

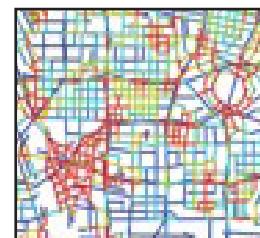
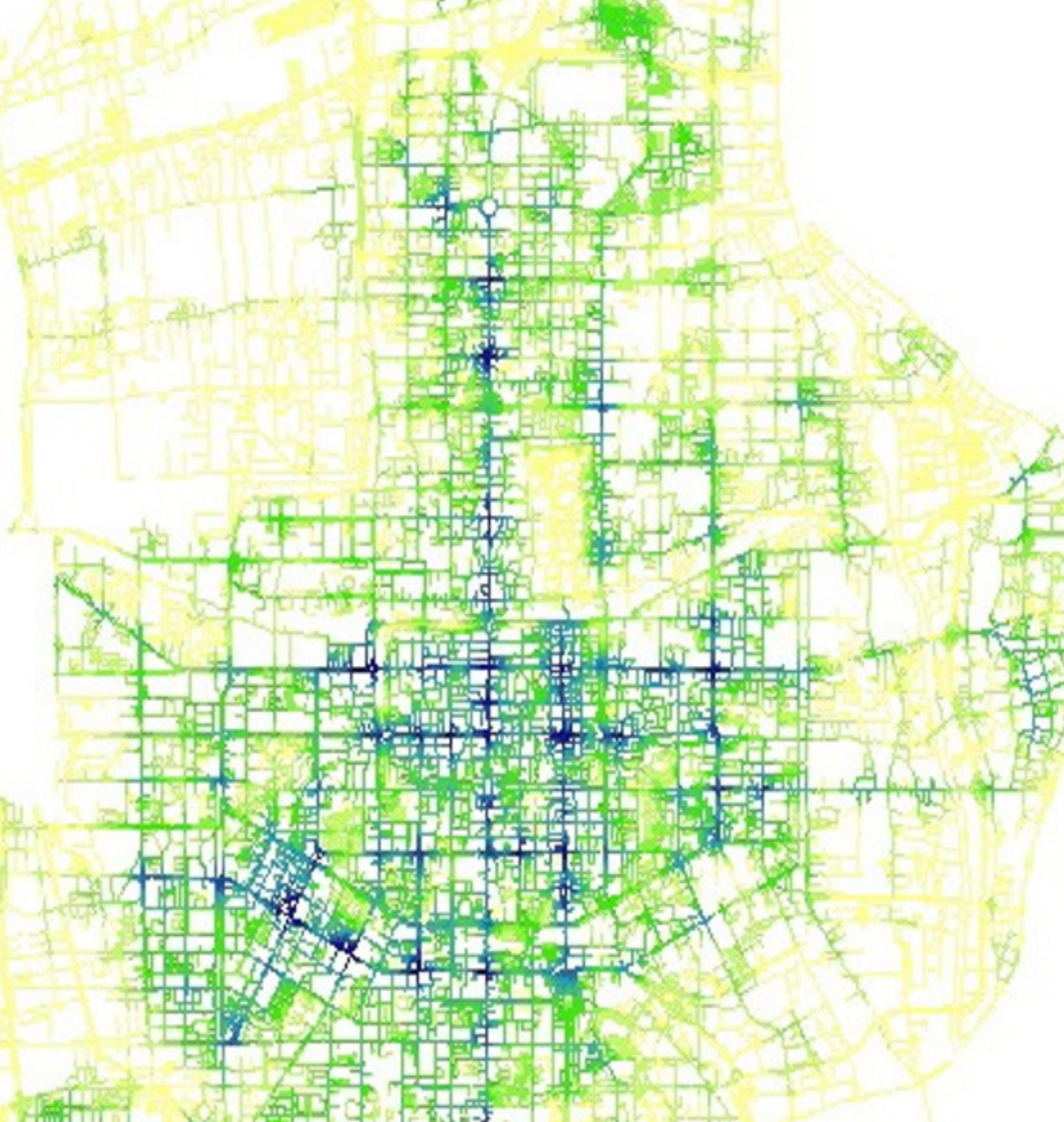
XU PEI | TONGJI UNIVERSITY | MASTER'S DEGREE
ARCHITECTURE AND URBAN DESIGN PORTFOLIO

SMART CITIES

DATA-INFORMED URBAN DESIGN

part 1 Big Data Analysis Aided Urban Design Practice
大数据分析辅助城市设计的实践

part 2 Data-informed urban design for smart cities
——North End Smart District
智慧城市——同济 - 北卡夏洛特联合设计



part 1

Big Data Analysis Aided Urban Design Practice

工具说明

在城市设计中，借助众多的大数据分析工具进行前期分析，对于设计的推进有非常大的帮助。在同济大学读研期间，我熟练掌握了多种大数据分析工具，最常用的是空间句法分析工具 DepthmapX，主要用于对路网结构进行分析；地理信息系统的分析平台 ArcGIS，主要用于对 Shp 数据进行深度处理；以及借助 Python 编写代码，在高德或者百度地图上爬取 POI 点（Point of interest），以此反映设计场地周边的功能分布情况。还有基于热环境分析的模拟软件 Envi-met，可以对城市微环境进行量化分析。我也有幸参与了很多实际项目，在项目中对这些工具的使用都有了更深刻的理解。

PROPOSAL

In urban design, it is very helpful for the promotion of urban design to carry out preliminary analysis with the help of many large data analysis tools. During my postgraduate study in Tongji University, I have mastered many kinds of big data analysis tools. The most commonly used tool is DepthmapX, which is mainly used to analyze the structure of road network; ArcGIS, an analysis platform of Geographic Information System, is mainly used to process Shp data in depth; and to write code with Python. Point of interest is crawled on the map of Gaode or Baidu to reflect the functional distribution around the design site. I have participated in many practical projects , and gradually I have a deep understanding of the utility of these tools in the project.

01

空间句法
Space syntax

02

地理信息系统
ArcGIS

03

地理信息爬取
Get POI

04

热环境模拟
Envi-met

05

风环境模拟
Wind Environment Simulation

云南楚雄大姚重点地段城市设计路网分析

设计基地位于大姚县城中心地区，占地 6.9 公顷，基地内部高差较为明显，周边有良好的资源，通过空间句法分析，可以量化城市设计更新前后车行和步行系统的状态。可以发现设计介入地块更新后，车行交通有微小提升，人行交通状态得到了很大改善。更有利于整个周边景观资源和步行系统。成为城区新的连接点和聚集点。



城市设计方案



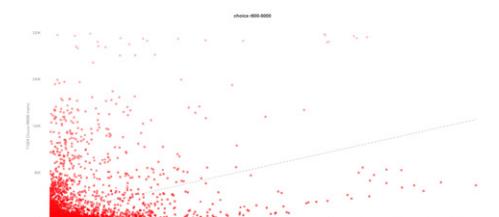
山东菏泽郓城县城市道路空间句法分析

通过对郓城中心城区的高清路网底图进行抽象，得到路网的 CAD 轴线图。并描出河流作为空间参照。

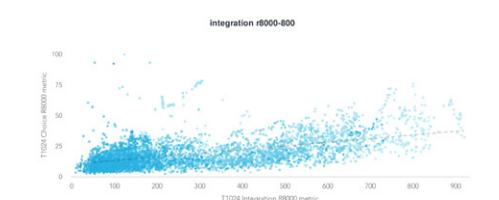
基于空间句法的城市形态特征分析包含两个尺度（全局尺度：8000米和步行尺度：800米）和两个测度（整合度与选择度）。

将普遍低值的一般路网（即右图灰色路网）排除后可见，在步行尺度下郓城县老城区的整体路网整合度较好，特别是东门街、西门街、义和路一线能形成良好的步行网络体系。东门街与郓州大道也形成的较好的路网架构。

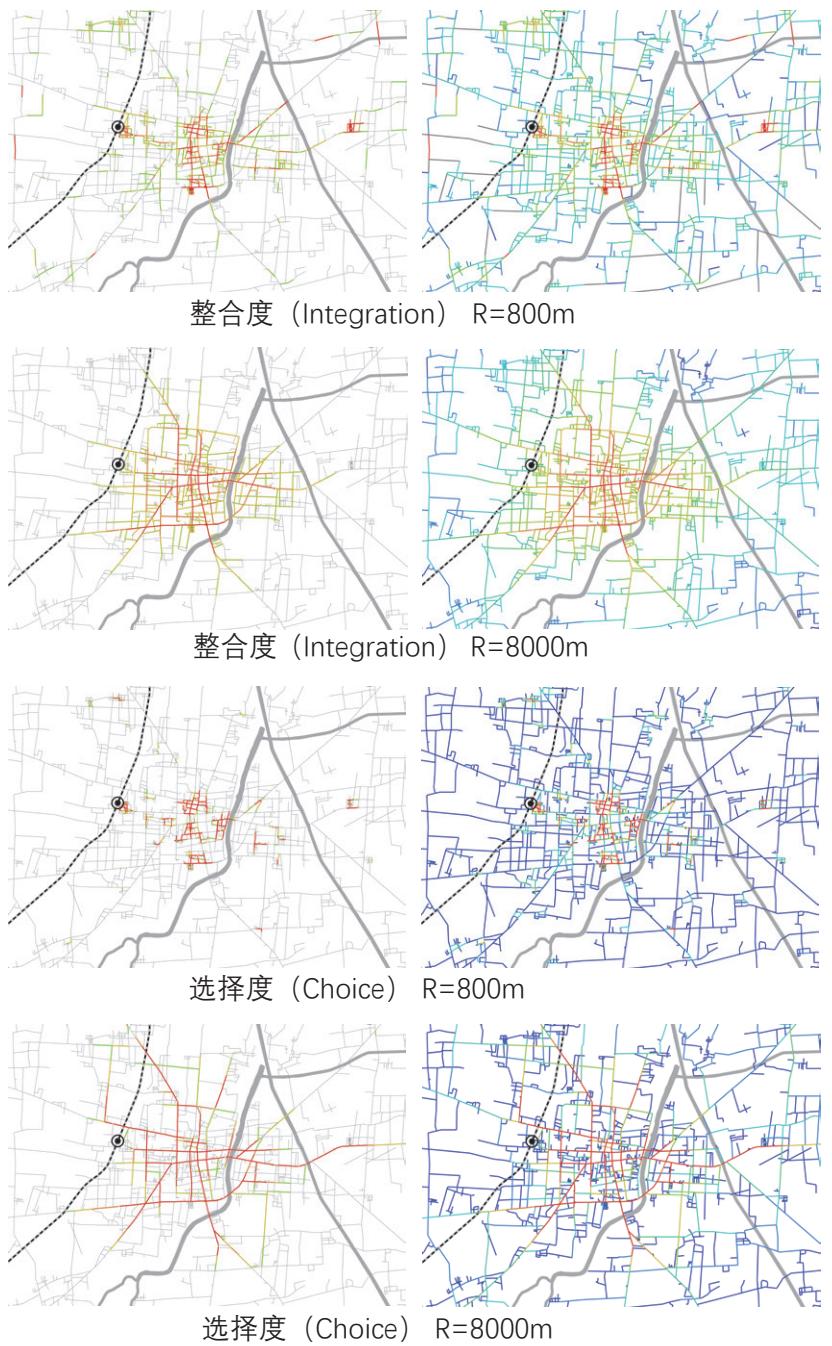
但郓城站与城区的步行尺度整合度不强。此外在路网体系中跨越宋金河的步行尺度整合度有待加强，目前仅临城路一线有较好的跨河联系，其他路段缺乏跨河通道，而且沿河步行尺度下的路网构建不完全，不利于宋金河两岸景观的充分利用。



Choice-R800-8000



Integration-R8000-800



郑州南站及周边地区“城站一体化”研究与设计

在郑州南站及周边地区“城站一体化”项目的研究中，我们希望根据空间句法的分析知道，地铁线路优化调整以后，对于现有基地会产生怎样的影响，以便使郑州南站及周围片区更好地与整体的城市道路系统相联系。

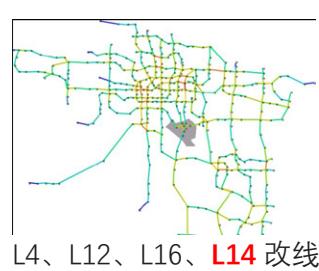
通过空间句法分析软件 DepthmapX，可将整理好的 CAD 文件导入，设置计算半径，进行选择度和整合度的分析，以此来判断道路系统在步行和车行尺度上的可达性。

地铁线路调整分析

Integration-R3



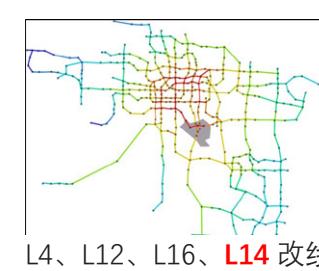
原始规划

L4、L12、L16、**L3** 改线L4、L12、L16、**L4** 改线

Integration-Rn



原始规划

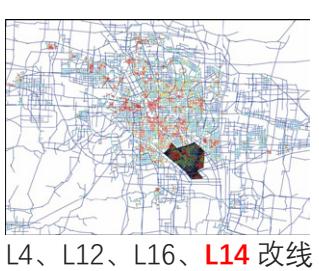
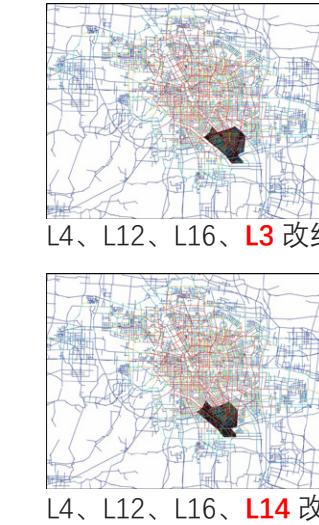
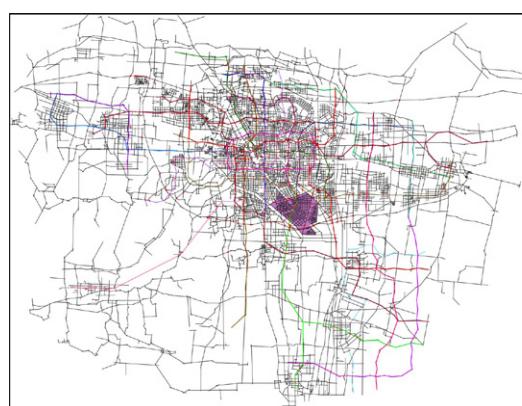
L4、L12、L16、**L3** 改线L4、L12、L16、**L4** 改线

地铁线路调整后与路网整合

Choice-R800



原始规划

L4、L12、L16、**L3** 改线L4、L12、L16、**L3** 改线L4、L12、L16、**L4** 改线L4、L12、L16、**L4** 改线

路网 + 地铁原始规划 VS 路网 + 地铁 L4、L12、L16、**L3** 改线
Choice-R800



Choice-R10000



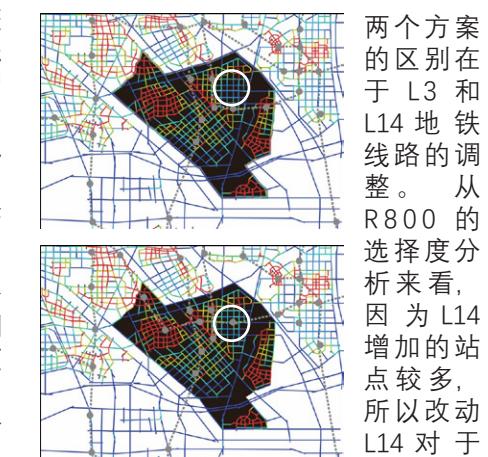
路网 + 地铁原始规划 VS 路网 + 地铁 L4、L12、L16、**L14** 改线
Choice-R800



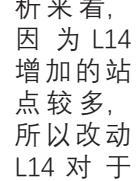
Choice-R10000



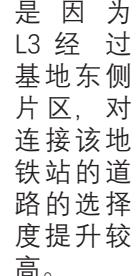
路网 +L4、L12、L16、**L3** 改线 VS 路网 + 地铁 L4、L12、L16、**L14** 改线
Choice-R800



两个方案的区别在于 L3 和 L14 地铁线路的调整。从 R800 的选择度分析来看，相比于原始地铁路网规划，调整 L4、L12、L16、L3 线路以后，基地内新增地铁站点附近 R800 的选择度有所提高，说明增加地铁站以后，周边路网的步行选择度和可达性有所提高



从 R10000 的选择度分析来看，地铁线路调整以后，对车行尺度的选择度影响不大，只对于基地东片区略有提高。



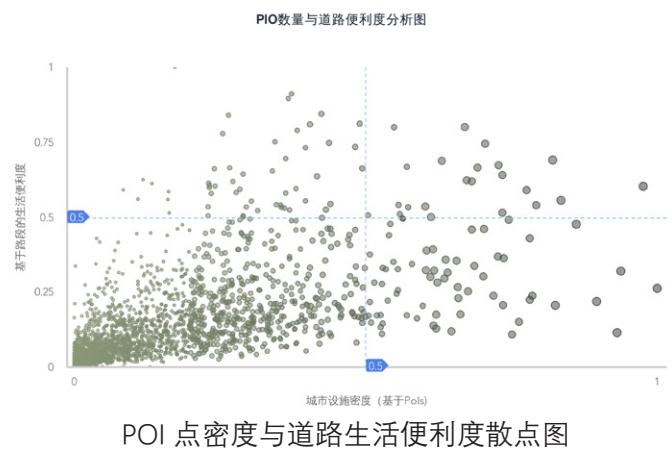
从 R800 的选择度分析来看，相比于原始地铁路网规划，调整 L4、L12、L16、L14 线路以后，基地内新增地铁站点附近 R800 的选择度有所提高，说明增加地铁站以后，周边路网的步行选择度和可达性有所提高

从 R10000 的选择度分析来看，对主要片区的影响区别不大，但是因为 L3 经过基地东侧片区，对连接该地铁站的道路的选择度提升较高。

西安路网加密规划设计导则 生活便利度量化分析

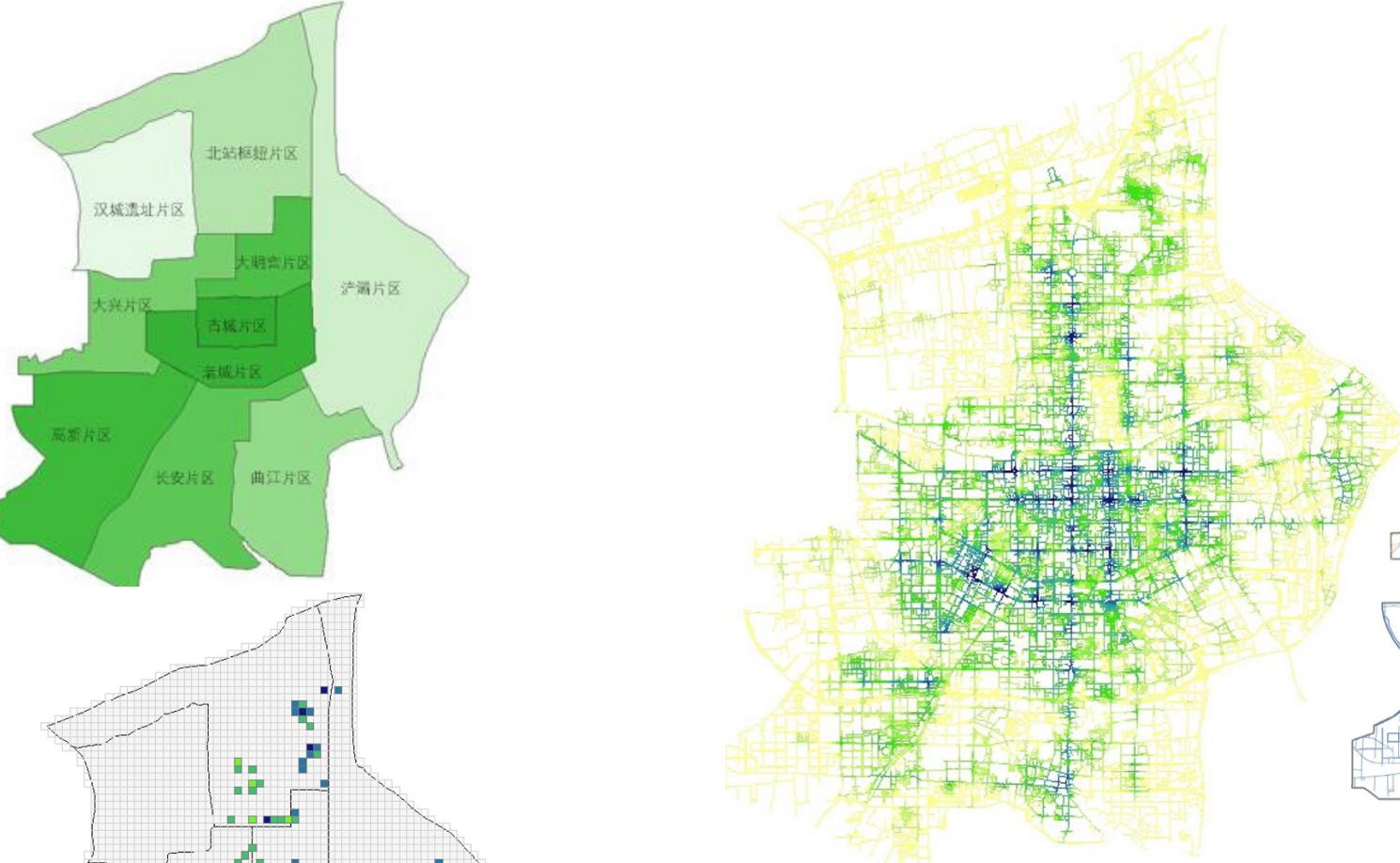
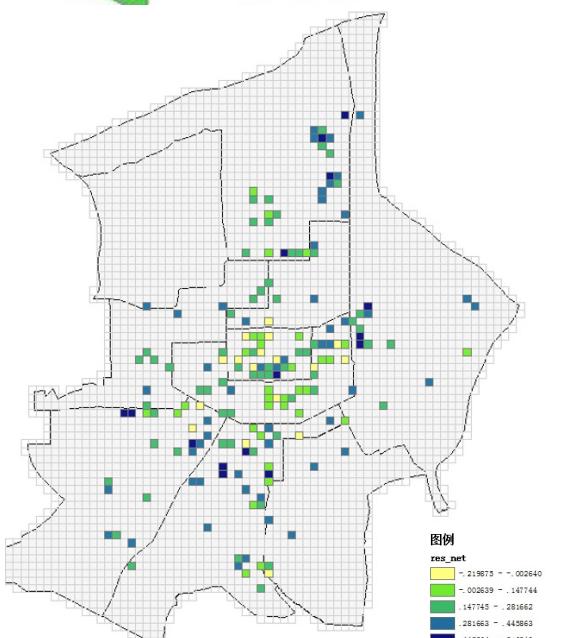
15分钟生活圈便利度指居民在步行范围内通过不同街道，开展购物、休闲、通勤、社交等多种活动的便利程度。结合高品质建成环境的相关5D理论、Spatial Capital理念，将其转译为居民从任意道路出发，接触各类POI设施数量和多样性的便利程度。

生活圈便利度 = POI 绝对数量 * POI 相对数量 * 设施多样性 * 交通可达性，即每一条街道段服务区内各类设施的数量、多样性、可接触程度的总结果。

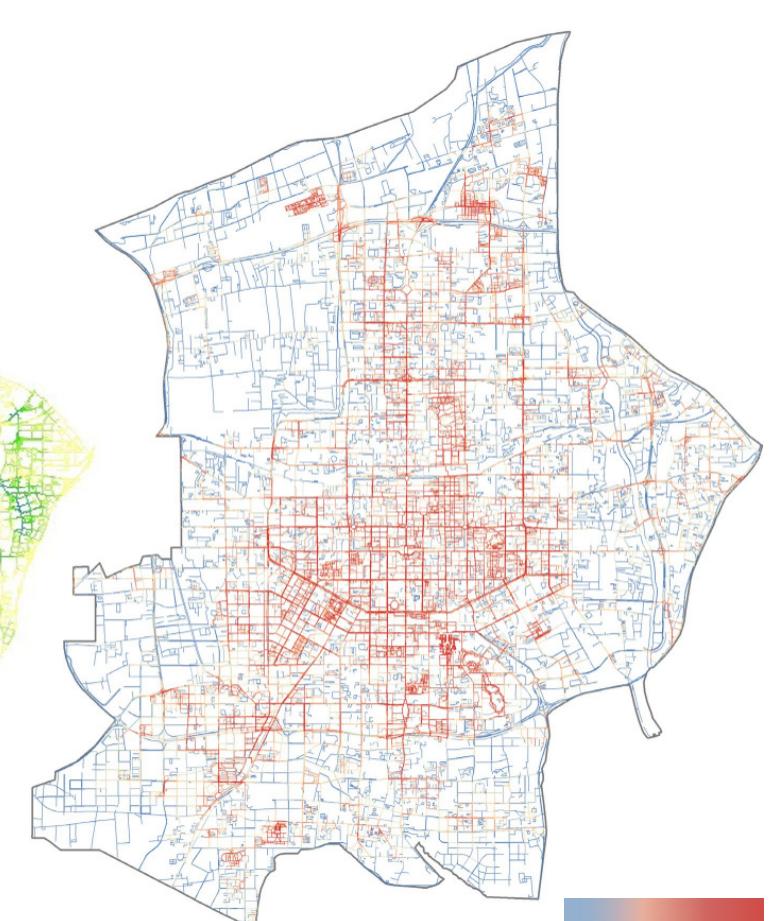


片区编号	片区名称	街道便利度平均值	街道便利度最大值	街道便利度中值	道路便利度求和
1	长安片区	939.1737244	7711.254184	626.5234951	22055555.74
2	高新片区	1079.769325	9623.841968	707.4107751	23799195.68
3	古城片区	2478.193089	7761.008217	2055.494411	22078222.23
4	大明宫片区	967.6899635	6082.214328	571.4852762	9417558.725
5	北站枢纽片区	669.995454	7167.161675	450.8028043	17814509.13
6	浐灞片区	562.7733539	6824.502869	355.524083	18774681.86
7	汉城遗址片区	171.484155	1570.17162	102.2559015	1488653.95
8	老城片区	1787.578347	6803.682094	1395.782856	37203080.55
9	大兴片区	896.5761912	6750.442558	639.5789406	10747258.8
10	曲江片区	719.7435166	5240.727964	433.7572449	15335575.11

根据部分路段便利度不高的现状，建议可适当增密路网。特别是汉城遗址片区、浐灞片区的部分路段，以提升对不同设施的接触便利条件，从而提升生活圈的可达性。由于长安片区与大兴片区存在便利度结果与设施数量的错位，可以针对这两个区域加大交通可达性。



根据部分路段便利度不高的现状，建议可适当增密路网。特别是汉城遗址片区、浐灞片区的部分路段，以提升对不同设施的接触便利条件，从而提升生活圈的可达性。由于长安片区与大兴片区存在便利度结果与设施数量的错位，可以针对这两个区域加大交通可达性。



西安街道步行可达性较高的道路主要集中在曲江片区、老城片区内，以及古城片区、长安片区等。不同片区步行与车行可达性的结果分布差异较大，老城在两个尺度结果均较好。步行可达性方面，曲江、古城片区较好，大兴、浐灞片区较差。大车行可达性方面，明宫、长安片区较好，曲江、高新、北站枢纽片区较差。

长沙洋湖景园路两厢城市设计结合 POI 点的功能分析

在长沙洋湖景园路两厢城市设计的项目中，结合 python 在高德地图上爬取的 POI 数据，以 GIS 为数据分析平台展开了一系列城市资源分析。

洋湖片区潭州大道以东集中了相对较多的商业与办公，潭州大道以西侧形成了以教育居住为主的生活社区。场地周边业态类型丰富主要的业态包括：总部办公、教育、创意、居住等。洋湖湿地公园以生态景点为主，零售点均匀穿插其中，并且设有较多文化科教场所，但缺少住宿、餐饮等业态，需周边地块支持补充。



全部 POI 点分布图（总数为 12176）

Python 爬取 POI 的部分代码

```
import requests,time,os,sys
from tqdm import tqdm
import numpy as np
import pandas as pd
from transCoordinateSystem import *

# 生成原始网格，间距大概 1km
# return: [[x1,y1,x2,y2],...]
def grid_making(lng_min,lat_min,lng_max,lat_max,edge):
    # 每次爬取方格的边长 (单位: km)
    edge = edge
    # 下面的参数不用设置
    lng_delta = 0.01167*edge
    lat_delta = 0.009*edge
    # 生成网格
    if lng_delta<(lng_max-lng_min):
        lngs = list(np.arange(lng_min,lng_max,lng_delta))
        lng_mins,lng_maxs = lngs,lngs[1:]
        lng_maxs.append(lng_max)
    else:
        lng_mins,lng_maxs=[[lng_min],[lng_max]]

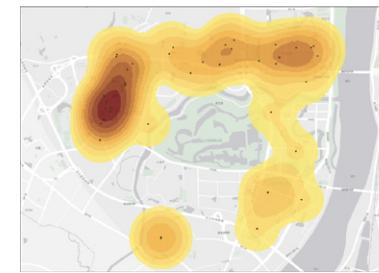
    if lat_delta<(lat_max-lat_min):
        lats = list(np.arange(lat_min,lat_max,lat_delta))
        lat_mins,lat_maxs = lats,lats[1:]
        lat_maxs.append(lat_max)
    else:
        lat_mins,lat_maxs=[lat_min],[lat_max]

    grids=[]
    for i in range(len(lng_mins)):
        for j in range(len(lat_mins)):
            grids.append([lng_mins[i],lat_mins[j],lng_maxs[i],lat_maxs[j]])
    return grids

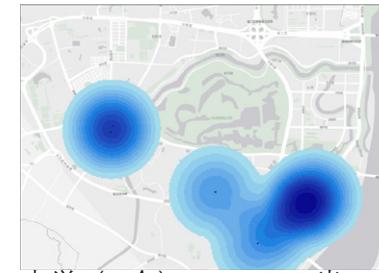
# 给出两点坐标，递归返回结果
def get_poi(lng1,lat1,lng2,lat2,num_
threshold=700,types=""):
    global poi_result
    global key
    global typecode,num
    url = 'https://restapi.amap.com/v3/place/polygon?key={key}&polygon={{lng1},{lat1}}{{lng2},{lat2}}&keywords=&types={types}&offset=20&page=1&extensions=all'.format(key=key,lng1=lng1,lat1=lat1,lng2=lng2,lat2=lat2,types=types)
    poi_num = int( requests.get(url).json()['count'])
    num +=1
    if num>1900:
        print('key 的限额快用完了 ')
    if poi_num>num_threshold:
        .....
    # 测试用的参数
    project_name = 'test'
    key = '35d8b08f1decf291081947717889c11f'
    lng_min,lat_min=116.439903,39.955736
    lng_max, lat_max = 116.458732,39.970888
    #try:
    #    [project_name,key] = sys.argv[1:3]
    #    lng_min,lat_min,lng_max, lat_max = [float(x) for x in sys.argv[3:]]
    #except:
    #    print('error')
    #    time.sleep(10)
    #print ( sys.argv)
    #time.sleep(20)
    .....
    #%% 输出结果
    if not os.path.exists('result'):
        os.mkdir('result')

    result_df.to_csv('result/%s_result_%s.csv'%(project_name,time.strftime('%Y%m%d',time.localtime()),index=1,encoding='gbk'))
    os.system('pause')
```

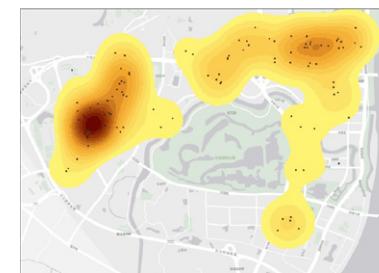
基于 POI 点的热力图分析



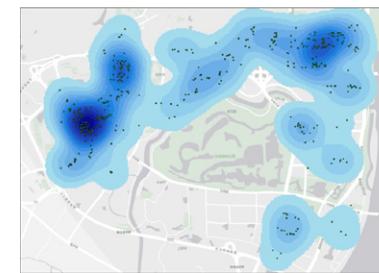
幼儿园 (43 个), R=300 米



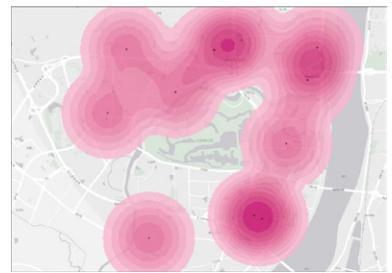
中学 (7 个), R=1000 米



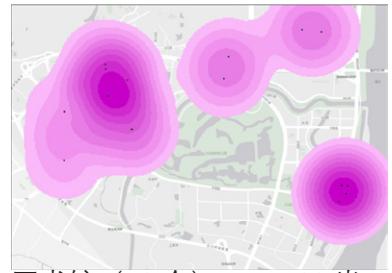
超市 (112 个), R=500 米



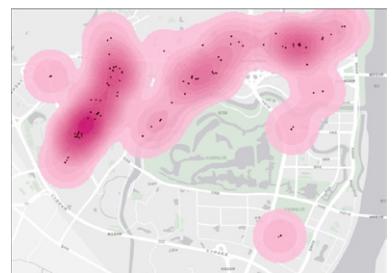
专卖店 (487 个), R=300 米



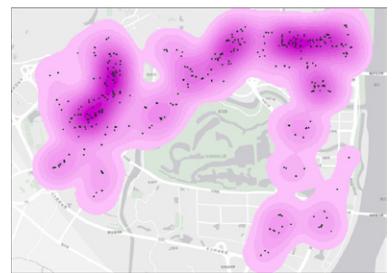
小学 (11 个), R=500 米



图书馆 (16 个), R=500 米



农贸市场 (93 个), R=300 米

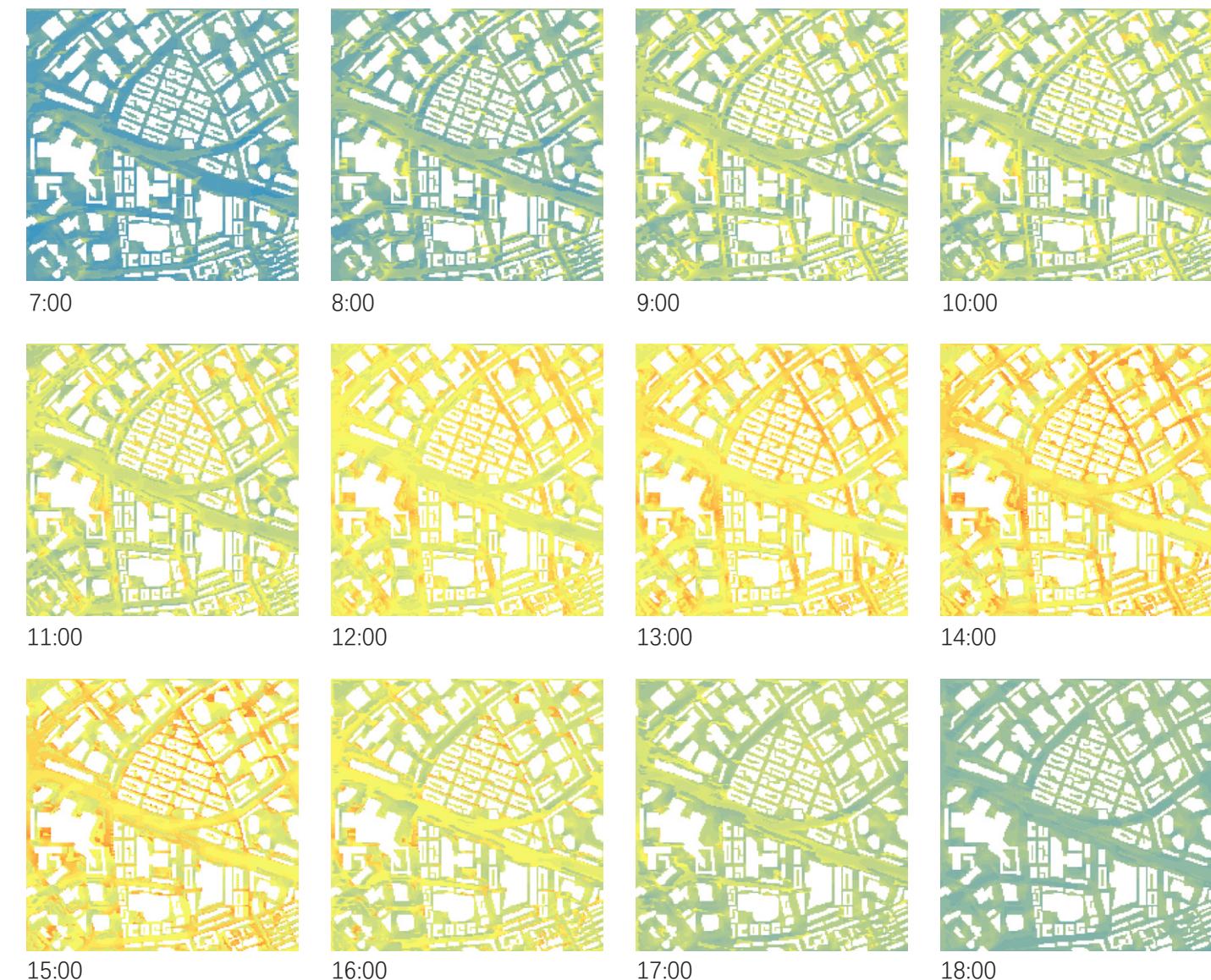
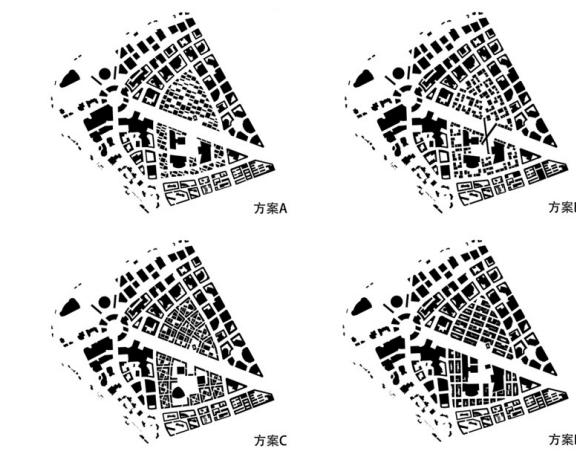
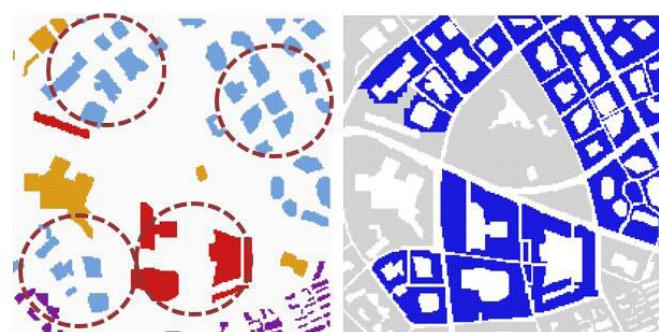
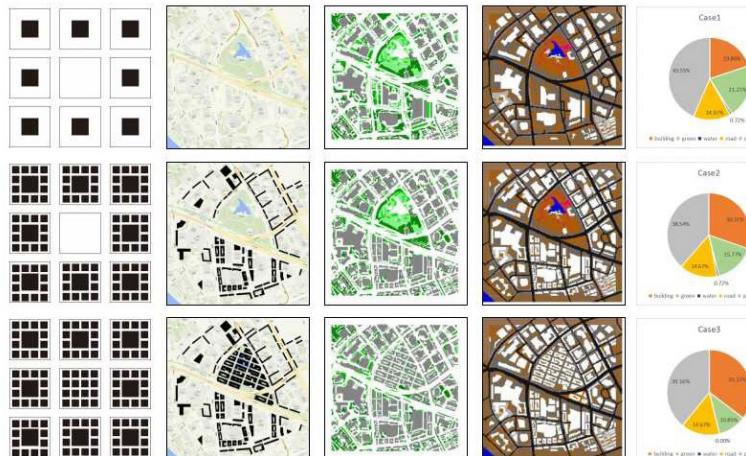


商店 (353 个), R=300 米

陆家嘴核心区街区室外热舒适性现状与更新方案对比研究

中国过去三四十年的新城建设发展迅速，但也问题频出，陆家嘴是新城更新的典型案例。本文对陆家嘴核心区街区的夏季室外气候参数进行实测、通过 ENVI-met 三维动态微气候软件，模拟现状与不同城市设计更新方案的热舒适值。对比传统城市设计方案与现状在室外热环境上的差异，探讨传统城市设计方法在新城更新中对城市街区热环境的影响，从热舒适性角度，提供同类型街区的城市设计参考。

新城更新 城市微环境 室外人体热舒适 软件模拟 对比分析



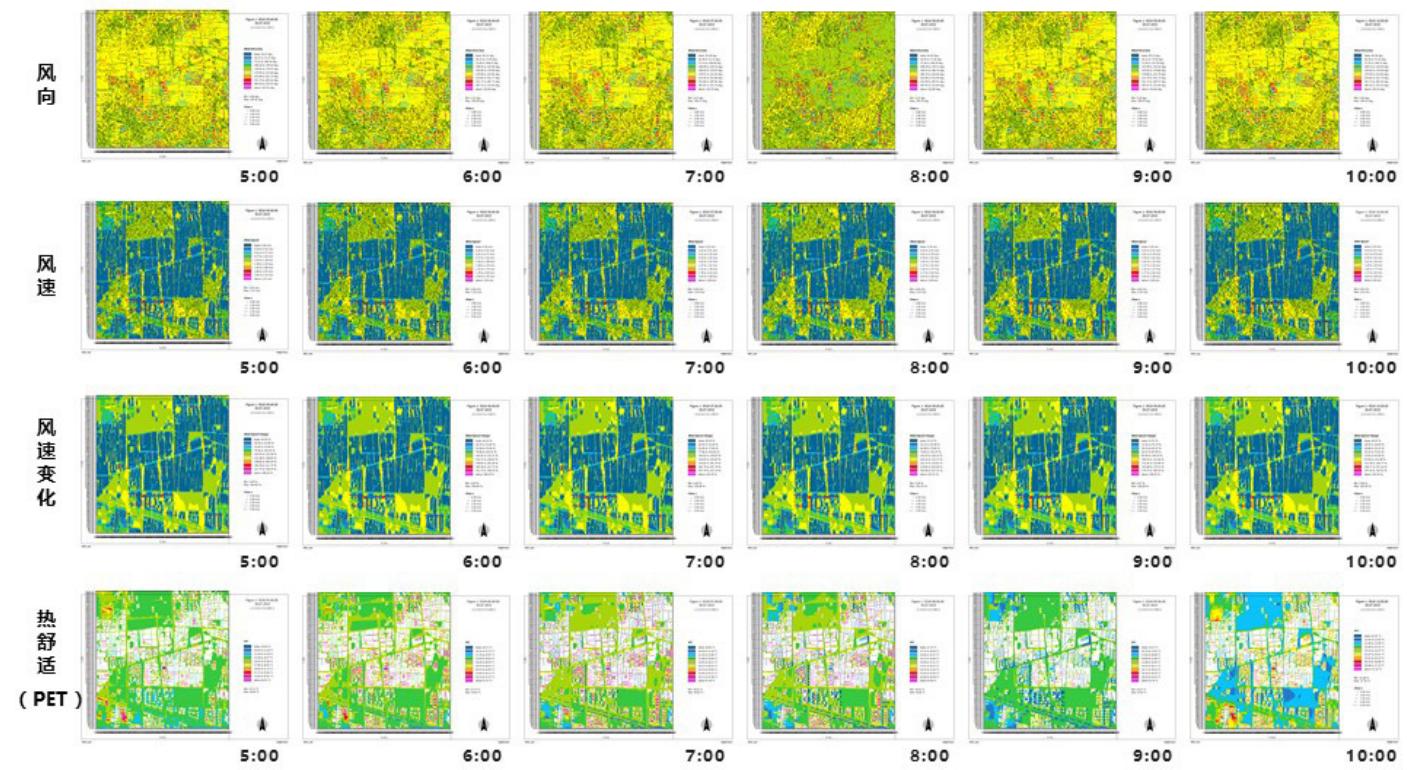
ENVI-met 软件是由德国 Michael Bruse(University of Mainz, Germany) 开发的一种三维动态微气候模型，综合考虑风速、风向、空气温度、湿度等多重变量因子。用 Envi-met 软件进行热舒适数值模拟已经成为近年来城市微气候研究的重要手段，特别是基于行为学的热舒适研究。

05 风环境模拟 Envi-met

山东菏泽东明县城区室外风环境及热舒适分析（夏季）

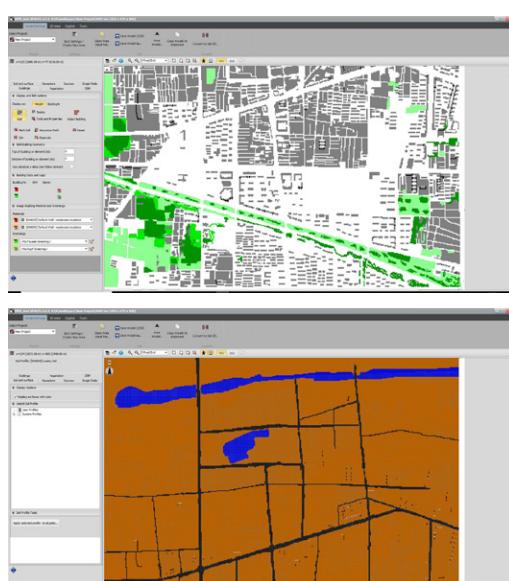
山东菏泽东明县在城市拓展和更新过程中需要评估其整体风环境，以确定未来乡镇工业园区的布置位置以及城市需要预留和改善的风廊道。以东明县 CAD 图纸与卫星图为参照进行建模，以 ENVI-met 软件为工具进行风环境模拟，结合风玫瑰图，可以知城市西侧受到化工园区影响较小。未来化工厂的扩展，建议不要在南侧和北侧，可以考虑向东或者向西发展。注意保留城市已有的南北方向风廊道，避免建筑密度过高，阻碍风流动。建议在主风廊道的基础疏通过出三级风廊道系统，作为一级、二级风廊道的补充。有助于提升整体的风环境品质。

新城更新 城市风环境 软件模拟 对比分析

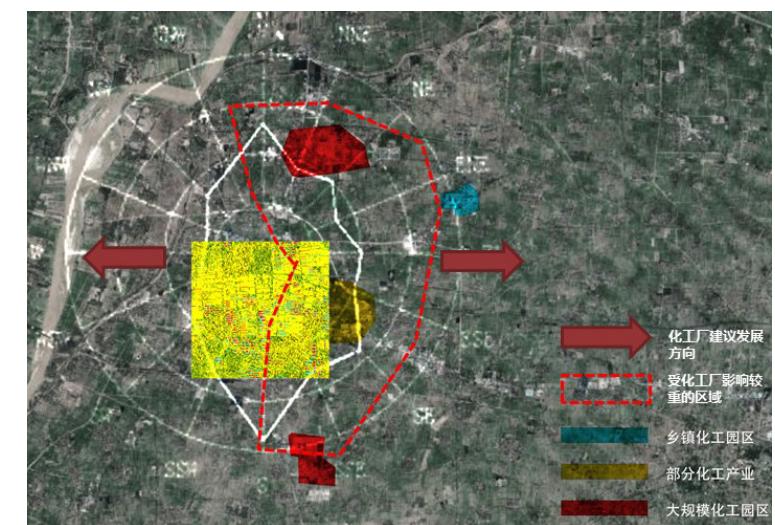


Big Data Analysis Aided Urban Design Practice

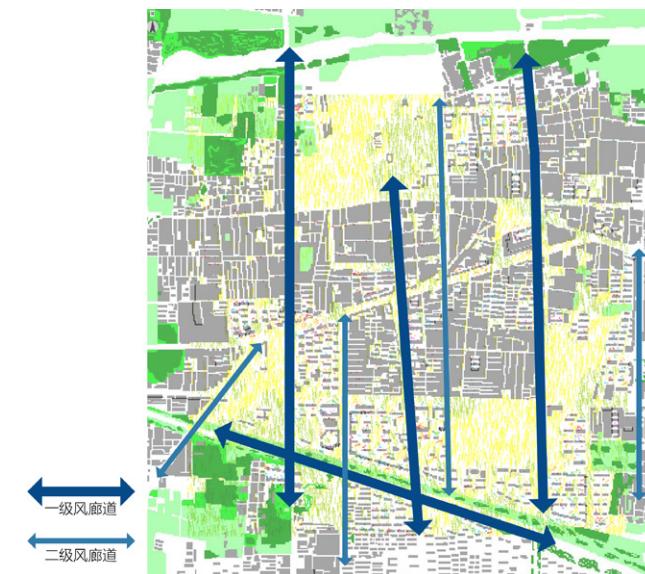
大数据分析辅助城市设计的实践



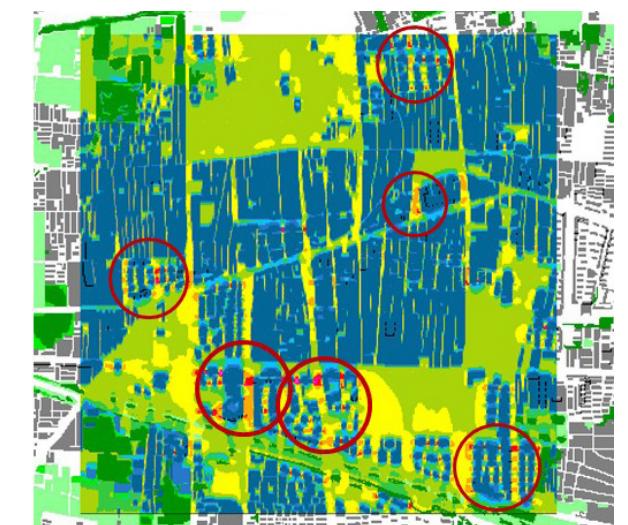
结论1：结合东明县夏季风向频率图和 Envi-met 的分析结果可知，相比之下，城市西侧受到化工园区影响较小。未来化工厂的扩展，建议不要在南侧和北侧，可以考虑向东或者向西发展。



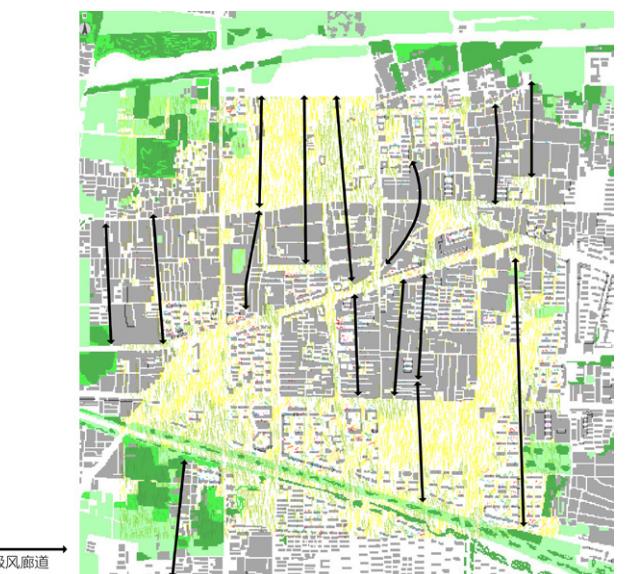
结论3：夏季主导风向为南风，高频风向为南风或者北风，要注意保留城市已有南北向风廊道，避免建筑密度过高，阻碍风流动。已有风廊道可根据宽度与风速大小分为一级风廊道和二级风廊道（如下图所示）



结论2：南侧建筑群为中、高层，局部风速大，中、北部建筑群层数低，密度大，风速小。建议在图示风速较大区域增加树木种植，降低人行高度的风速，提高城市舒适性。



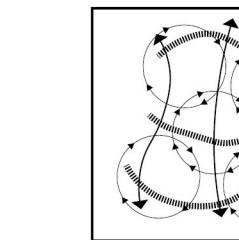
结论4：在未来的城市规划中，建议在主风廊道的基础疏通过出三级风廊道系统，作为一级、二级风廊道的补充。这些廊道虽然宽度窄，但密度高，有助于提升整体的风环境品质。（如下图所示）



Big Data Analysis Aided Urban Design Practice

大数据分析辅助城市设计的实践

04 热环境模拟 Envi-met



part 1

FLOW INTEGRATION

设计说明

在这次的智慧城市设计中，我们关注的重点是连接和流动，在流动中整合城市的各种要素，希望创造一个更加具有公共性，更有活力的地区。在调研中我们发现 North End 地区缺乏东西向的联系，而水网正好提供了这种联系的线索。所以我们通过整合水网和景观，将公共空间串联起来。通过自己设计的水陆两用的新型交通工具，将交通、娱乐、工作和大型的社会活动整合在一起。实现随时随地可变的场景转换。这是智慧城市区别于原始的传统城市最重要的地方——即可以更大限度的，更及时的满足人们不同的需求。

PROPOSAL

In the data-informed urban design for smart cities, we focus on connectivity and mobility, especially on flow integration, hoping to create a more public and dynamic region. During the survey, we found that the North End area lacks east-west connections, and the water network provides just the clues for this connection. So we connect the public space by integrating the water network and the landscape. We design a kind of new amphibious modes of transportation, it integrates transportation, entertainment, work, and large-scale social activities together for anytime, anywhere variable scene conversion.

This is the most important place for a smart city to be distinguished from the original traditional city - that is, it can meet people's different needs in a larger scale and more timely manner.

01

现状条件
KEY WORDS

02

概念生成
CONCEPT

03

策略分析
STRATEGY

04

智慧系统
URBAN SYSTEM

05

场景深化
OVERALL SCENE

第三组
GROUP 3



杜平
DU PING



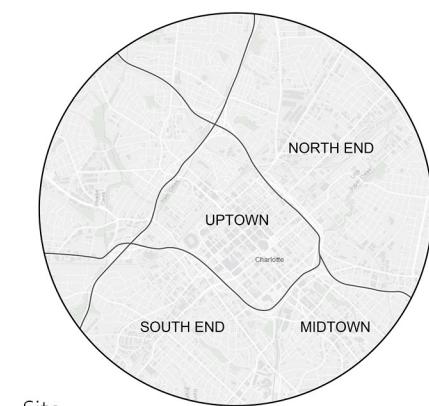
杨芳
YANG FANG



徐沛
XU PEI

01 现状条件

Key Words



Site



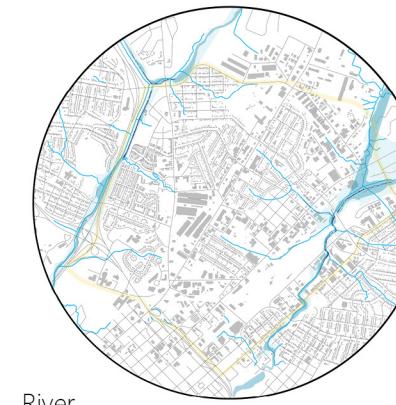
Light rail



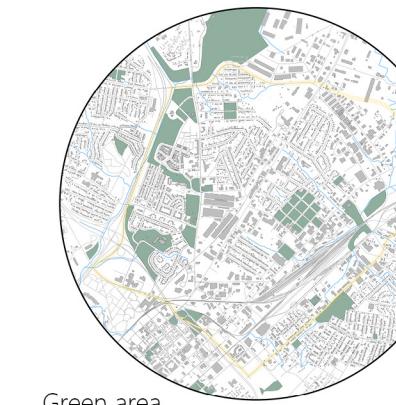
Texture



Road



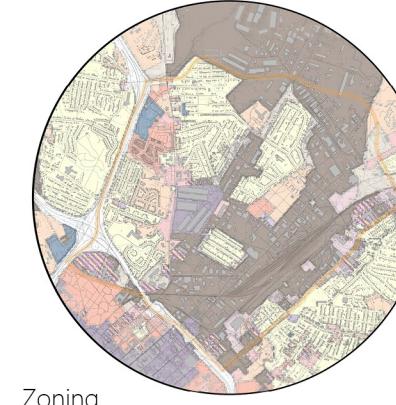
River



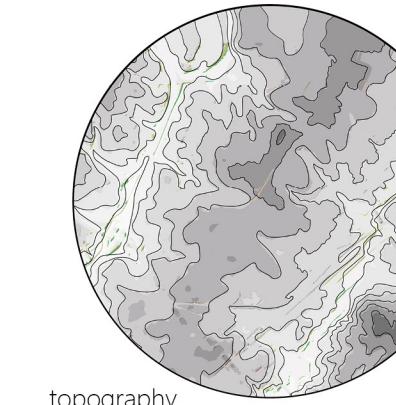
Green area



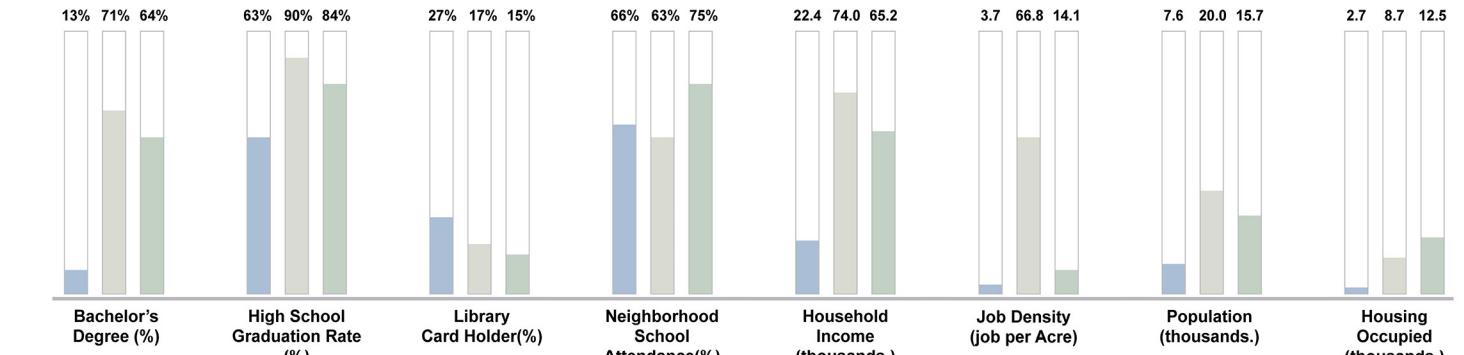
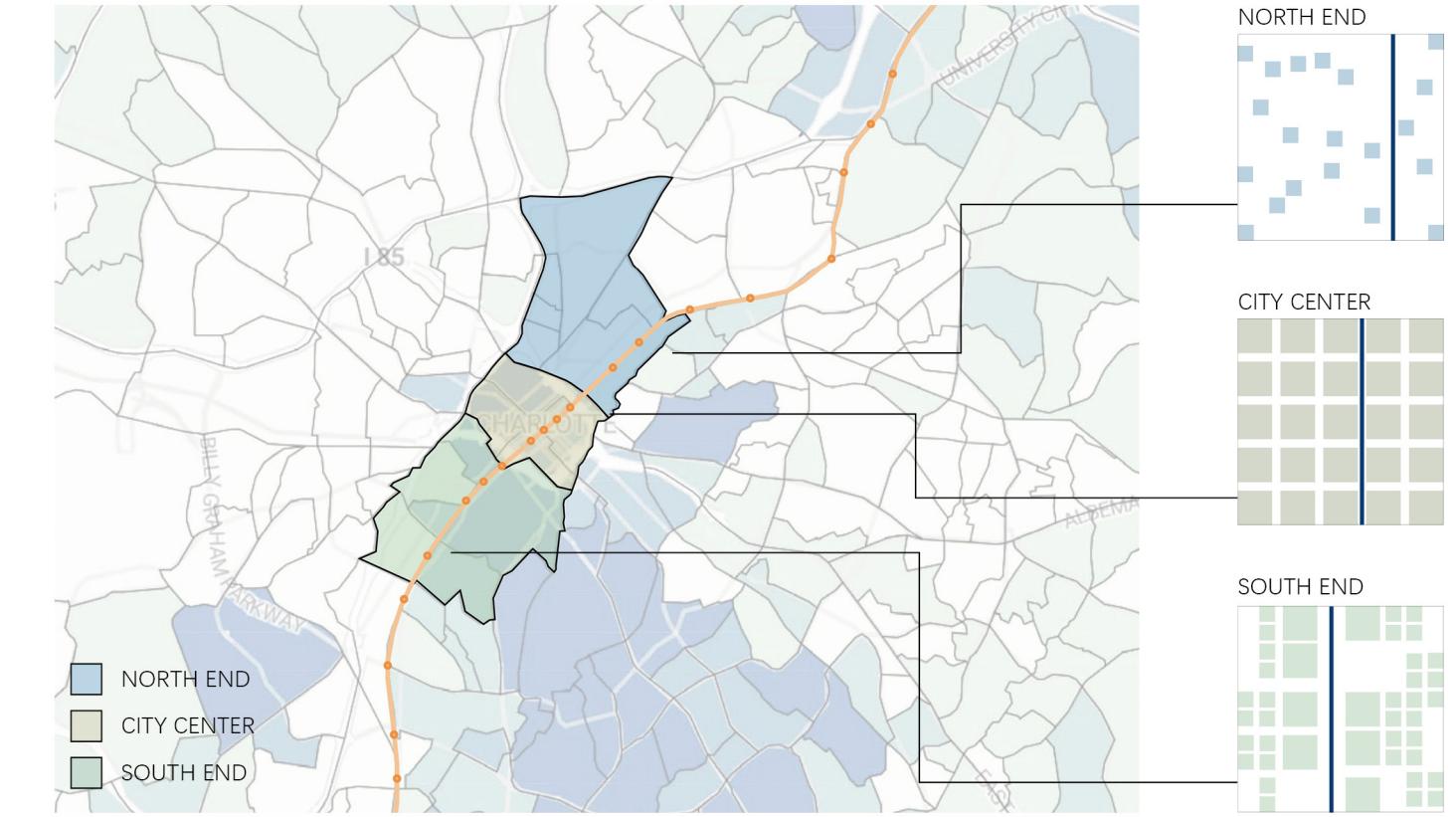
Residential area

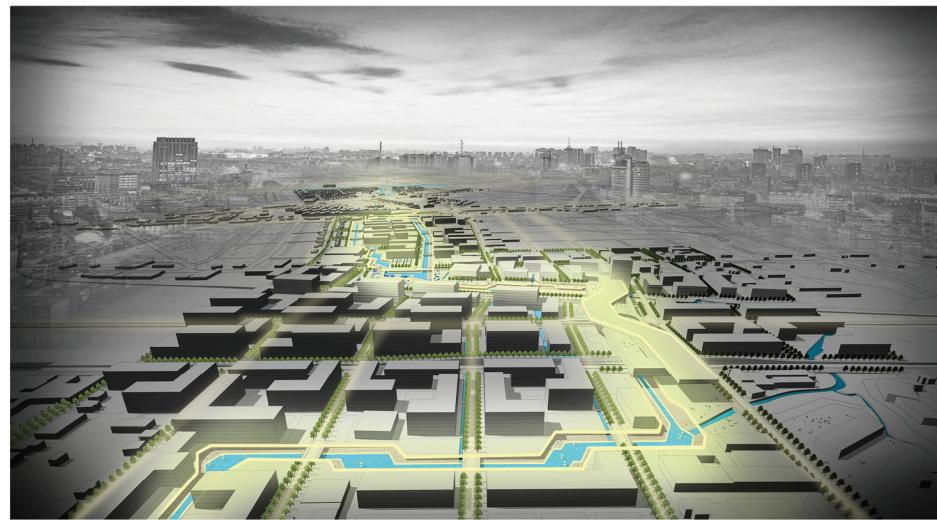


Zoning



topography



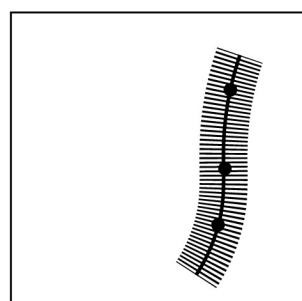


The Blue line is so important in Charlotte, linking the city center with the north and south ends. At present, the south end has been developed into a good community driven by the Blue Line, while the northern end is still under construction. In the future, when the blue line extends northward, it will pass through the east side of NORTH END. There are a large number of undeveloped open spaces around the station due to the old train marshalling yards, the first step in designing is to develop high-intensity development on the open space after relocation of the marshalling yard and activate the surrounding area first.

The main traffic lines of North End are north-south direction, so the communication between east and west is so weak. When the blue line station area develops, the need to extend westward became more important. Based on the original remains of industrial plants, we chose to extend to the west and run through the entire site to radiate a greater range.

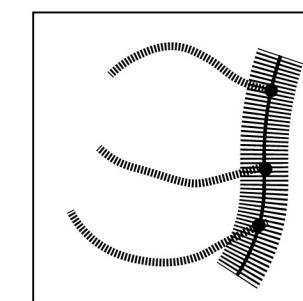
STEP1

Motivation from Blue line



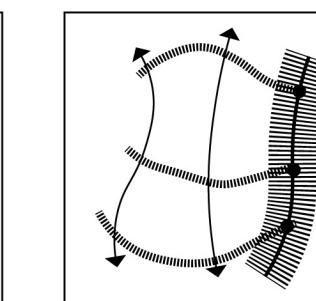
STEP2

Linear extension to west



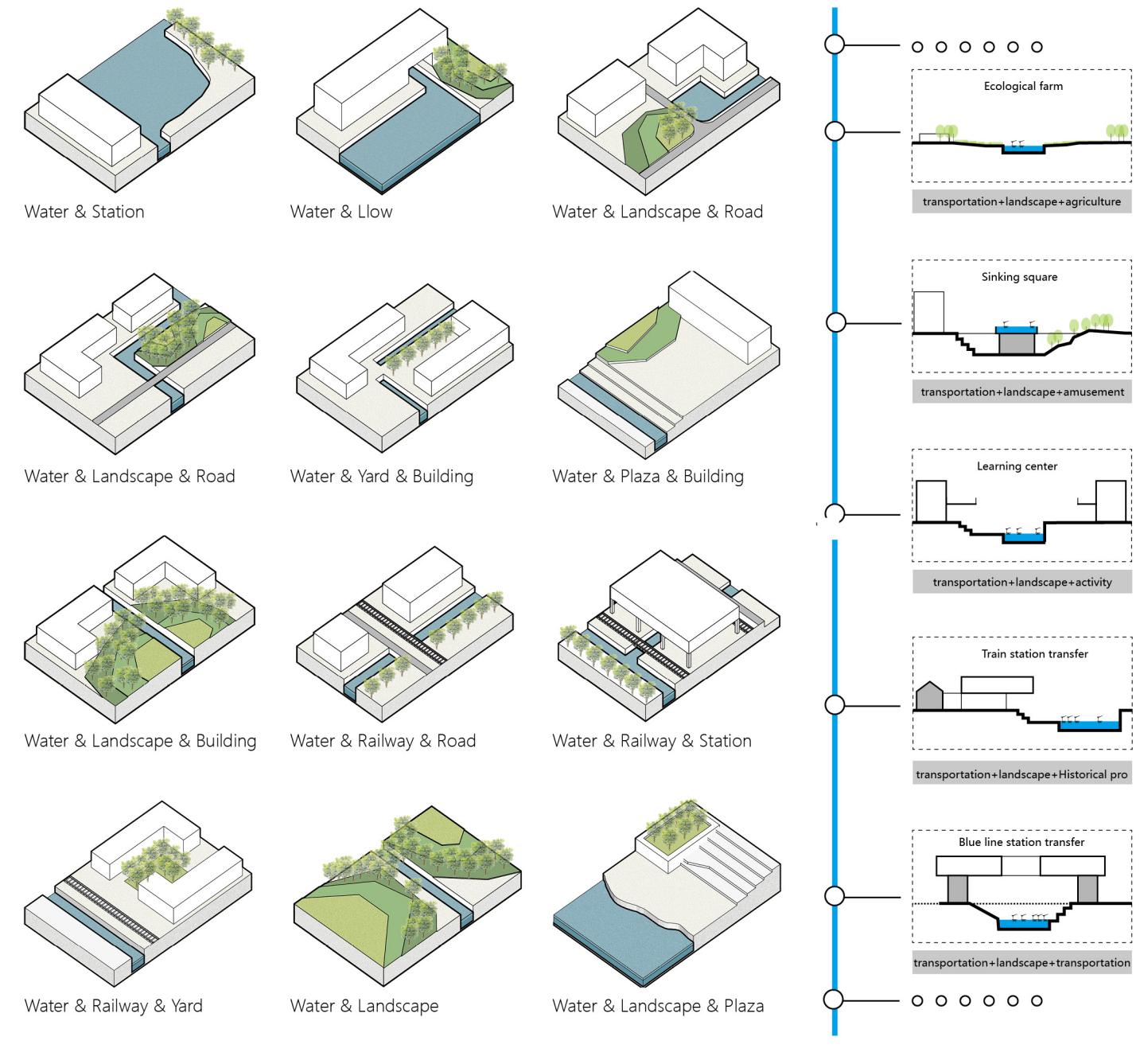
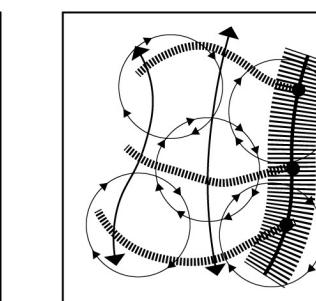
STEP3

From linear to reticular



STEP4

From fixed to flow



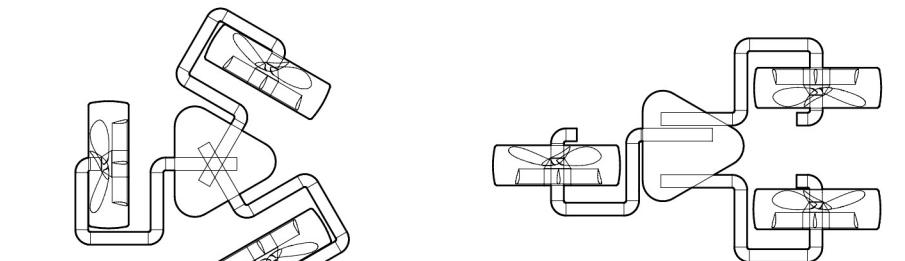
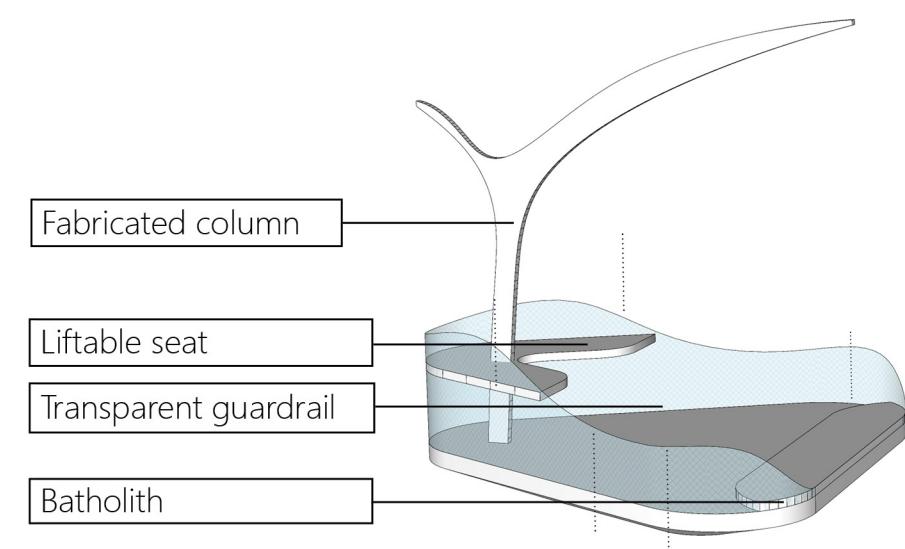
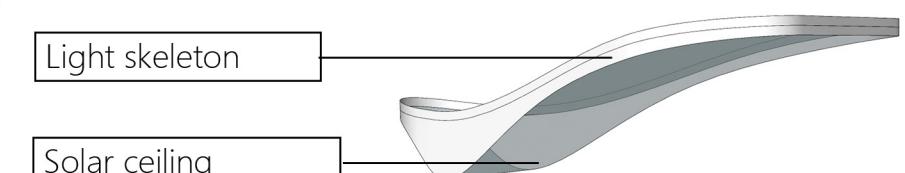
Smart amphibious transportation design



Lack of public transportation
Lack of departure frequency
Many people share one bus
Lack of efficiency
Can only be used as vehicles
Fixed connection point
Do not smart

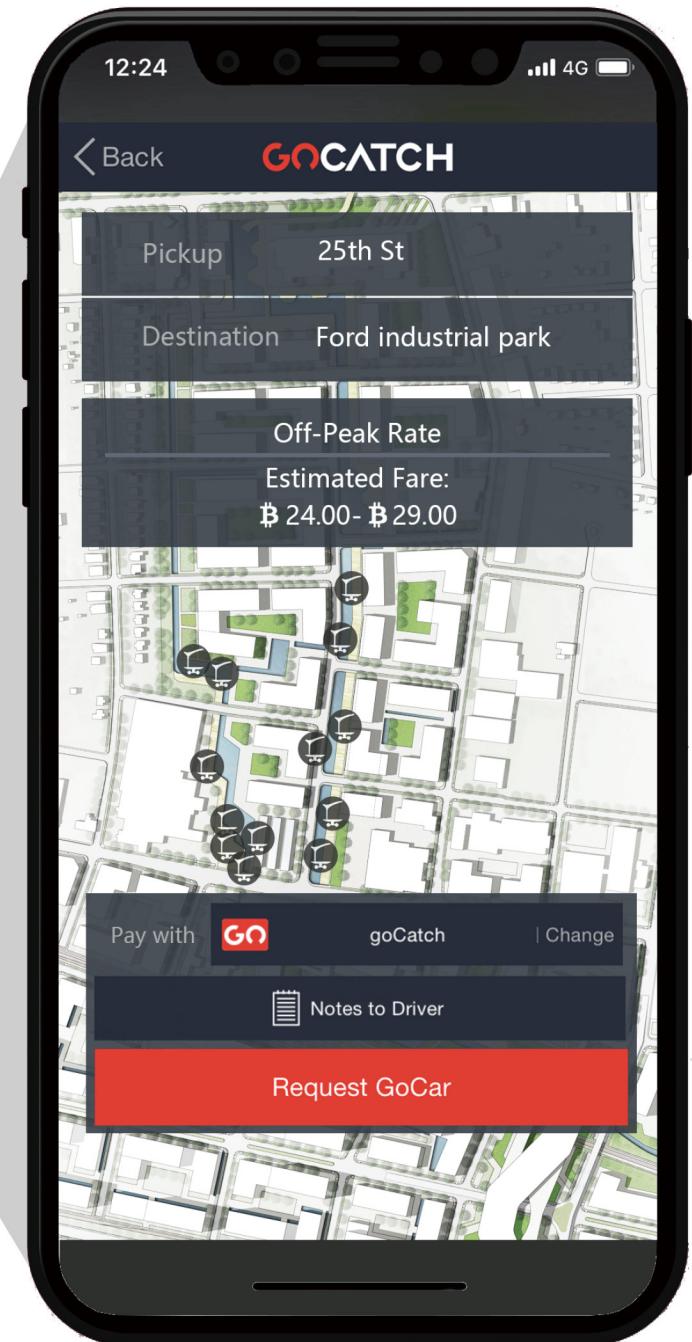


Private public transportation
Always on call
Much more quickly
Driven by solar energy
Linked with internet
With high efficiency
Not only be used as vehicles
Flexible connection point
Will be more smart



In water

On grass

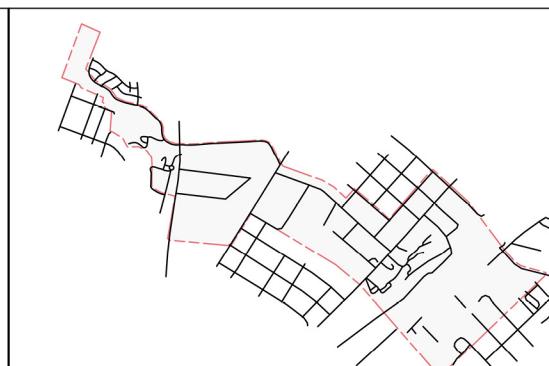


PRESENT SITUATION

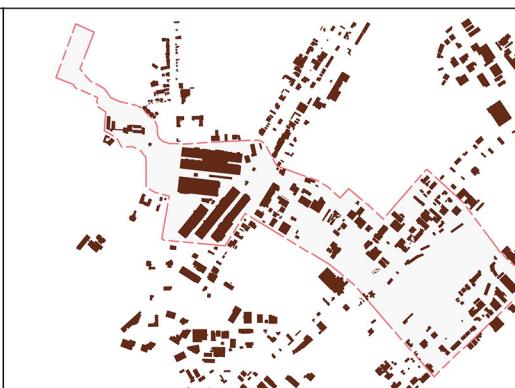
RESIDENTIAL AREA



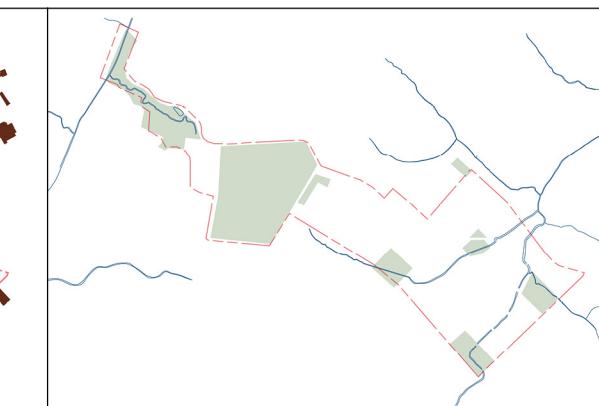
ROAD NETWORK



BUILDING TEXTURE



PUBLIC PLACE



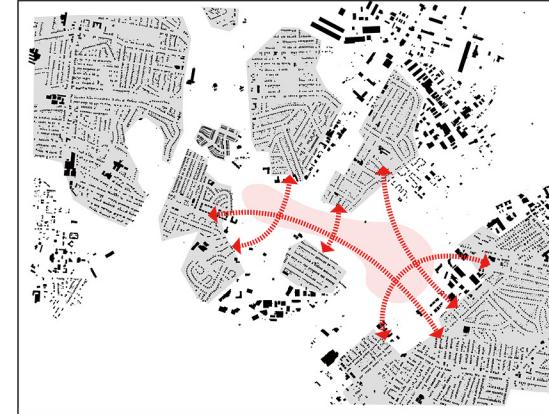
ZONING



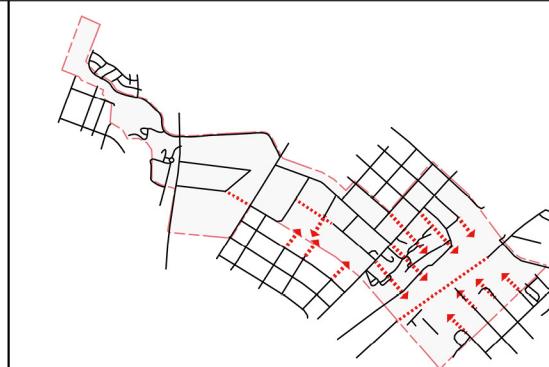
STRATEGY

AFTER IMPROVEMENT

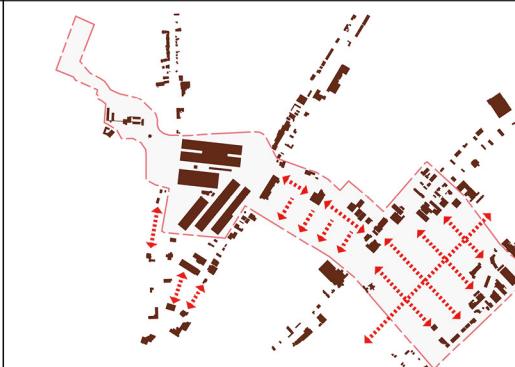
RESIDENTIAL AREA



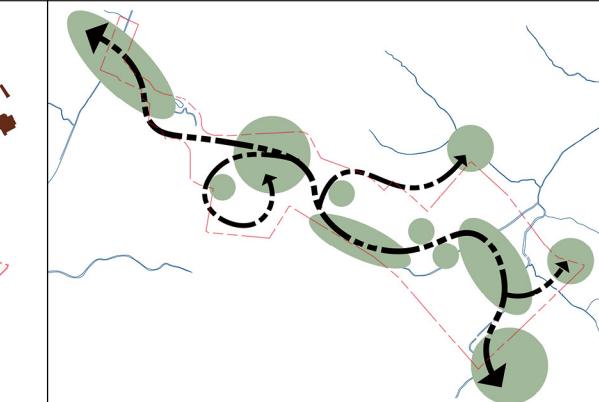
ROAD NETWORK



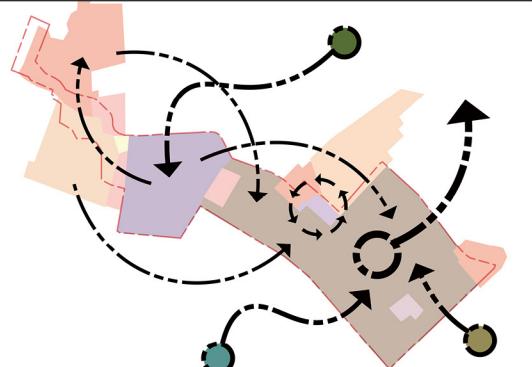
BUILDING TEXTURE



PUBLIC PLACE



ZONING



04 智慧系统 Urban System

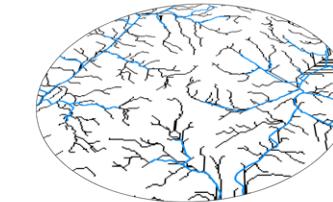


Data-informed urban design for smart cities——North End Smart District

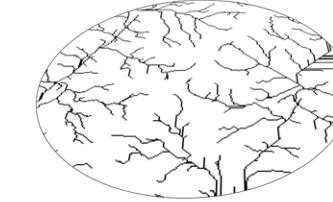
智慧城市——同济 - 北卡夏洛特联合设计

智慧系统 04 Urban System

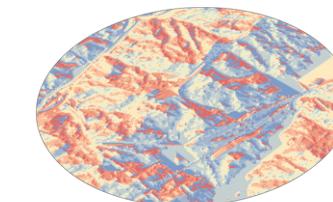
Water analysis from GIS



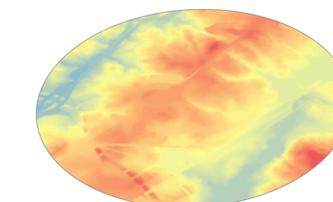
Comparison with original water system



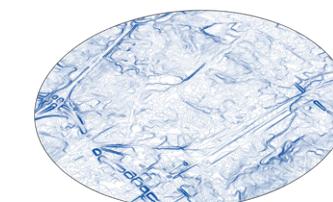
Generating Bow direction



Simulated generated f low



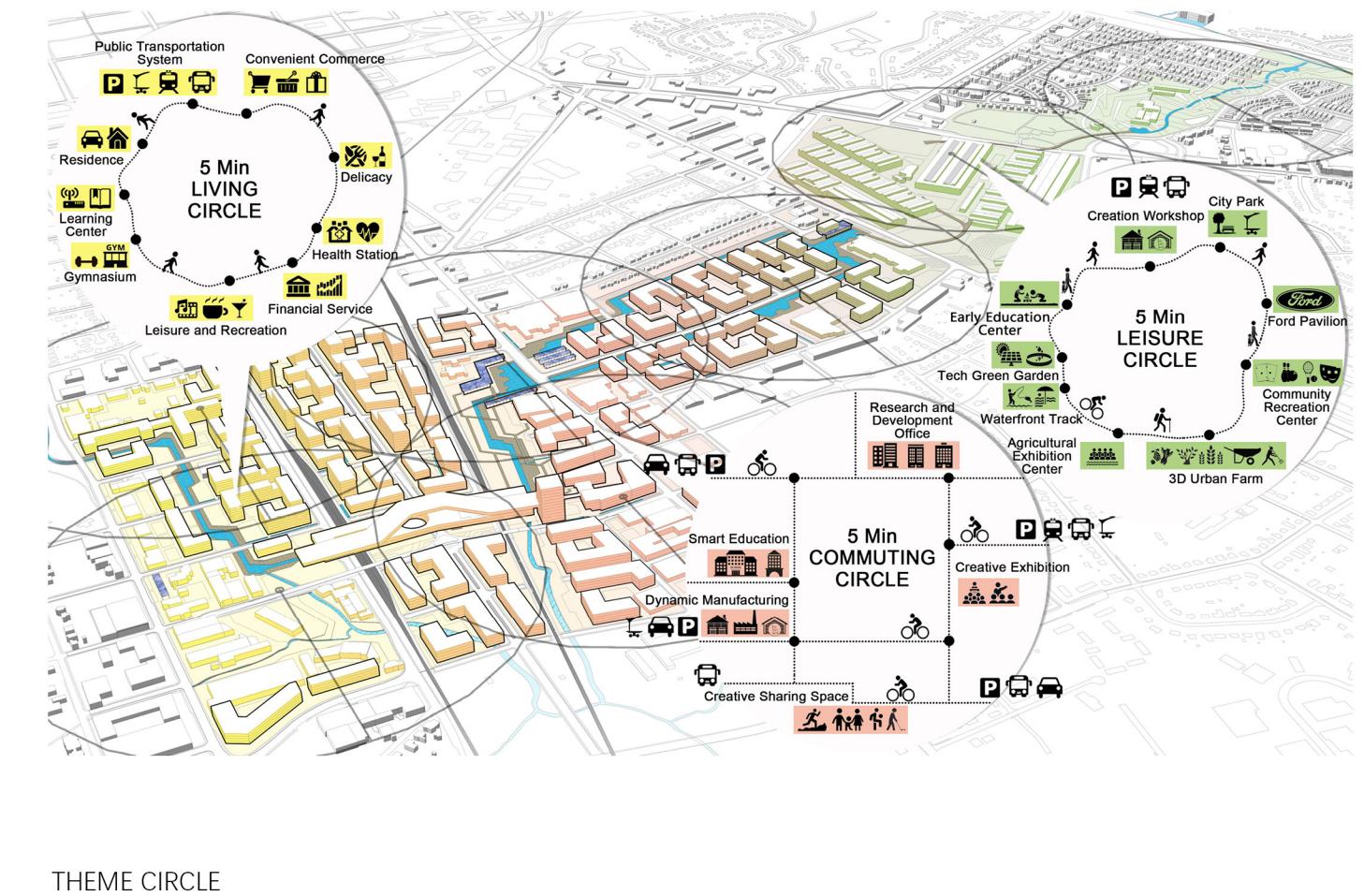
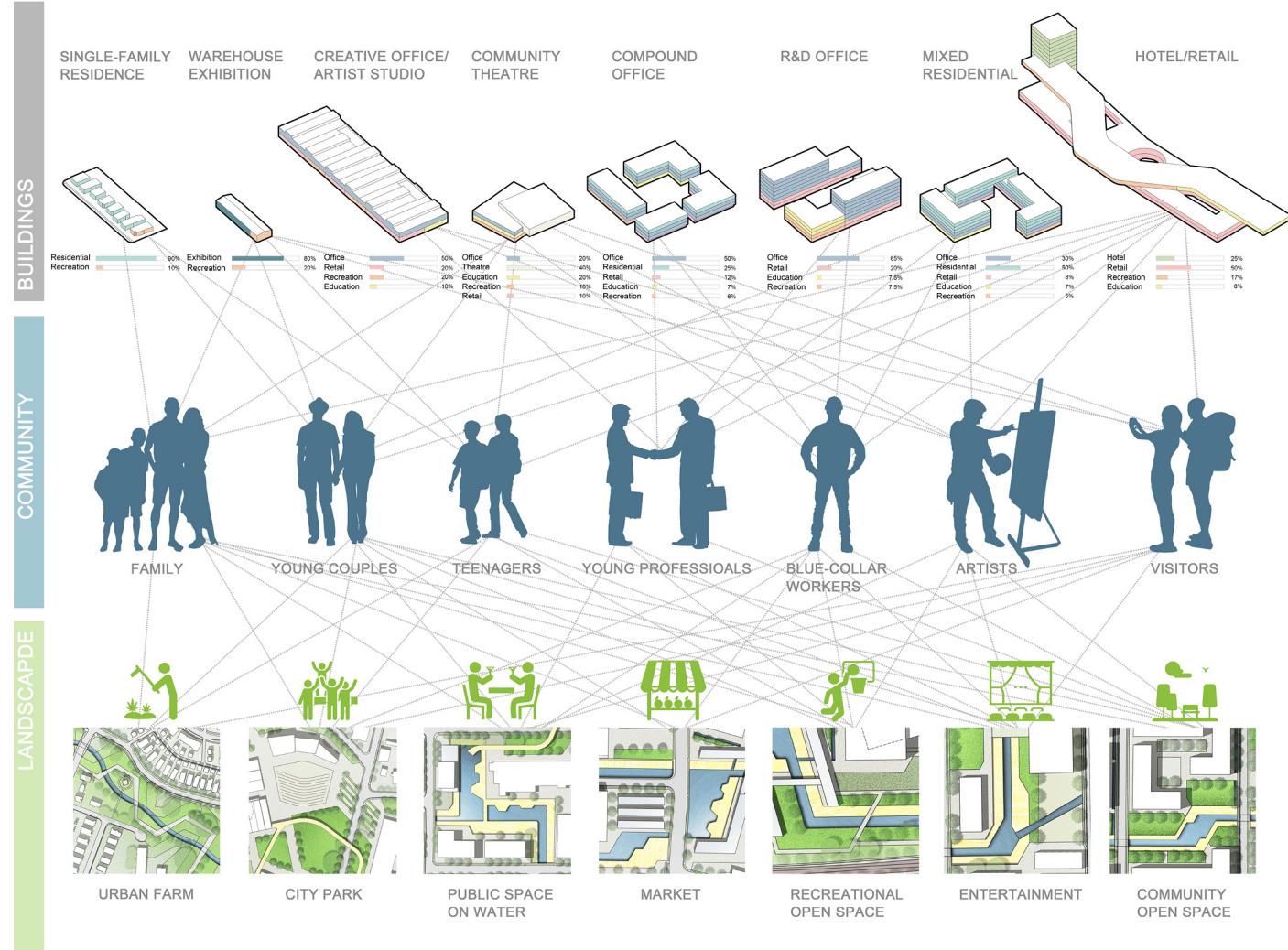
Generating DEM data without depressions

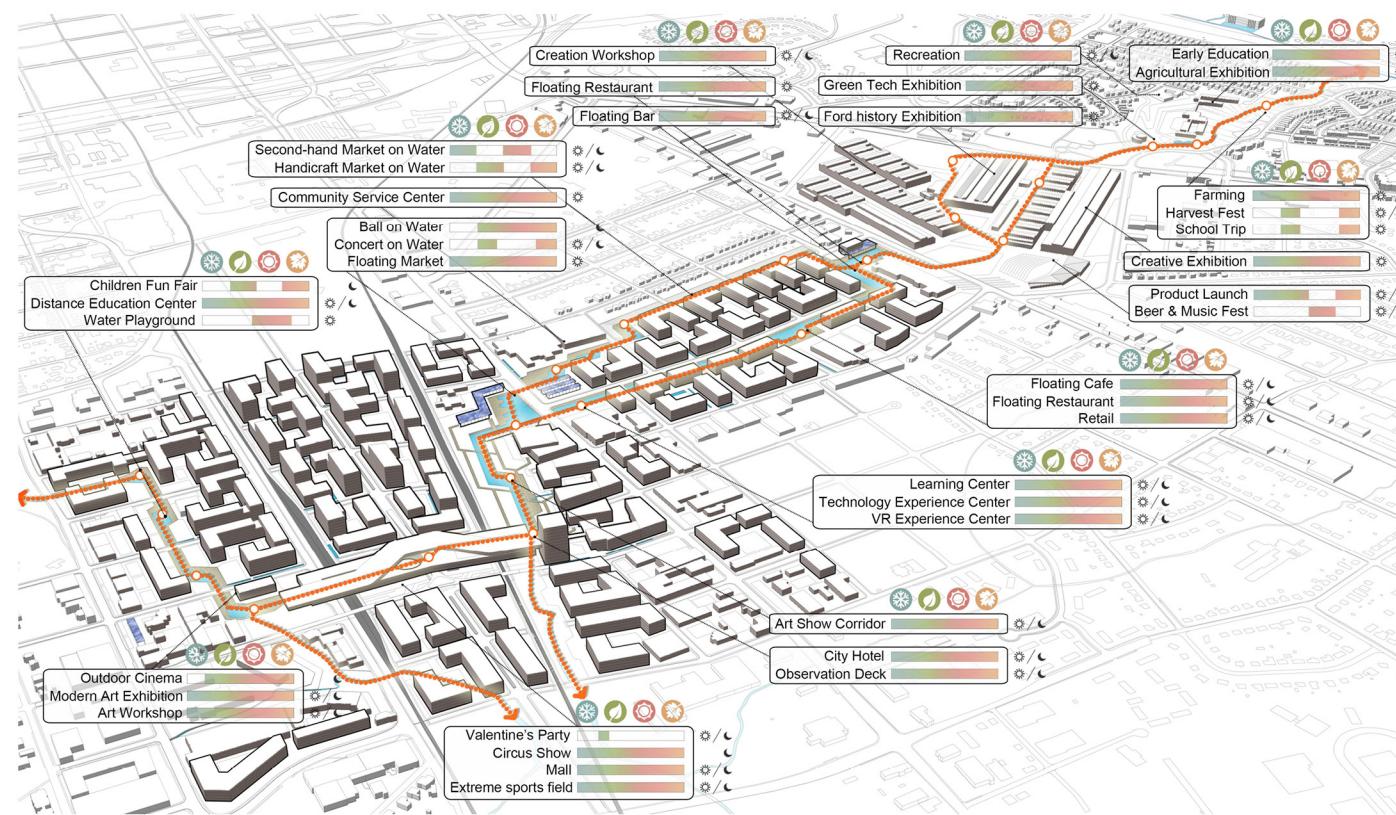


Original contour (line)

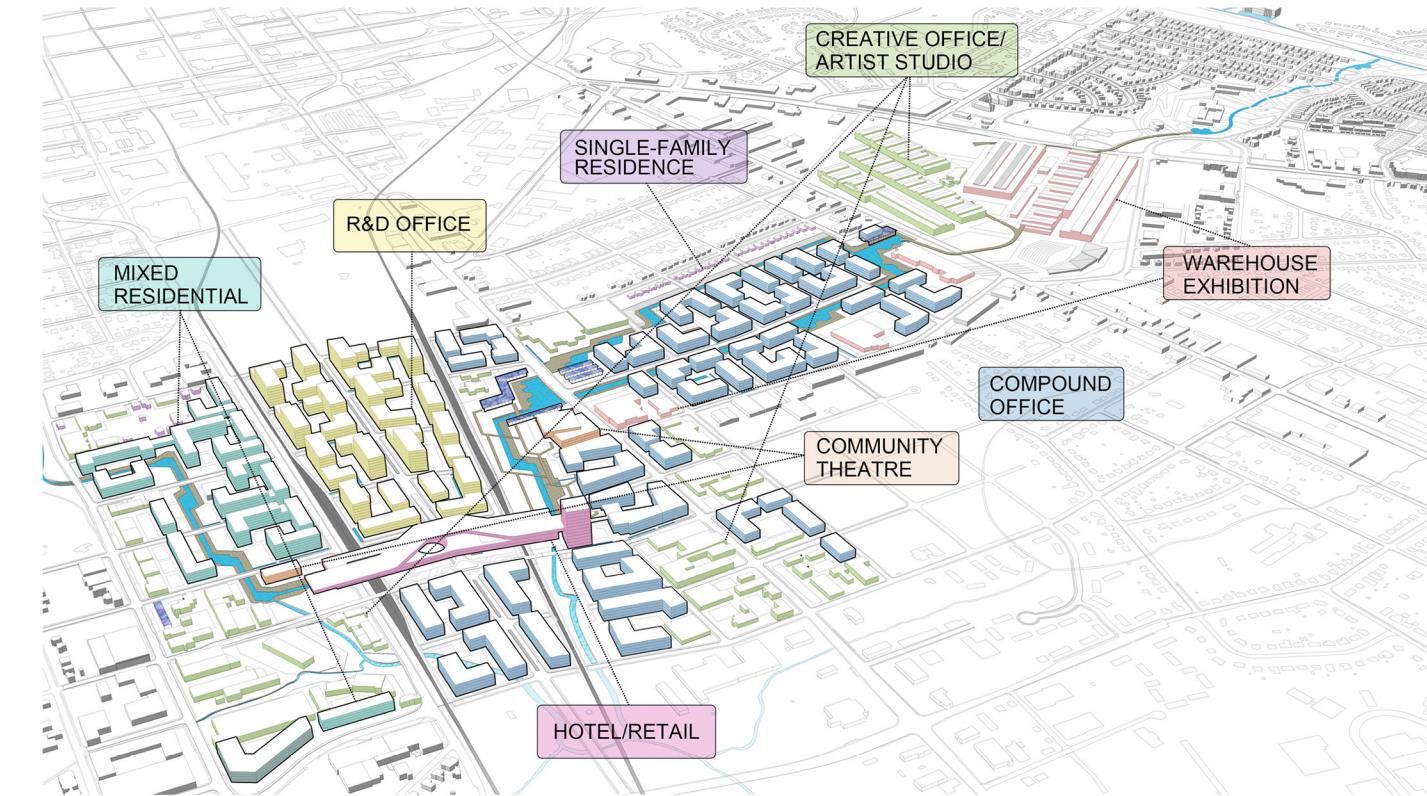
Data-informed urban design for smart cities——North End Smart District

智慧城市——同济 - 北卡夏洛特联合设计

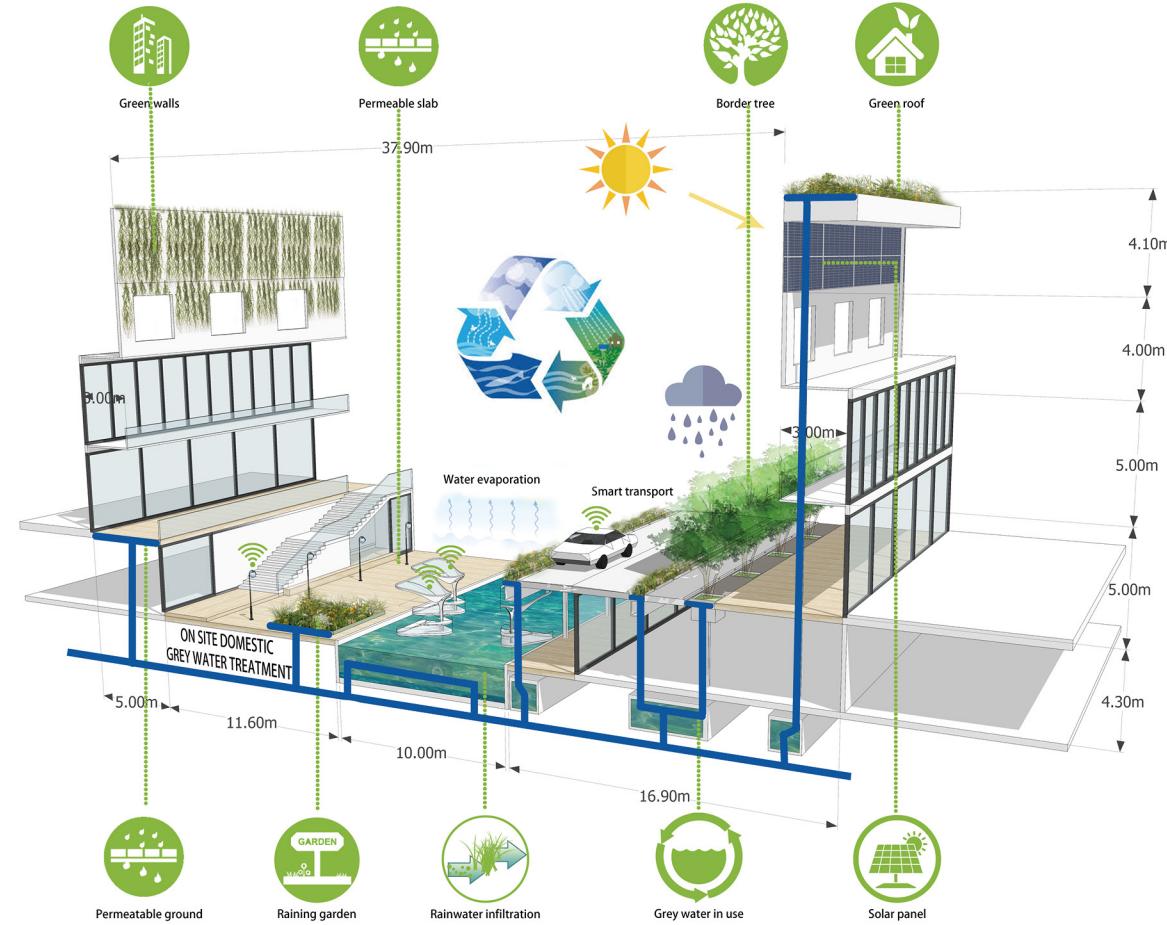




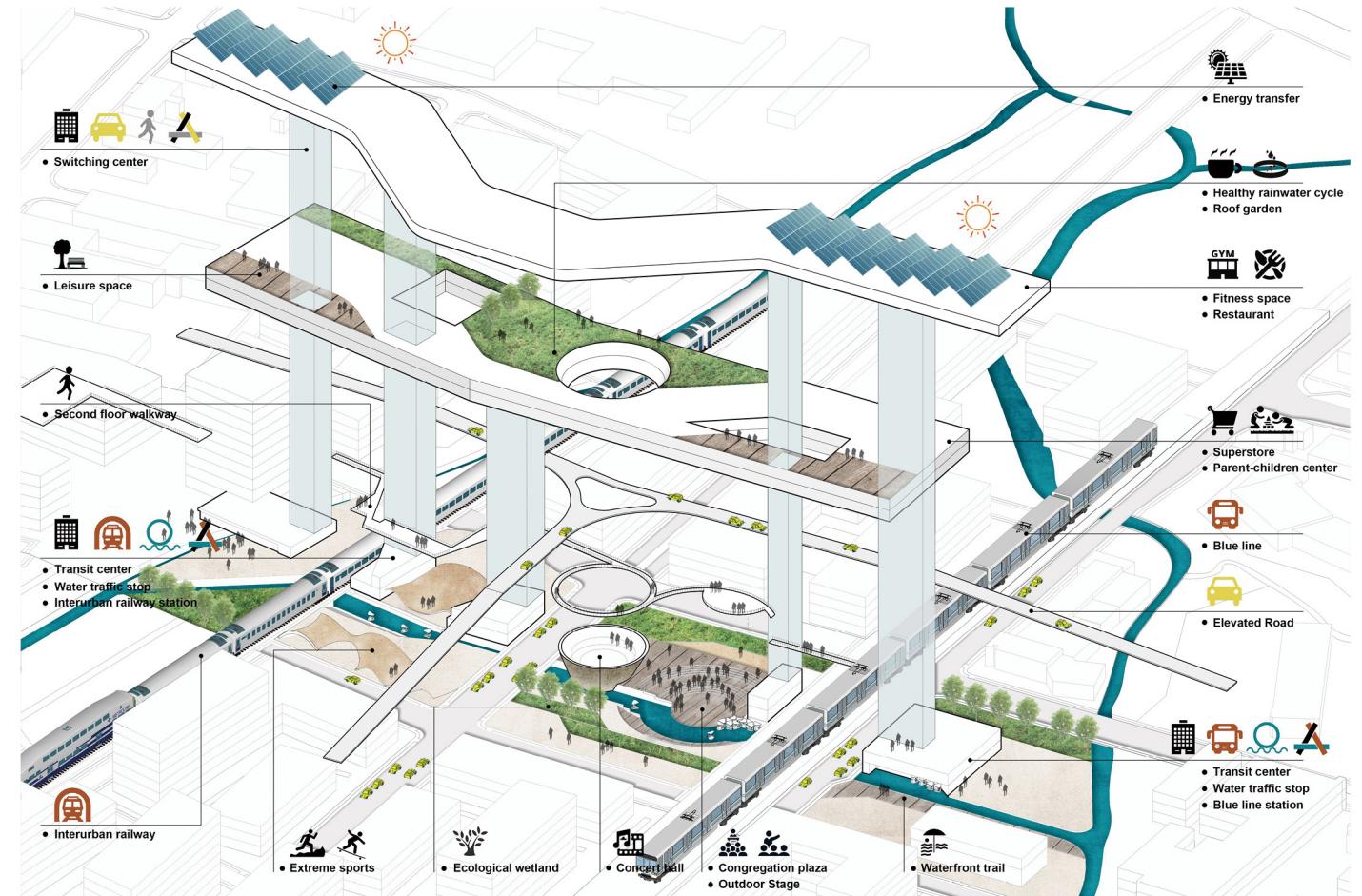
BEHAVIOR ORGANIZATION



BUILDING TYPOLOGY



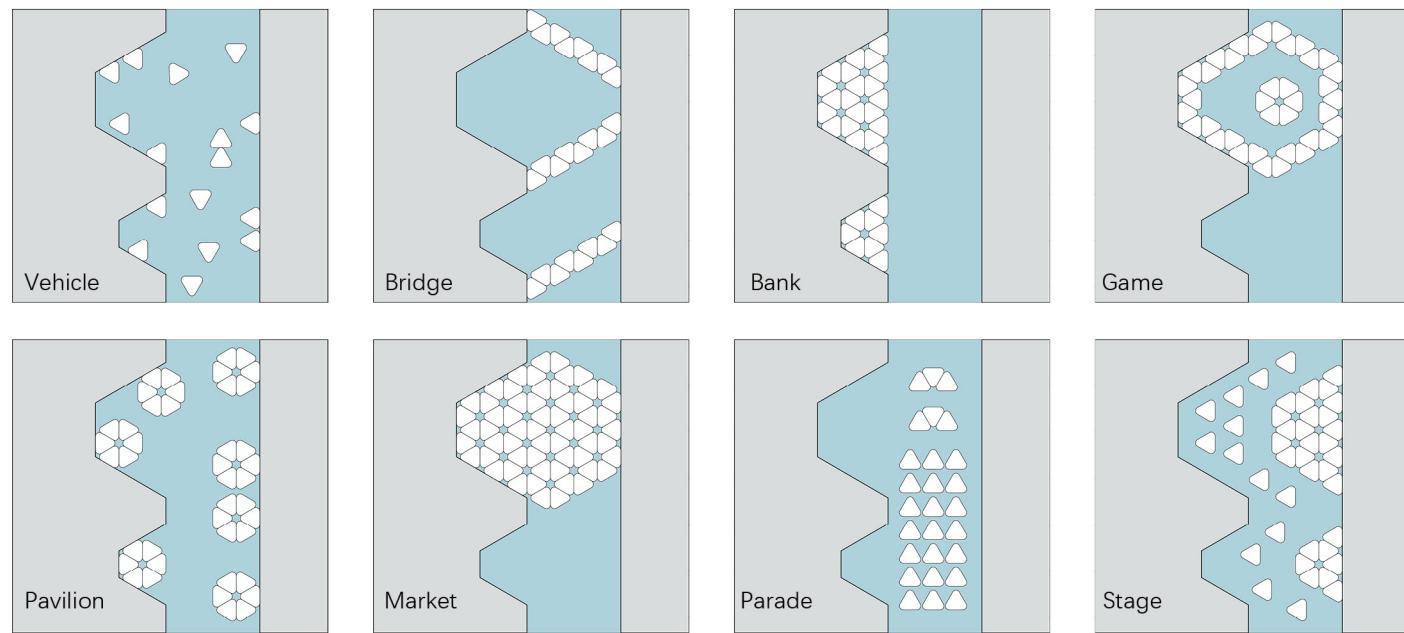
The section of the road shows off lots of technics used in smart urban design, such as permeable ground, raining garden, rainwater infiltration, grey water in use, solar panels, smart transport, green walls, permeable slab, green roof as well as on site domestic grey water treatment. All are joined together to make life more easy and convenient.



The biggest building in our site will be the one above. It is not only a Blue line station, but also a shopping mall, a ecological wet land, a leisure space. People can do extreme sports, enjoy concert, fitness and wonderful meal here. It goes across blue line, rail way and several roads to link east and west neighborhood.

06 节点深化 Overall Scene

We design a special vehicle which can be used in quite a lot of situations. It is at first a quick transportation vehicle both in water and on land in daily life. What's more, many of them can be assembled into bridges, pavilions, floating markets, stages. Besides of changing the shape of river bank, they can be also used to play games and serve for celebration parade during the holidays. All can be easily controlled by smart phone if you like.

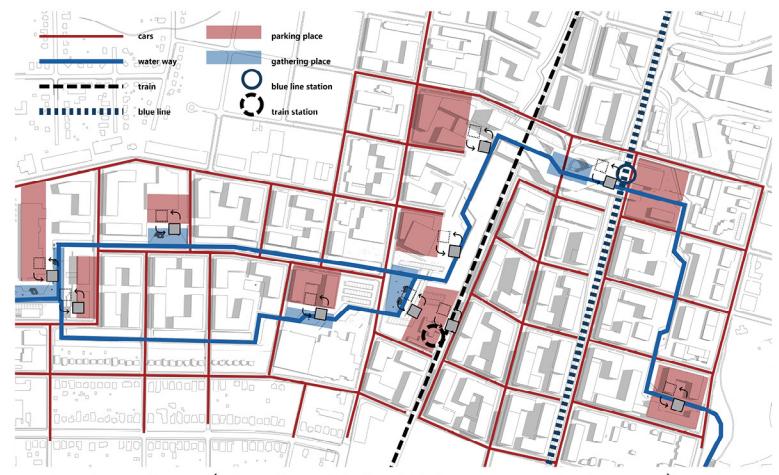


Data-informed urban design for smart cities——North End Smart District

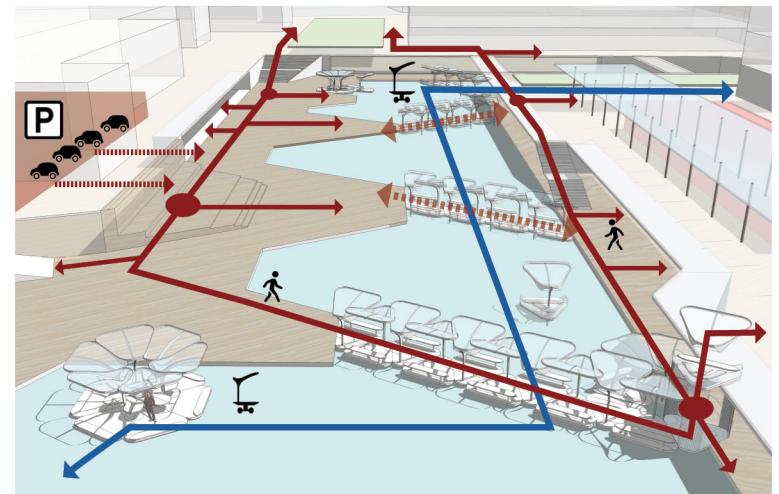
智慧城市——同济 - 北卡夏洛特联合设计

节点深化 06 Overall Scene

Can you imagine how many activities you can take part in during weekends? Go skiding, enjoy music show, dating with your friends, go shopping near your home or attending wedding dance at night...In raining days, roof of the smart vehicles can prevent you from beeing caught in the rain. Also, they will be glorious like streetlight in dark situation.



Traffic transfer- (Blue line, Train, Water way, private cars)



Flexible traffic transfer- (From a local point of view)

Data-informed urban design for smart cities——North End Smart District

智慧城市——同济 - 北卡夏洛特联合设计

06 节点深化
Overall Scene

节点深化 06
Overall Scene

