize our relationship with trees as an inseparable part of our lives, our minds and our survival.

“The best time to plant a tree was 20 years ago. The second best time is now.”
— African Proverb^[9]

The Age of the Trees is now. **LAF**

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10. “纽约城市街道树木地图”是一个记录了全纽约城逾68万棵行道树信息的复杂数据库。
11. 地图根据每棵树的规格、物种和位置，分别为它们标定“生态价值”。

10. The New York City Street Tree Map, a comprehensive database of over 680,000 street trees throughout New York City.
11. The map assigns an ecological value to each tree in the city based upon size, species and location.