Smart and Healthy Cities

Connect and Collaborate!

Africa GIS 2019
November 21, 2019

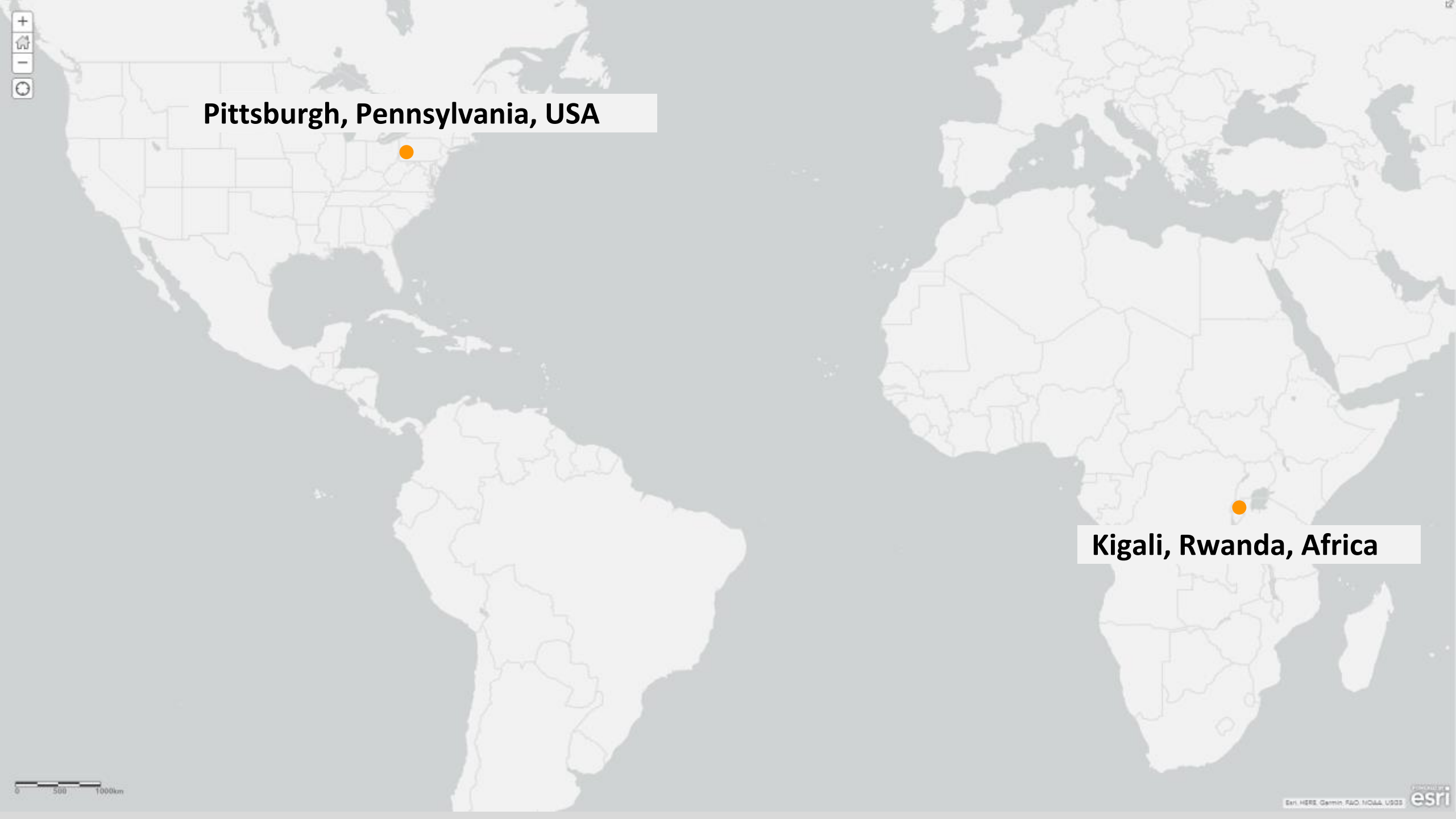
Professor Kristen Kurland

Carnegie Mellon University
Pittsburgh, Pennsylvania, USA

kurland@cmu.edu

@kurlandk

My City


Pittsburgh, Pennsylvania, USA
Kigali, Rwanda, Africa

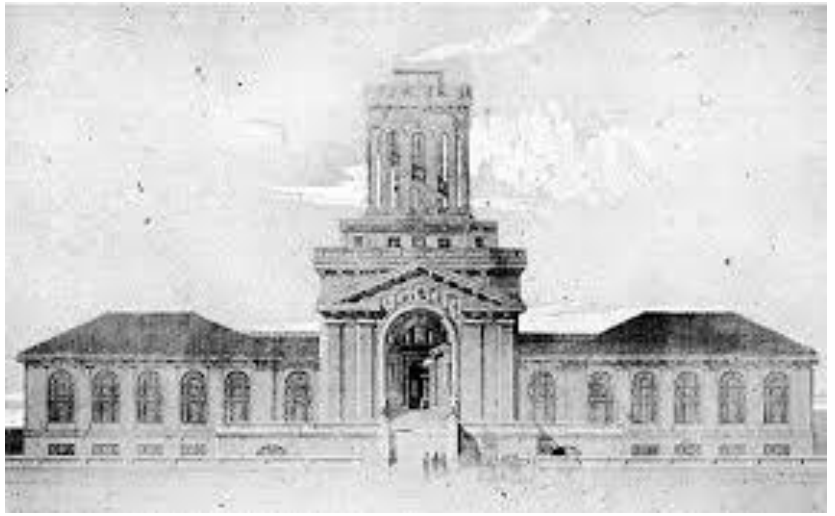
Welcome to Pittsburgh!

1940 - 1950

“Abandon it!”

- Frank Lloyd Wright,
on being asked how he
would go about improving
Pittsburgh

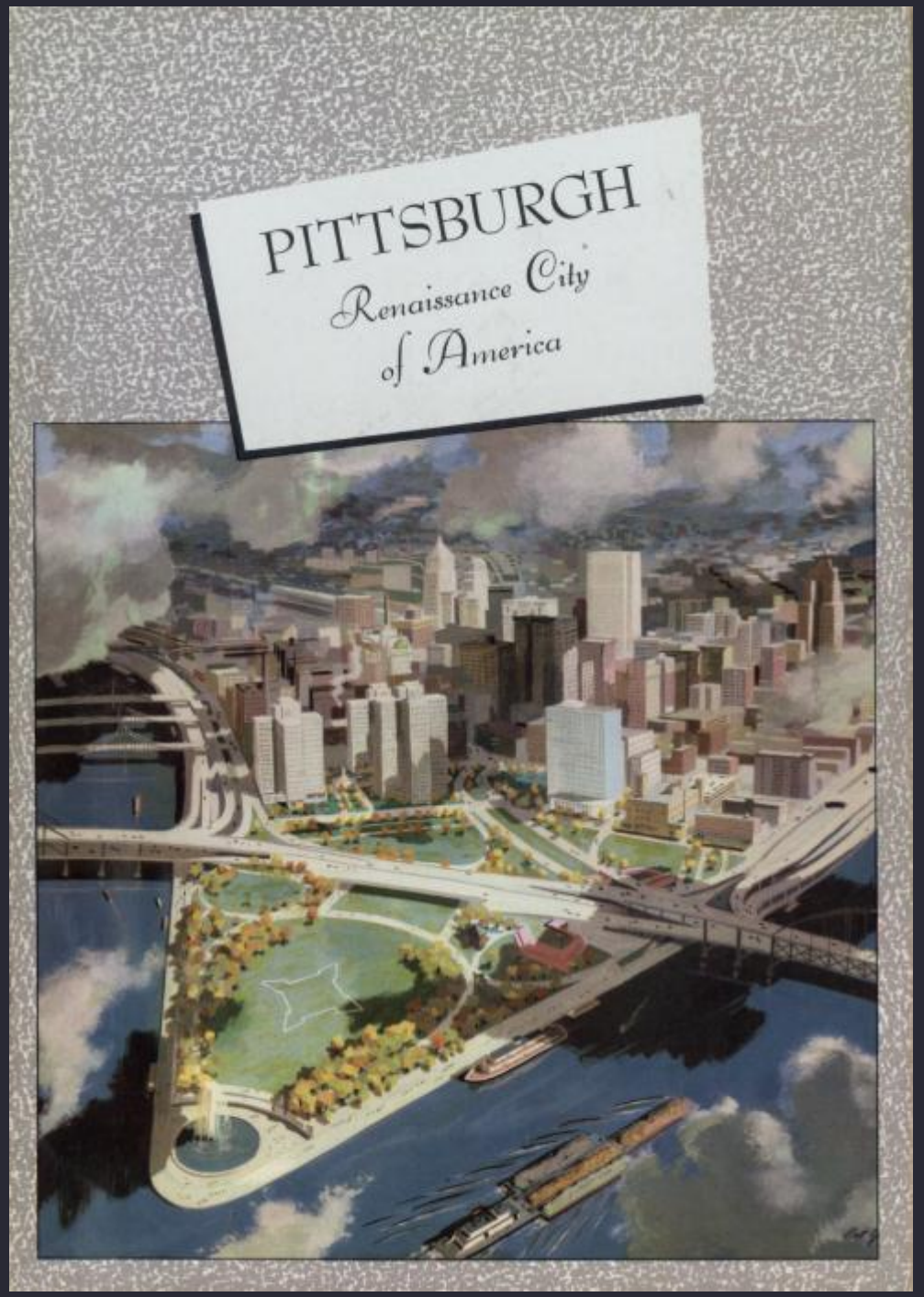
Carnegie Technical Schools



1903 Pittsburgh chosen as the site for Andrew Carnegie's technical schools

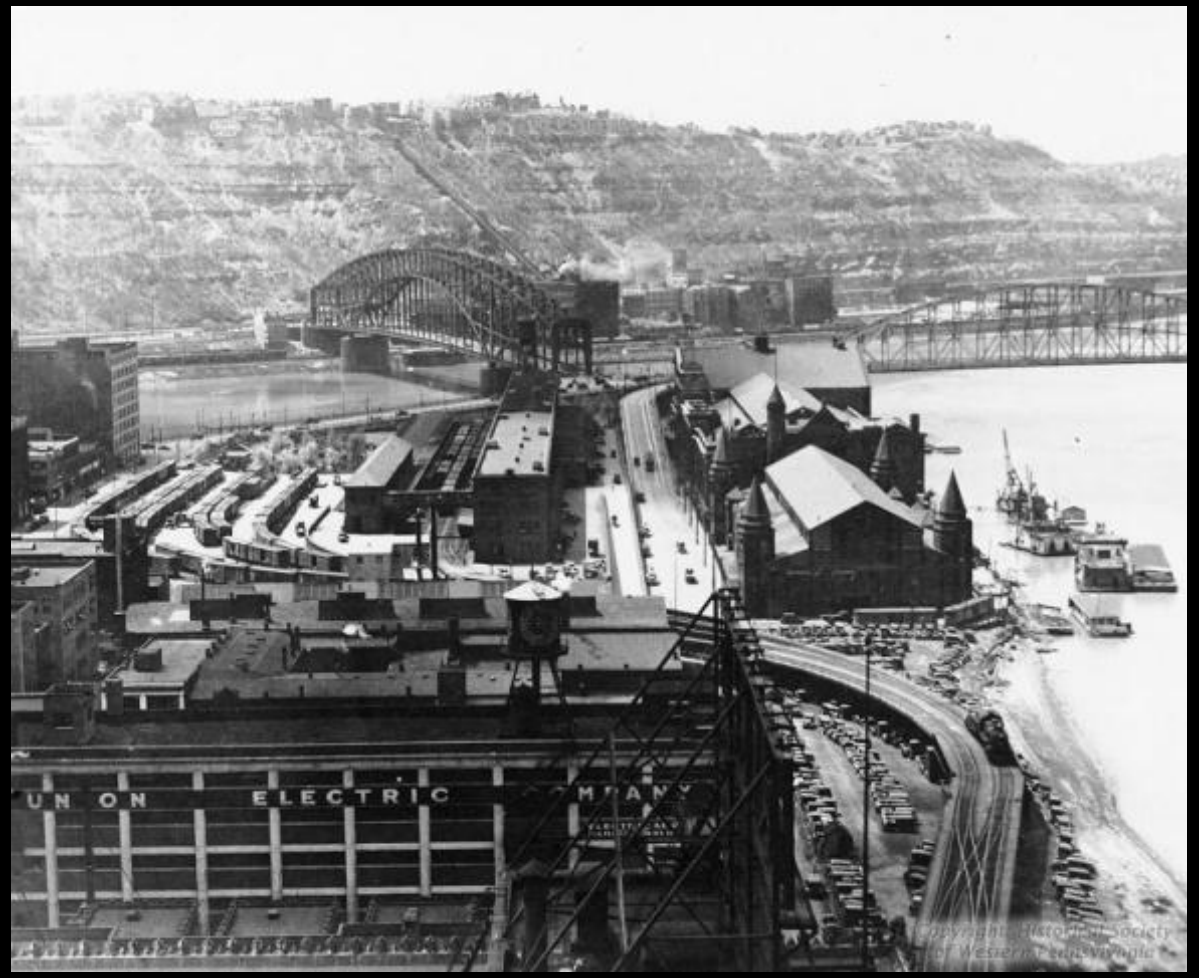
1908 The class of 1908 consists of 58 graduates

Architectural Practice: **4**
Chemical Engineering Practice: **2**
Metallurgical Engineering Practice: **8**
Civil Engineering Practice: **7**
Electrical Engineering Practice: **23**
Mechanical Engineering: **14**


PITTSBURGH
Renaissance City
of America


SMOKE MUST GO!
FOR
BETTER HEALTH
CLEANER LIVING
A BRIGHTER PITTSBURGH.

Pittsburgh Today



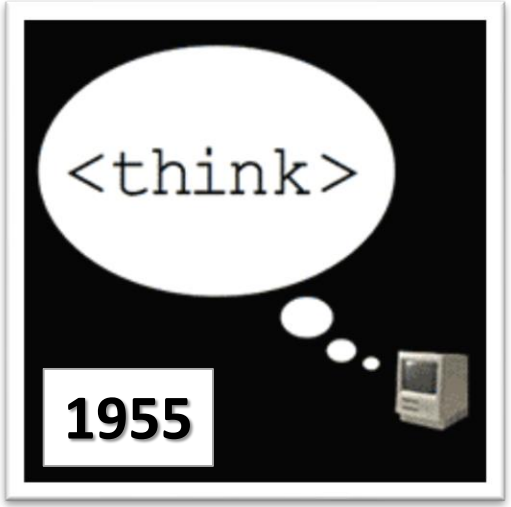
from Steel Town…

… to “Eds” and “Meds”

- **College of Engineering**
- **College of Fine Arts**
- **Dietrich College** of Humanities and Social Sciences
- **H. John Heinz III College** of Information Systems and Public Policy
- **Mellon College of Science**
- **School of Computer Science**
- **Tepper School of Business**

Research **Education** **Interdisciplinary Collaboration**

Engineering & Science



Herb Simon and Alan Newell
"thinking machine"
founders of

Artificial Intelligence

nations first

Robotics Institute

unmanned vehicles clean up
3 Mile Island nuclear accident

U.S.'s first undergraduate degree in

Drama

Andy Warhol
student in the Department of Painting & Design
Pioneer in computer generated art

Humanities & Art

Innovation Corridor

CMU Global


Carnegie Mellon University
in Australia


Carnegie Mellon University Qatar

Carnegie Mellon University

Africa!!


Carnegie Mellon University Africa
World-Renowned Faculty | Collaborative Learning | Innovative Solutions | Graduates Employers Hire


Carnegie Mellon University
Africa College of Engineering
Educating and empowering the next generation of
African leaders and innovators


Carnegie Mellon University
Africa College of Engineering

Heinz College

Civil and Environmental Engineering

Design

Drama

Computer Science

Carnegie Mellon University

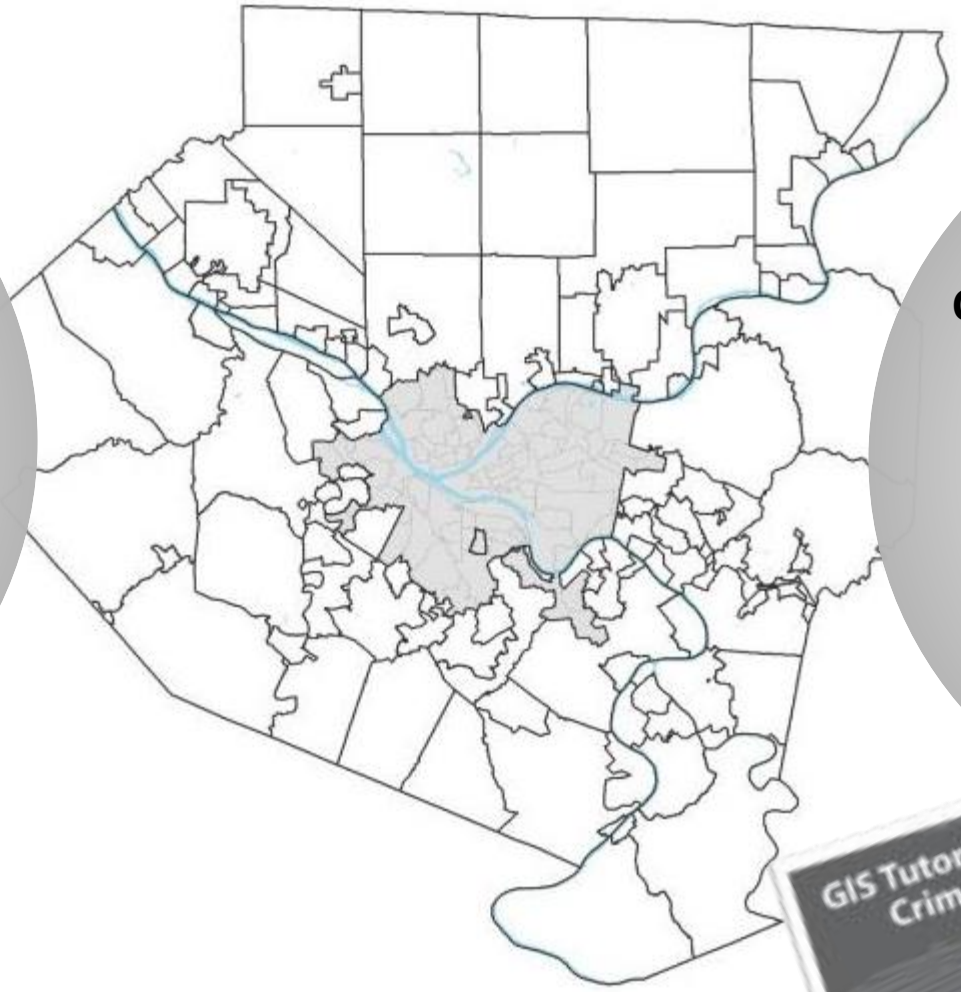
Music

Robotics

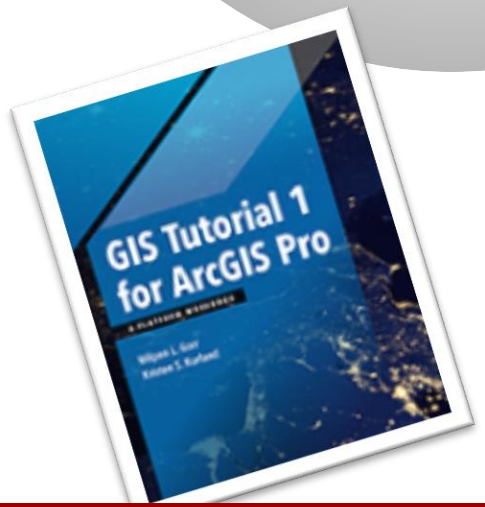
Library

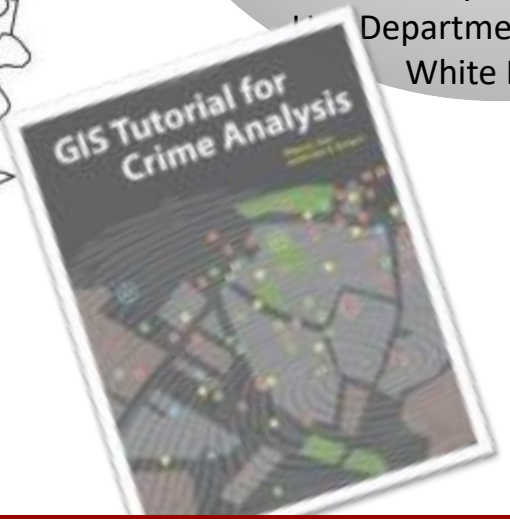
School of Architecture

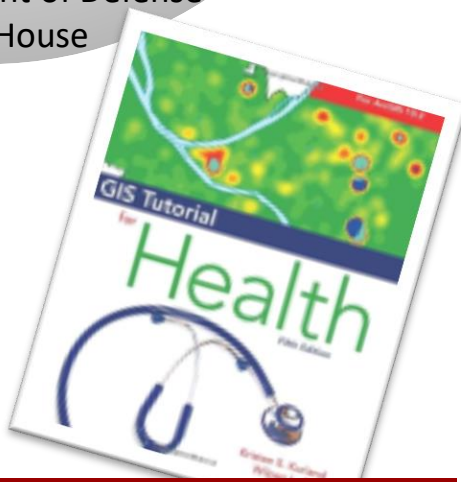
Entertainment Technology



Allegheny County:
Health Department & Medical Society
Allegheny Health Network
Children's Hospital of Pittsburgh
Central Blood Bank
City of Pittsburgh
Greater Pittsburgh Food Bank
New York City Health Department
Pennsylvania Poison Center
Pittsburgh Public Schools
RAND Corporation
University of Pittsburgh Medical Center
University of Pittsburgh
Department of Defense
White House

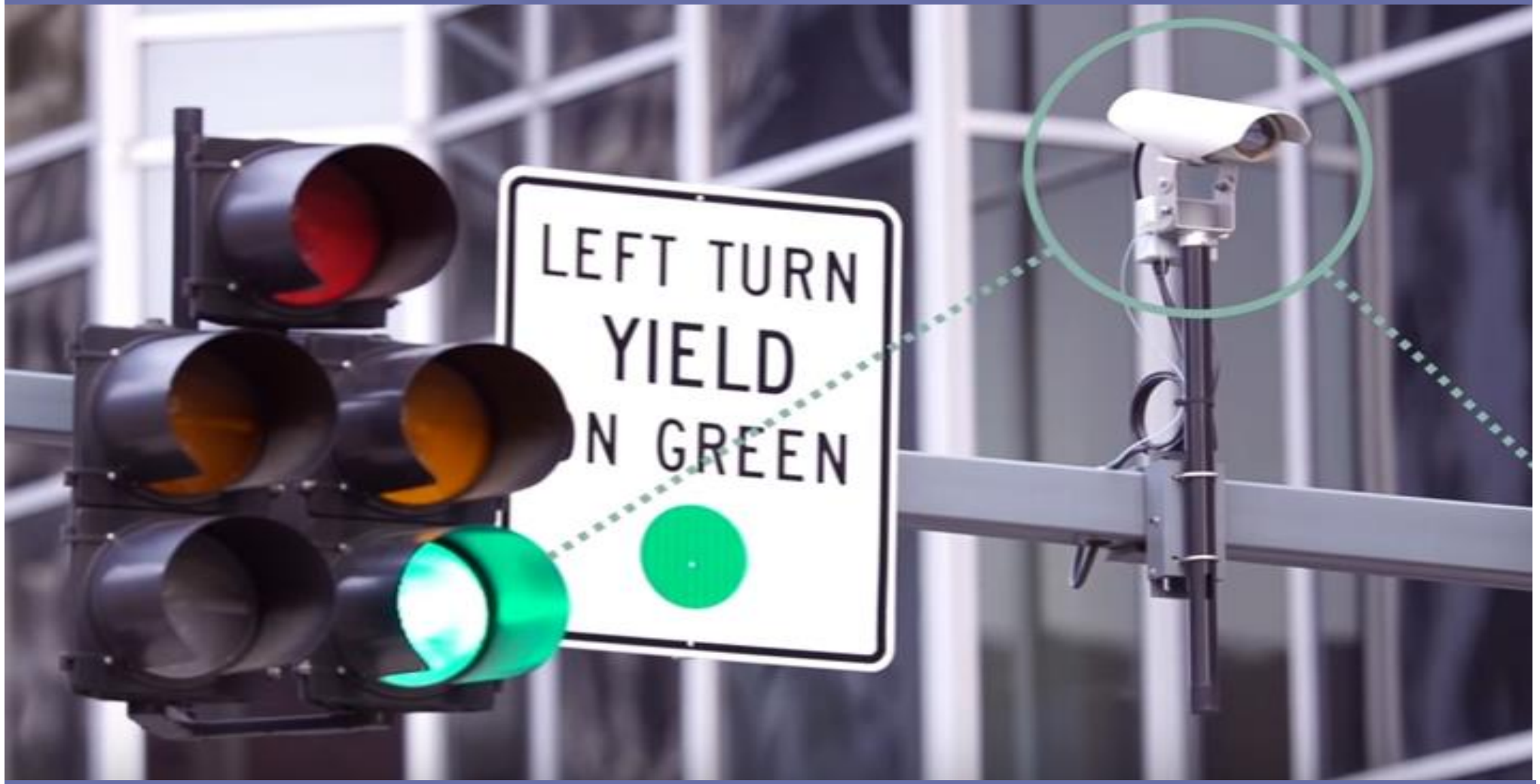






Crossing Boundaries…Connecting and Collaborating

information and communication technologies



sensors meters big data analytics

Smart Cities

are **far greater** than an assembly of technologies and data

true **mobility**

net zero **energy**

clean **air** and **water**

economic **prosperity**

safe and **healthy** citizens

Collaboration **Engagement** **Transparency**

City Partnerships

2009

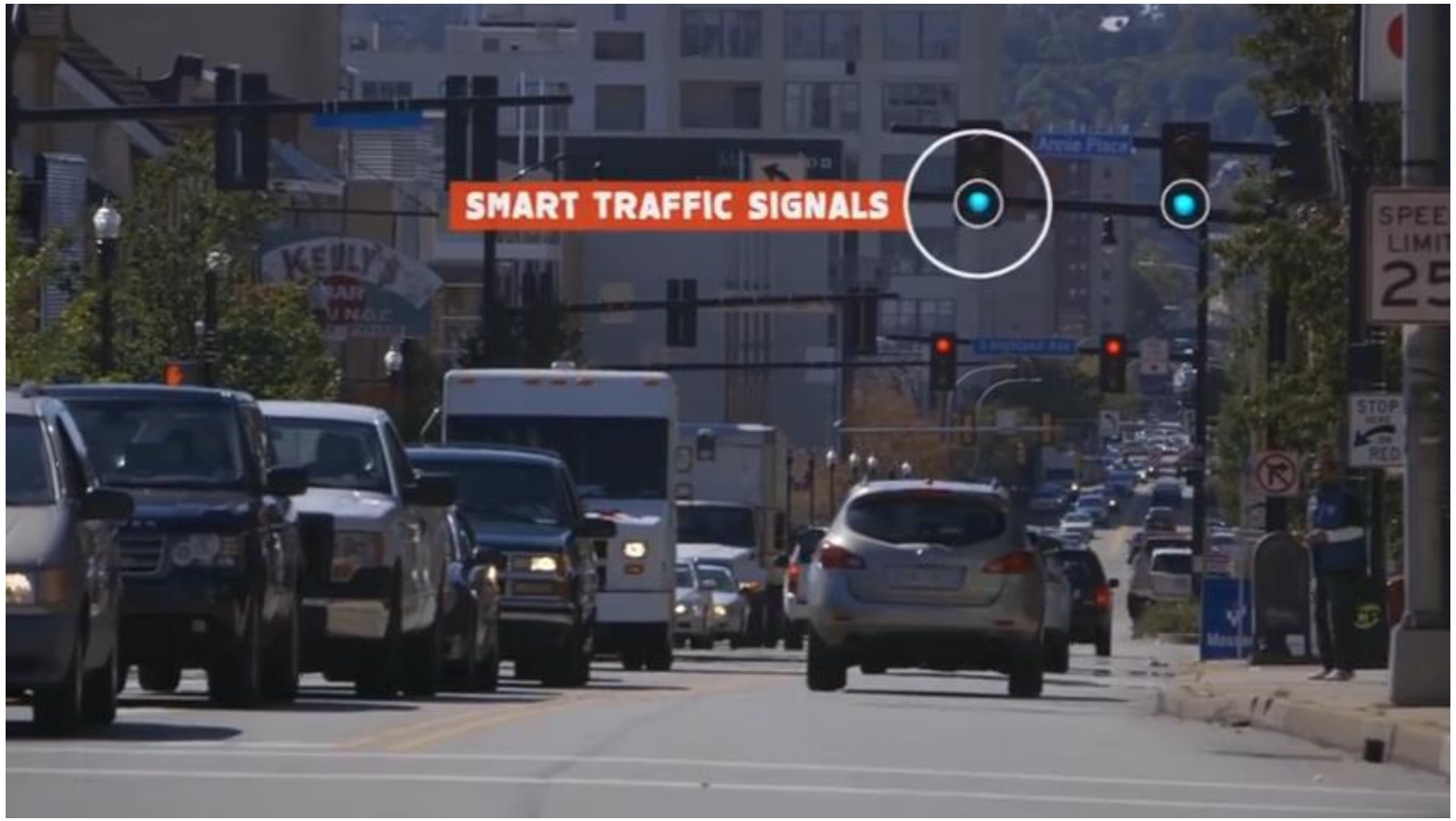
traffic21

a transportation research institute of Carnegie Mellon University

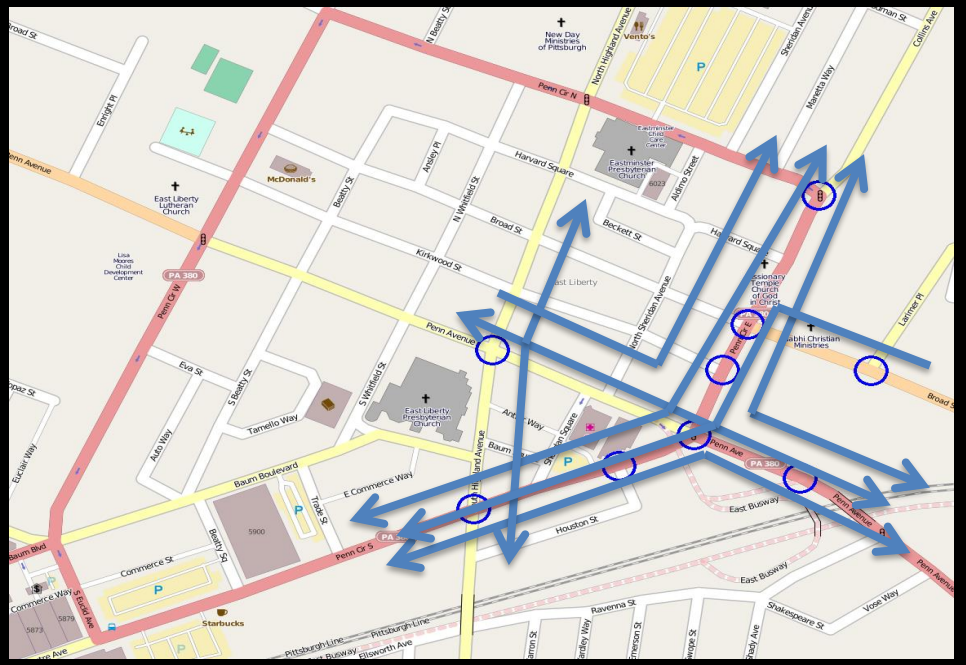
RD&D

Research and Development and Deployment

Traffic research with Pittsburgh as test bed



CMU and the City of Pittsburgh



Pilot project

EMMISSIONS
20%

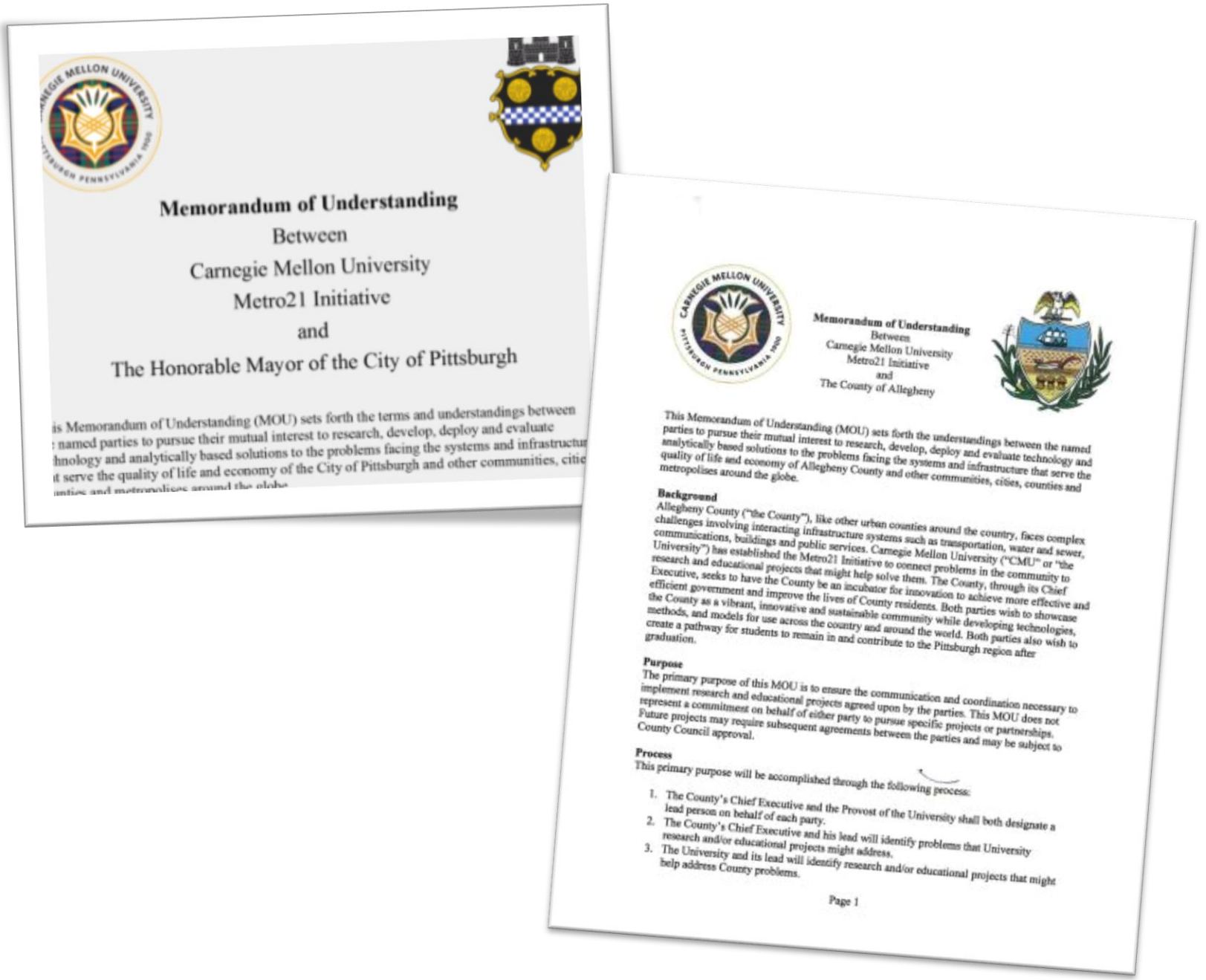
IDLE TIME
40%

TRAVEL TIME
25%

2014

Metro21
Carnegie Mellon University

Economic Development
Human Capital
Governance & Civic Engagement
Health & Public Safety
Transportation and Infrastructure
Water, Energy, Sustainability



Memorandum of Understanding
Between
Carnegie Mellon University
Metro21 Initiative
and
The Honorable Mayor of the City of Pittsburgh

is Memorandum of Understanding (MOU) sets forth the terms and understandings between
named parties to pursue their mutual interest to research, develop, deploy and evaluate
hnology and analytically based solutions to the problems facing the systems and infrastructur
t serve the quality of life and economy of the City of Pittsburgh and other communities, citie
nties and metropolises around the globe.

Memorandum of Understanding
Between
Carnegie Mellon University
Metro21 Initiative
and
The County of Allegheny

This Memorandum of Understanding (MOU) sets forth the understandings between the named parties to pursue their mutual interest to research, develop, deploy and evaluate technology and analytically based solutions to the problems facing the systems and infrastructure that serve the quality of life and economy of Allegheny County and other communities, cities, counties and metropolises around the globe.

Background
Allegheny County ("the County"), like other urban counties around the country, faces complex challenges involving interacting infrastructure systems such as transportation, water and sewer, communications, buildings and public services. Carnegie Mellon University ("CMU" or "the University") has established the Metro21 Initiative to connect problems in the community to research and educational projects that might help solve them. The County, through its Chief Executive, seeks to have the County be an incubator for innovation to achieve more effective and efficient government and improve the lives of County residents. Both parties wish to showcase the County as a vibrant, innovative and sustainable community while developing technologies, methods, and models for use across the country and around the world. Both parties also wish to create a pathway for students to remain in and contribute to the Pittsburgh region after graduation.

Purpose
The primary purpose of this MOU is to ensure the communication and coordination necessary to implement research and educational projects agreed upon by the parties. This MOU does not represent a commitment on behalf of either party to pursue specific projects or partnerships. Future projects may require subsequent agreements between the parties and may be subject to County Council approval.

Process
This primary purpose will be accomplished through the following process:

1. The County's Chief Executive and the Provost of the University shall both designate a lead person on behalf of each party.
2. The County's Chief Executive and his lead will identify problems that University research and/or educational projects might address.
3. The University and its lead will identify research and/or educational projects that might help address County problems.

Page 1

Street Lighting


SMART STREET LIGHTS
CITYWIDE NETWORK OF AIR EMISSIONS SENSORS
ENERGY USAGE
▼ 60%

Innovative
Buildings and Districts

City-County Building

I.E.Q

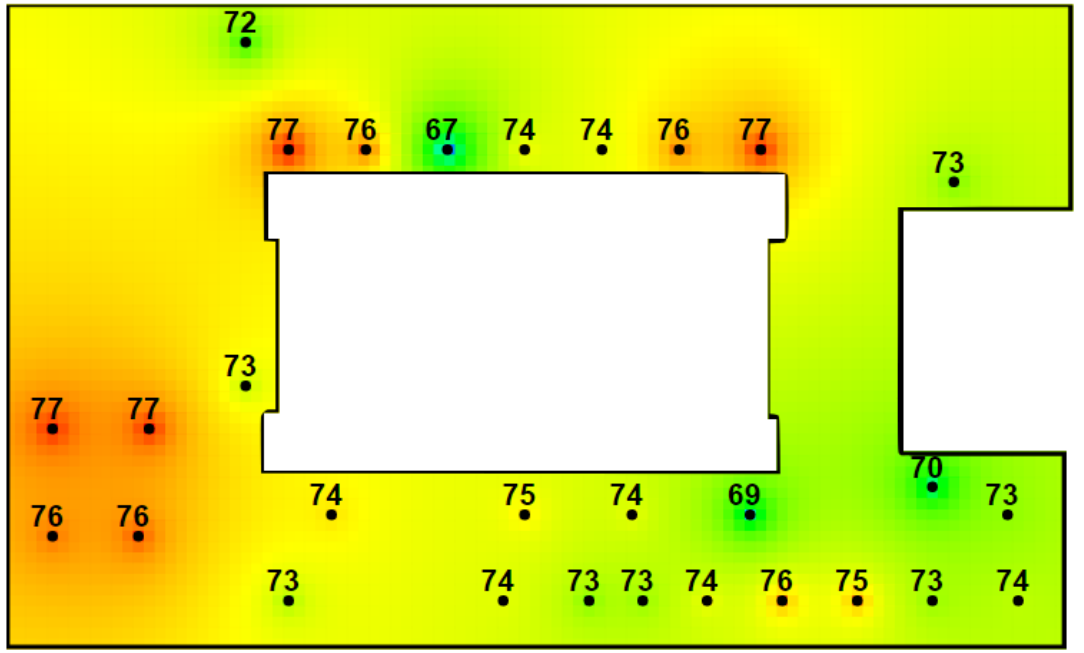
CLOUDY

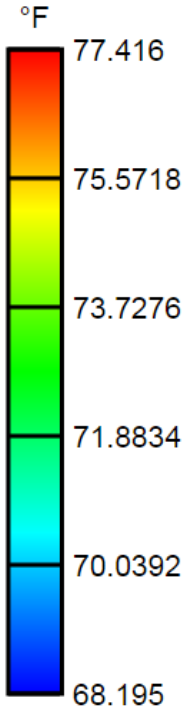
64.1°F
TEMPERATURE

77%
HUMIDITY

0PPM
CO_2

L6





Temperature


Pittsburgh 2030 District
Signed Buildings
Signed-Unbuilt
Buildings
Unbuilt
Parks
Copyright 2016 Green Building Alliance
PITTSBURGH
2030
DISTRICT®

Energy Use

minimum 10% reduction below the **national average** by 2015, with incremental targets reaching a 50% reduction by 2030

Water Use and Transportation CO2 emissions

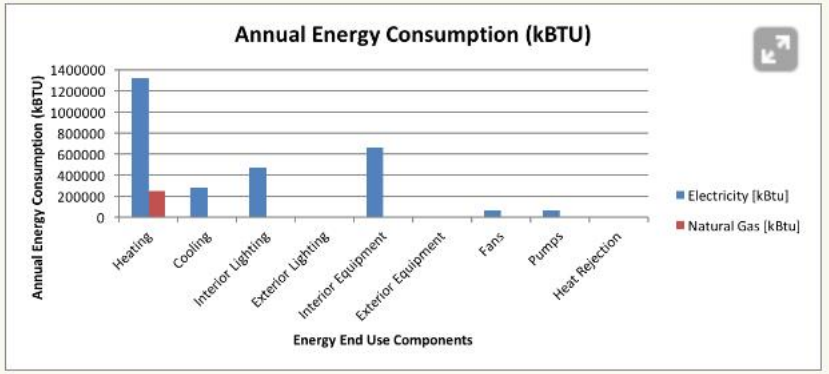
minimum 10% reduction below the **district average** by 2015, with incremental targets reaching a 50% reduction by 2030

Indoor Air Quality

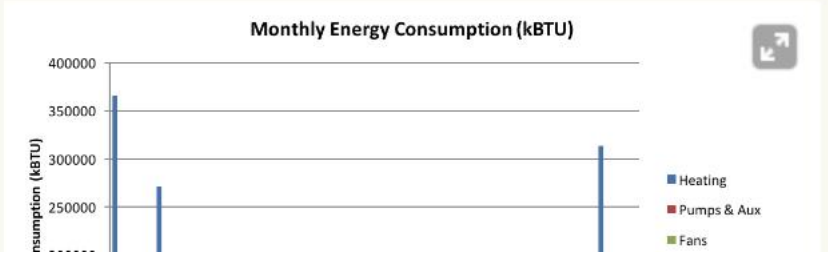
determined by District Partners

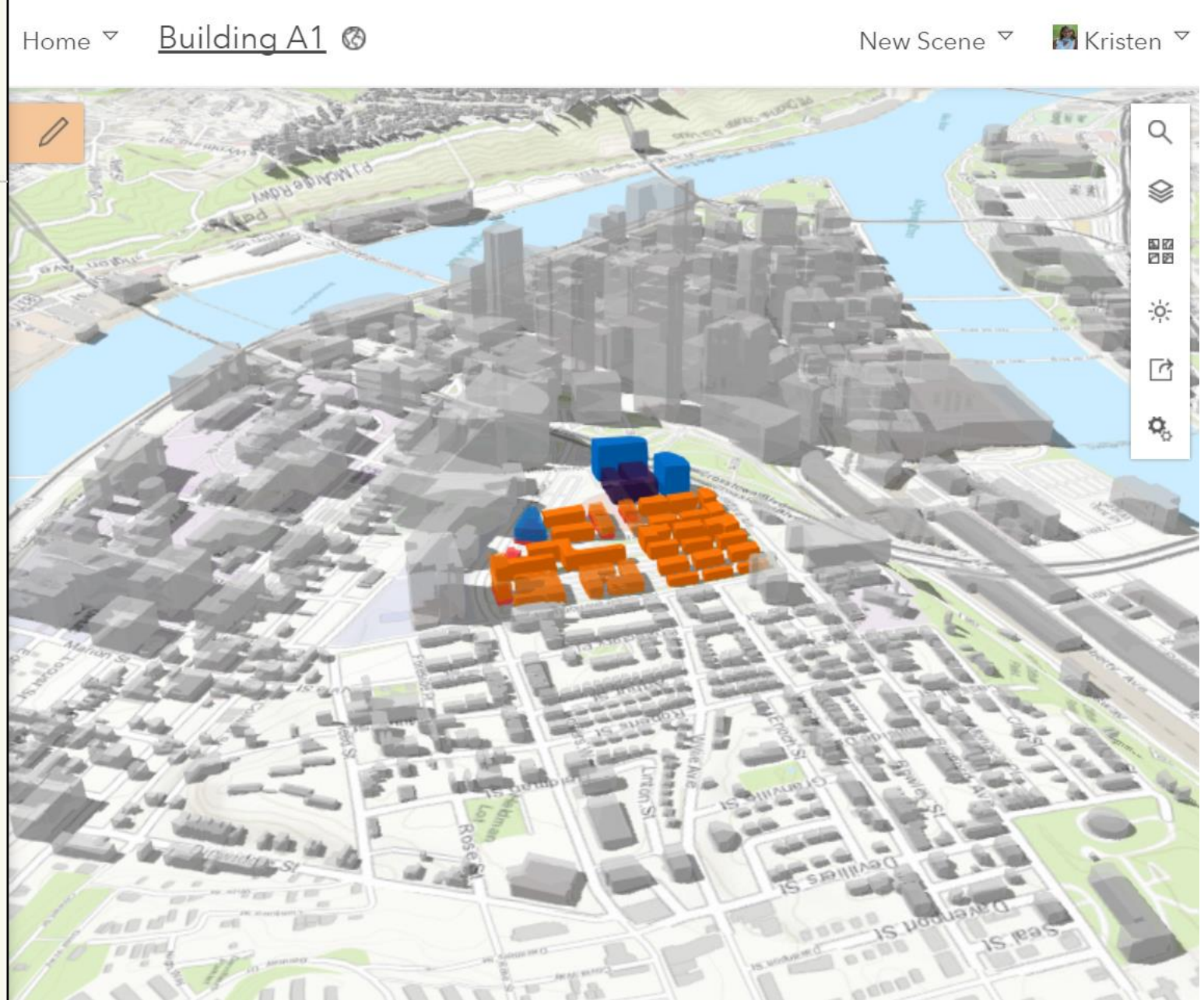
The Pittsburgh Arena District Master Development Plan

Energy simulation results - Building A1



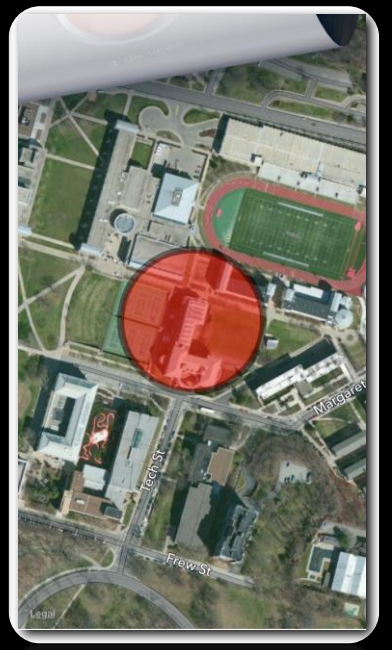
Building A1 Energy End-Use Consumption

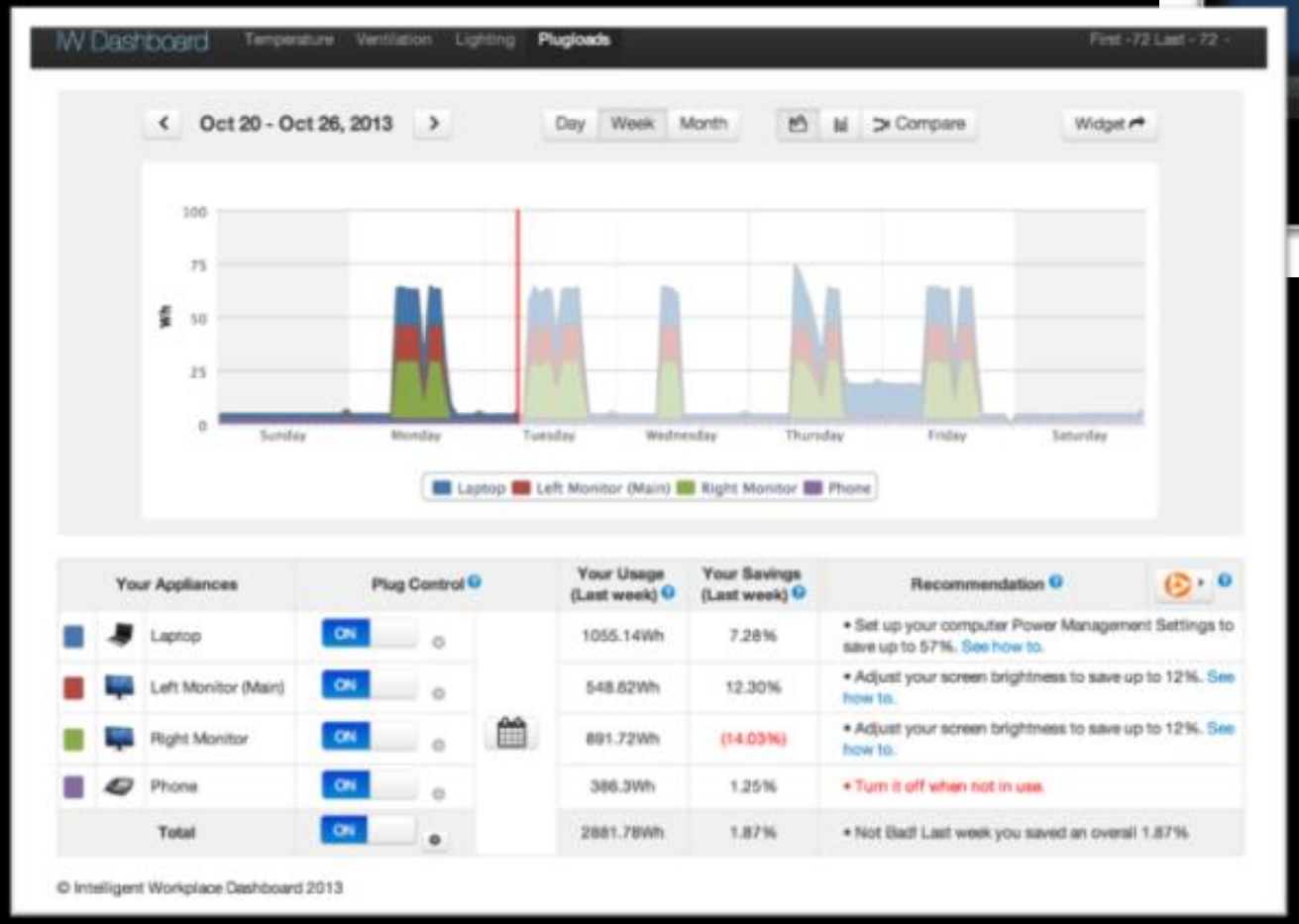




Engaging

Occupants & Public





Innovations in Urban Design

PITTSBURGH

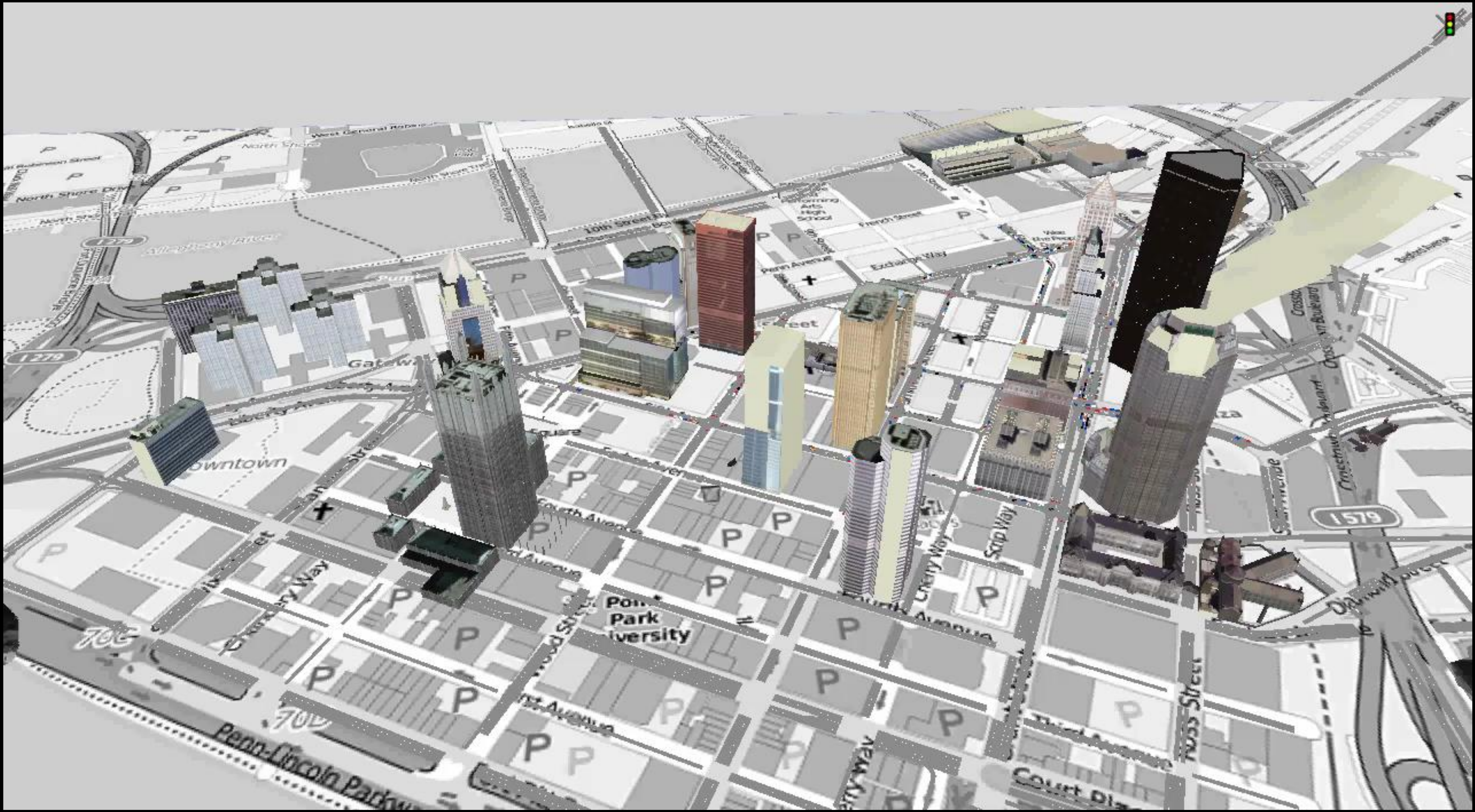
People Planet Place Performance

2015 Summit

Pittsburgh p4 Performance Measures

3D at CMU

More traffic studies



North Shore
Allegheny River
10th Street
Penn Avenue
Exchange Way
French Street
I 279
I 579
Park
Wood Street
Cherry Way
Scrip Way
Ross Street

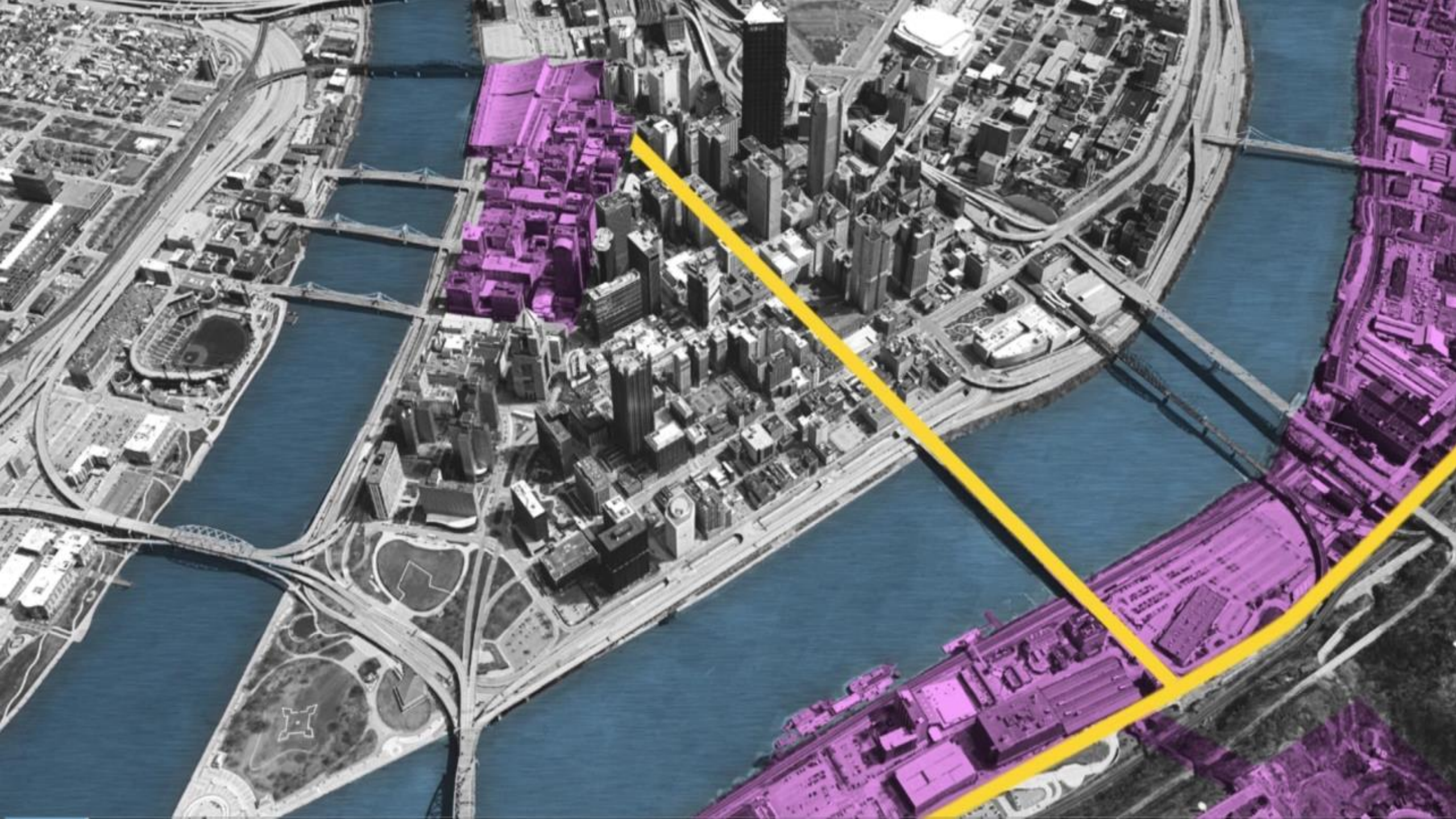
Gaming


BRTSIM
BRT Station: Fifth Ave
SUBMIT
STATION DESIGN OPTIONS
STATION AMENITIES
COMPLETE STREET OPTIONS
Street Options
+ADD NEW LANE
CURRENT ROAD WIDTH 39'
CURRENT SIDEWALK WIDTH 20'
AVAILABLE LANE SPACE 21'
CURB CHANGE REQUIRED Yes
BACK TO MAP
6' Bike
MOVE
12' Bus
MOVE
11' Traffic
MOVE
11' Traffic
MOVE
SERVICE
BUS TYPE
BRANDING
DISPLAYS
FARES

BIM and 3D Rendering

OK, let’s build a 3D GIS virtual reality tool

…in less than 3 months!




Thompson's
RESTAURANT
UMBRELLA


STANDARD
LIFE
BUILDING


DOGS

Master of Urban Design Studio

Carnegie Mellon University
School of Architecture
Masters of Urban Design

Smithfield Street Corridor Plan Objective

Re-Energize Smithfield Street

Site Survey + Systems Analysis

- History + Preservation
- Environment
- Demographics + Data
- Land + Building Uses
- Infrastructure
- Pedestrian Movement
- Vehicular + Mass Transit
- Complete Streets Details

3 Perspectives

1. Regional
2. Downtown
3. Street

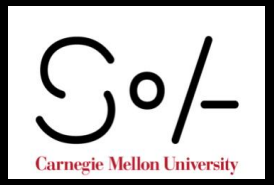
Design Principles

1. Walkable.
2. Safe.
3. Green.
4. Want to Return.
5. Create a Place.
6. Recreation.
7. Energy Efficient.
8. Socially Equitable.
9. Healthy Environment.

3 VISIONS

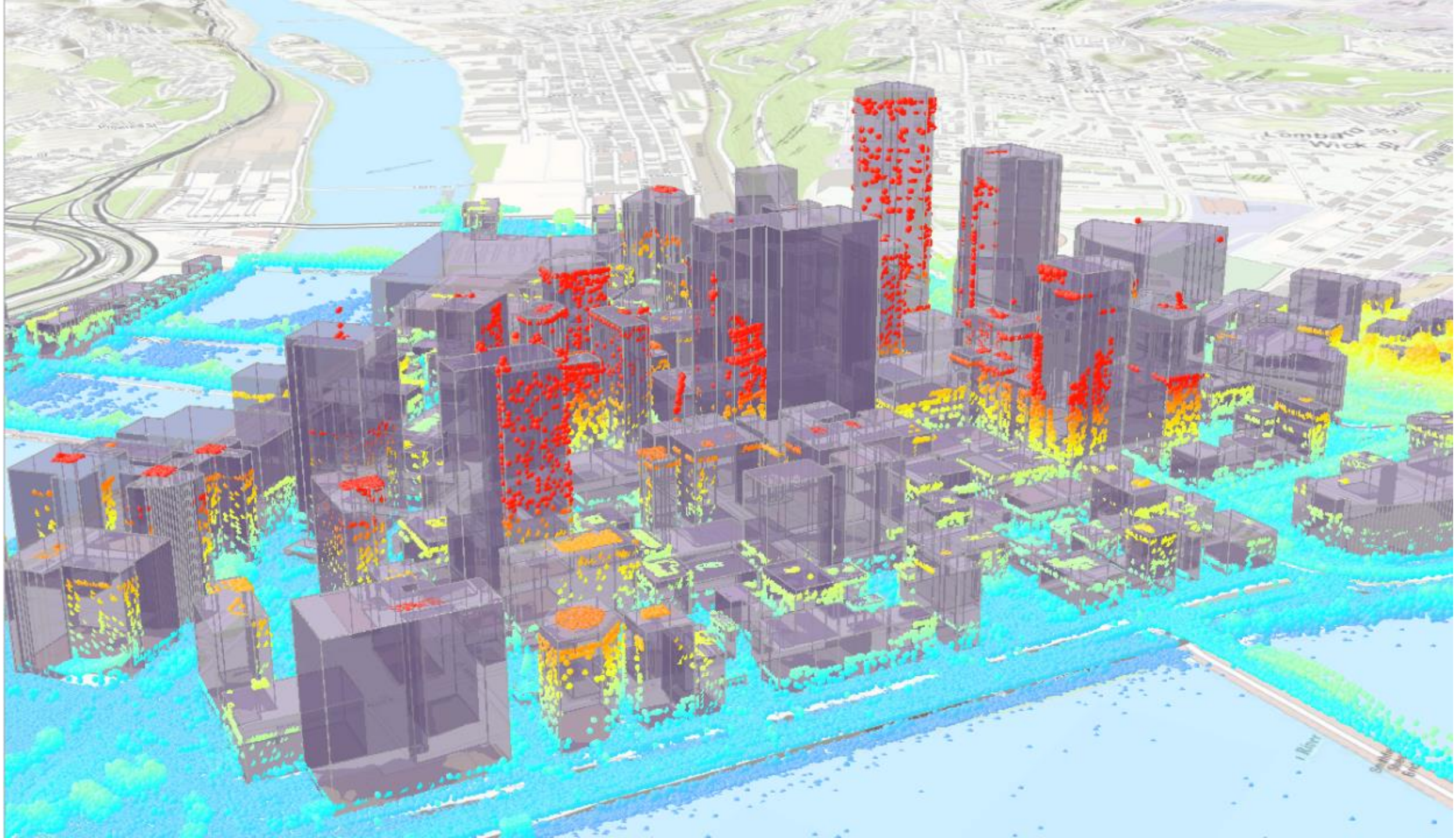
- Destination Street
- Local Street
- Connector Street

Building the model

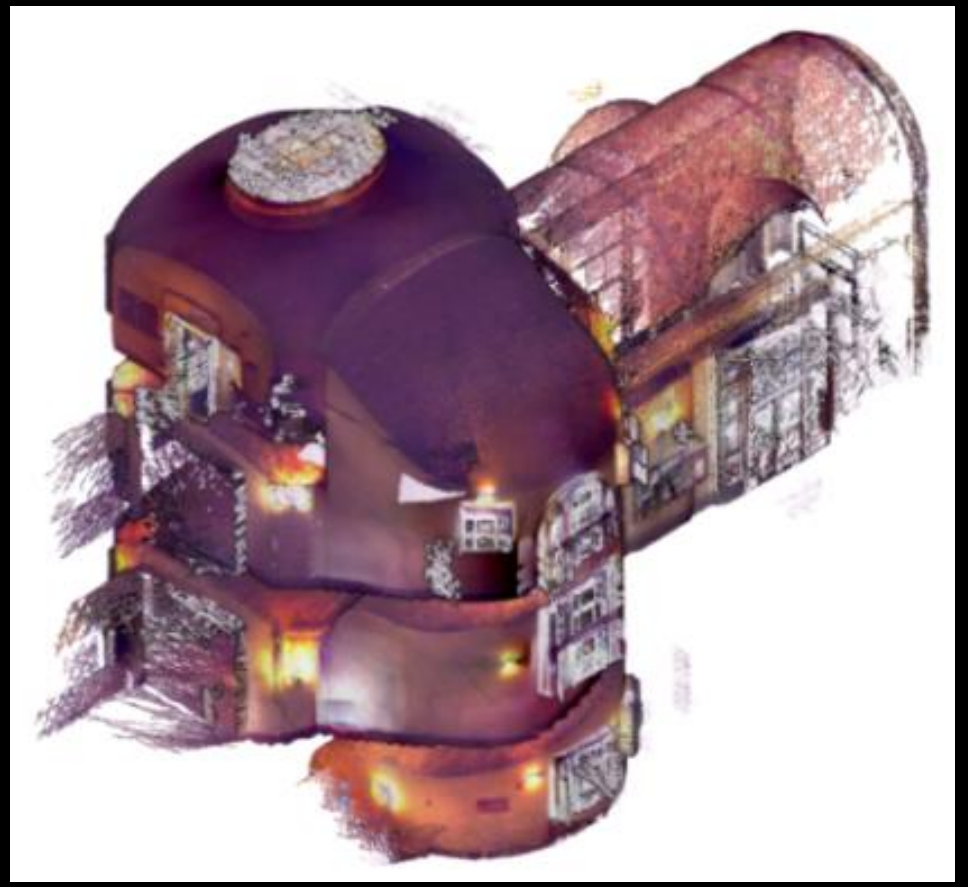


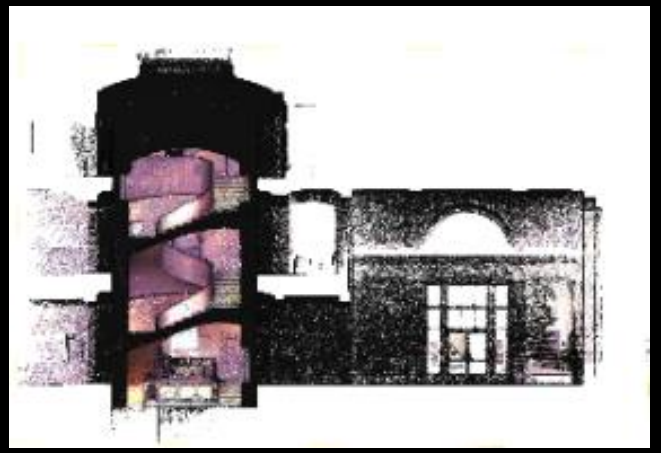
CMU and **Esri**

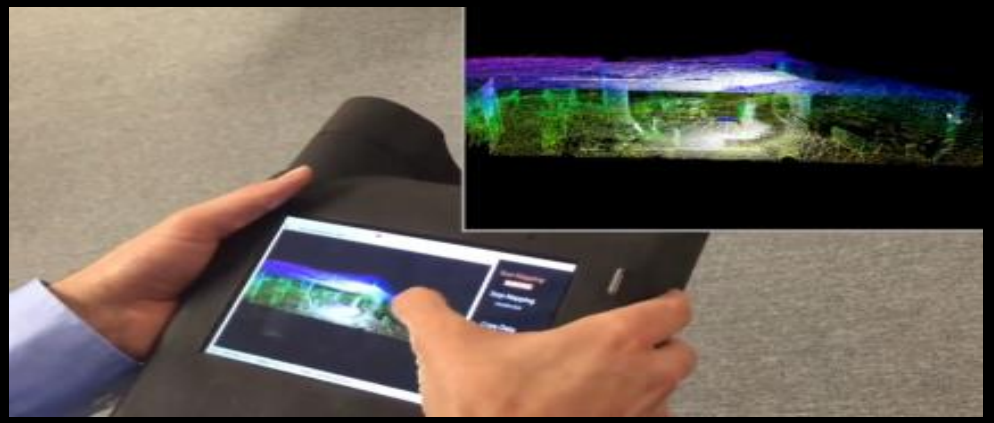
LiDAR data

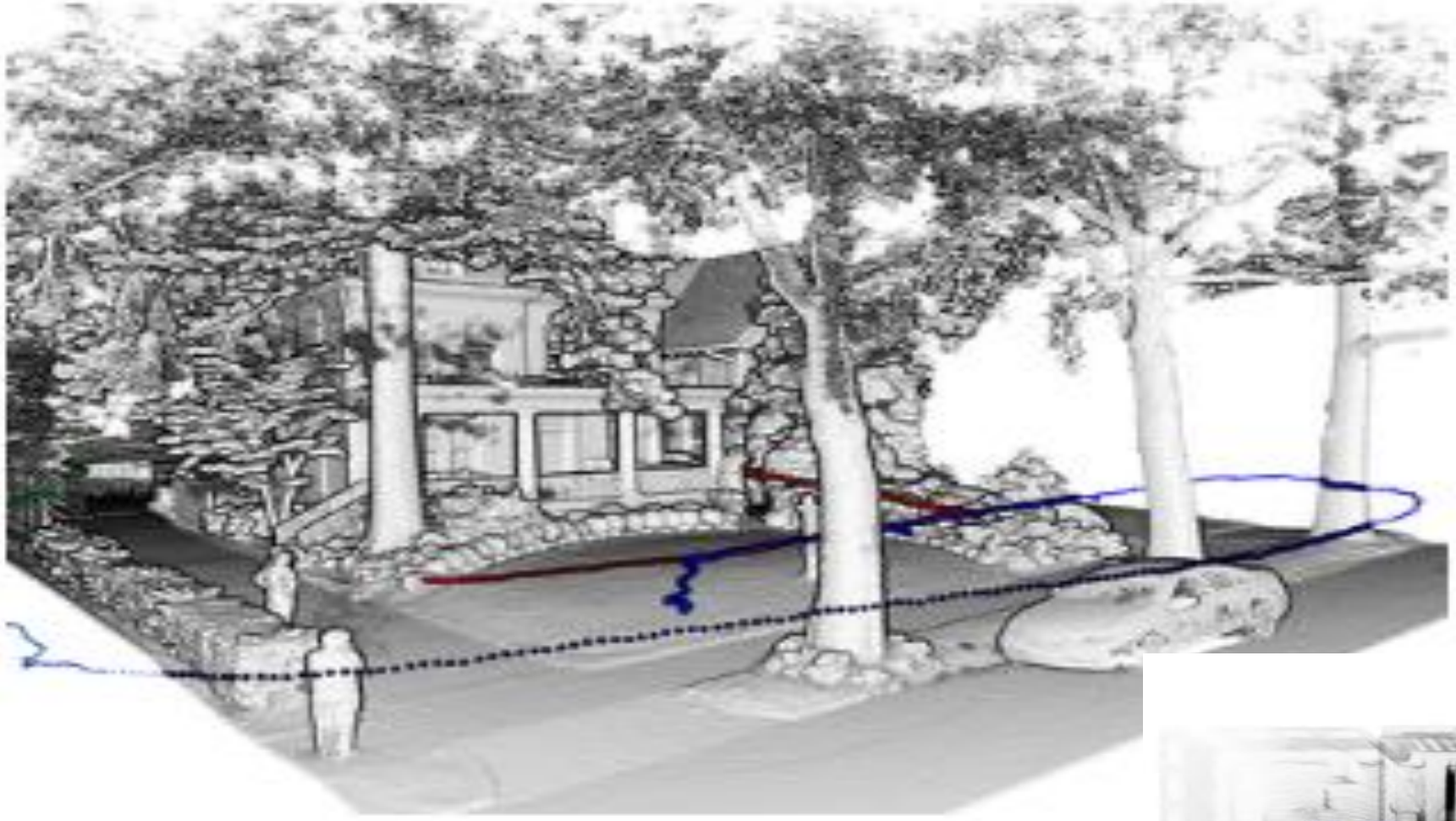

Lombard St
Wick St

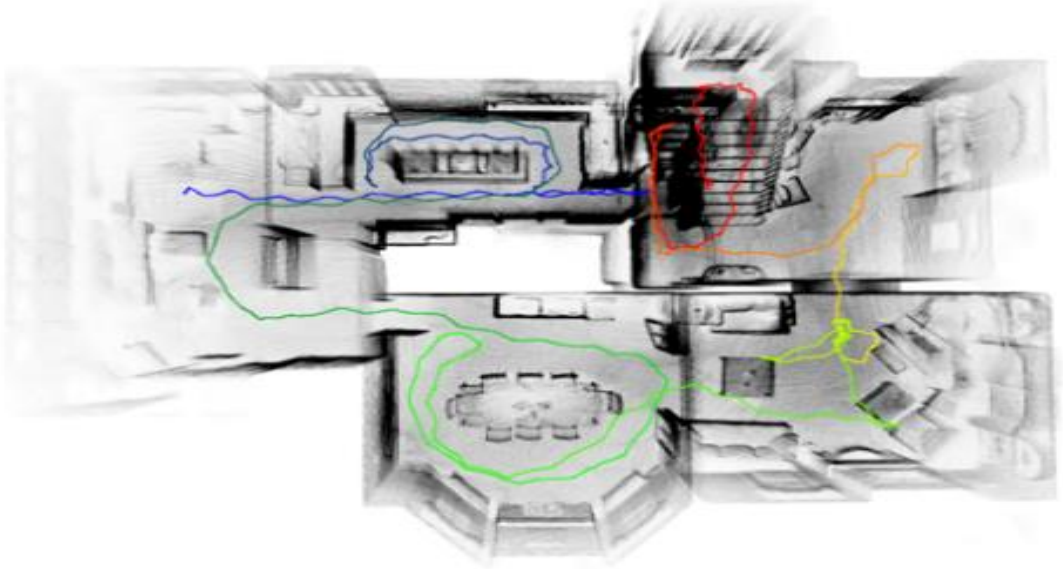
Kaarta







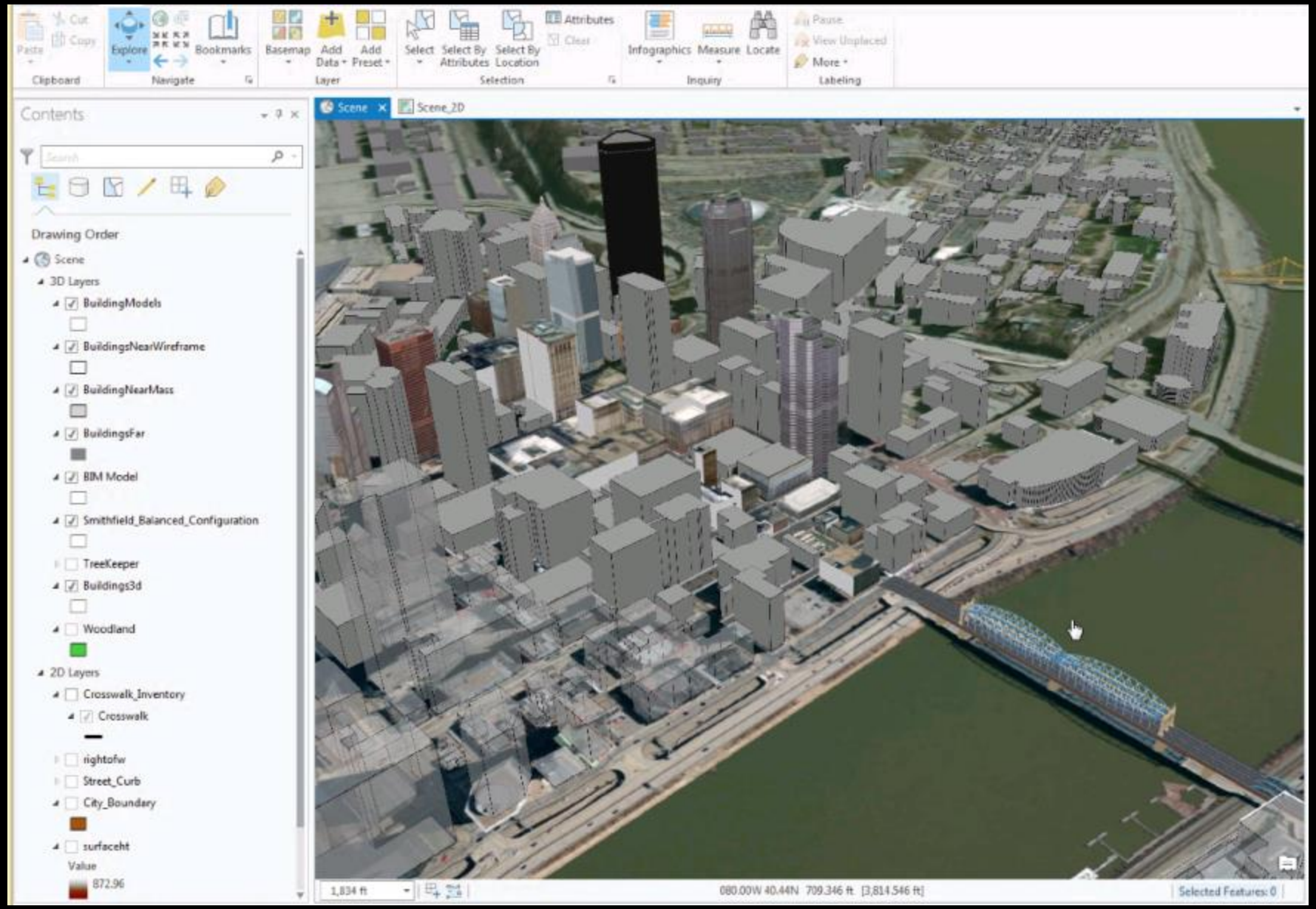


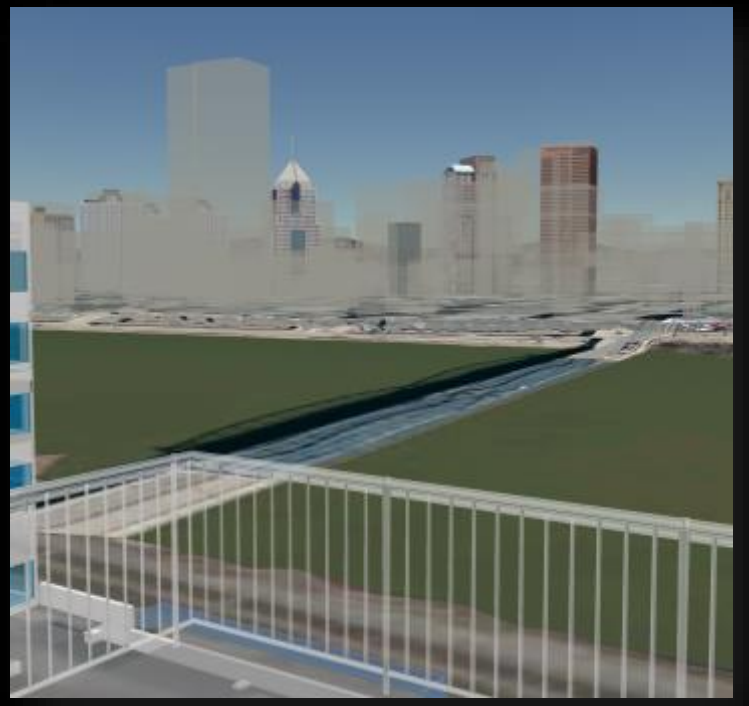


Residence

Scanned with [Stencil] in a few minutes by walking around front yard. Path shown in dotted line.

Sketch Up and Revit


Paste
Cut
Copy
Explore
Bookmarks
Basemap
Add Data
Add Preset
Select
Select By Attributes
Select By Location
Attributes
Clear
Infographics
Measure
Locate
Pause
View Unplaced
More
Clipboard
Navigate
Layer
Selection
Inquiry
Labeling
Contents
Drawing Order
Scene
3D Layers
BuildingModels
BuildingsNearWireframe
BuildingNearMass
BuildingsFar
BIM Model
Smithfield_Balanced_Configuration
TreeKeeper
Buildings3d
Woodland
2D Layers
Crosswalk_Inventory
Crosswalk
rightofw
Street_Curb
City_Boundary
surfaceht
Value
872.96
Scene
Scene_2D
1,834 ft
080.00W 40.44N 709.346 ft [3,814.546 ft]
Selected Features: 0



City Engine

Settings

Sunlight

3:10 PM

GMT-5

July

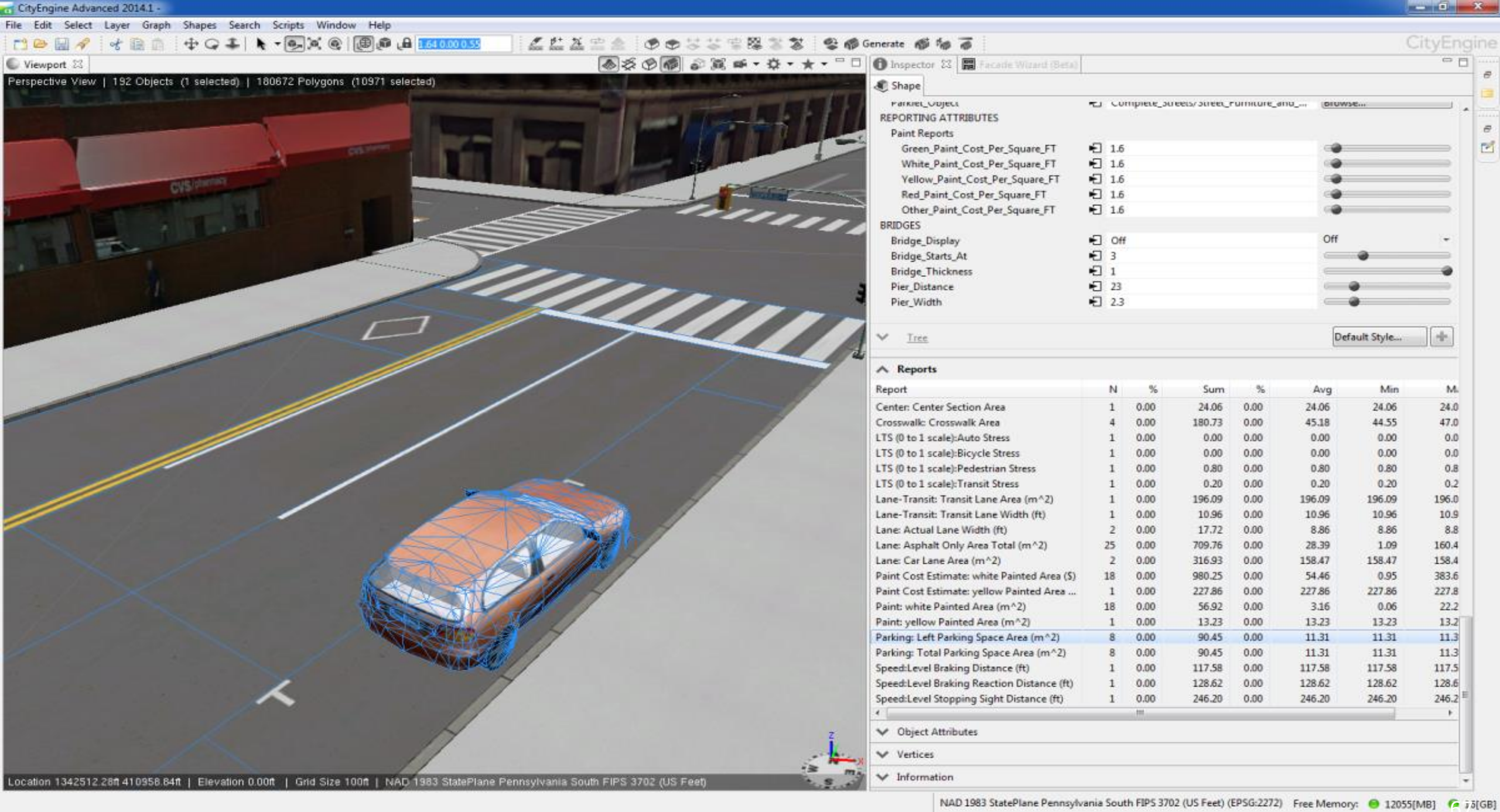
Shadowing

- [x] Direct Shadow (cast by sunlight)
- [ ] Diffuse Shadows (ambient occlusion)

Screenshot

Viewport size

Save

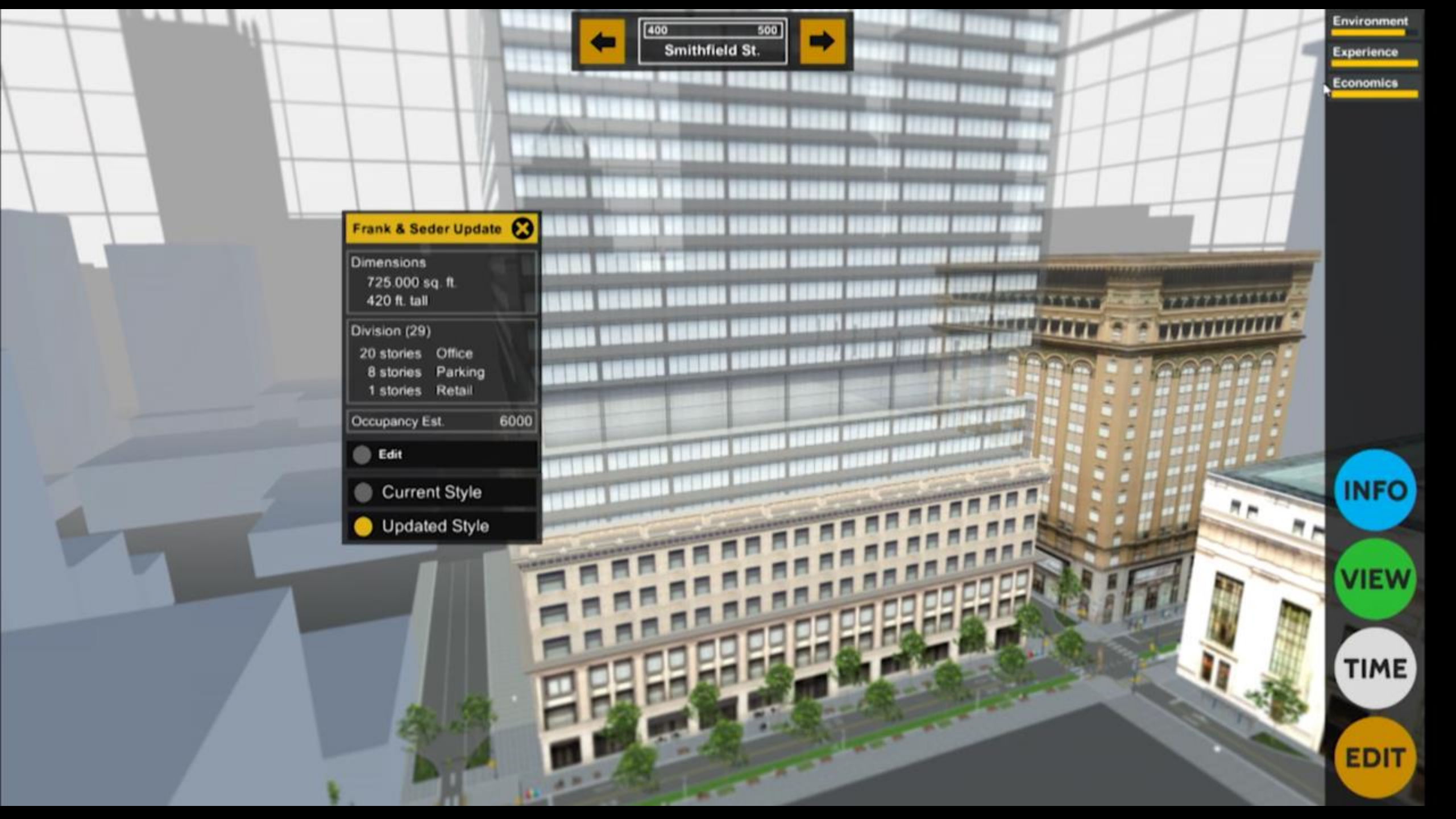

CityEngine Advanced 2014.1 -
File Edit Select Layer Graph Shapes Search Scripts Window Help
Generate
CityEngine
Viewport
Perspective View | 192 Objects (1 selected) | 180672 Polygons (10971 selected)
Location 1342512.28ft 410958.84ft | Elevation 0.00ft | Grid Size 100ft | NAD 1983 StatePlane Pennsylvania South FIPS 3702 (US Feet)
Inspector
Facade Wizard (Beta)
Shape
REPORTING ATTRIBUTES
Paint Reports
Green_Paint_Cost_Per_Square_FT 1.6
White_Paint_Cost_Per_Square_FT 1.6
Yellow_Paint_Cost_Per_Square_FT 1.6
Red_Paint_Cost_Per_Square_FT 1.6
Other_Paint_Cost_Per_Square_FT 1.6
BRIDGES
Bridge_Display Off
Bridge_Starts_At 3
Bridge_Thickness 1
Pier_Distance 23
Pier_Width 2.3
Tree
Default Style...
Reports
Report N % Sum % Avg Min M
Center: Center Section Area 1 0.00 24.06 0.00 24.06 24.06 24.0
Crosswalk: Crosswalk Area 4 0.00 180.73 0.00 45.18 44.55 47.0
LTS (0 to 1 scale):Auto Stress 1 0.00 0.00 0.00 0.00 0.00 0.0
LTS (0 to 1 scale):Bicycle Stress 1 0.00 0.00 0.00 0.00 0.00 0.0
LTS (0 to 1 scale):Pedestrian Stress 1 0.00 0.80 0.00 0.80 0.80 0.8
LTS (0 to 1 scale):Transit Stress 1 0.00 0.20 0.00 0.20 0.20 0.2
Lane-Transit: Transit Lane Area (m^2) 1 0.00 196.09 0.00 196.09 196.09 196.0
Lane-Transit: Transit Lane Width (ft) 1 0.00 10.96 0.00 10.96 10.96 10.9
Lane: Actual Lane Width (ft) 2 0.00 17.72 0.00 8.86 8.86 8.8
Lane: Asphalt Only Area Total (m^2) 25 0.00 709.76 0.00 28.39 1.09 160.4
Lane: Car Lane Area (m^2) 2 0.00 316.93 0.00 158.47 158.47 158.4
Paint Cost Estimate: white Painted Area ($) 18 0.00 980.25 0.00 54.46 0.95 383.6
Paint Cost Estimate: yellow Painted Area ... 1 0.00 227.86 0.00 227.86 227.86 227.8
Paint: white Painted Area (m^2) 18 0.00 56.92 0.00 3.16 0.06 22.2
Paint: yellow Painted Area (m^2) 1 0.00 13.23 0.00 13.23 13.23 13.2
Parking: Left Parking Space Area (m^2) 8 0.00 90.45 0.00 11.31 11.31 11.3
Parking: Total Parking Space Area (m^2) 8 0.00 90.45 0.00 11.31 11.31 11.3
Speed:Level Braking Distance (ft) 1 0.00 117.58 0.00 117.58 117.58 117.5
Speed:Level Braking Reaction Distance (ft) 1 0.00 128.62 0.00 128.62 128.62 128.6
Speed:Level Stopping Sight Distance (ft) 1 0.00 246.20 0.00 246.20 246.20 246.2
Object Attributes
Vertices
Information
NAD 1983 StatePlane Pennsylvania South FIPS 3702 (US Feet) (EPSG:2272) Free Memory: 12055[MB]

Unity


Smithfield St.
400
Fifth Ave
Experience
Economics
INFO
VIEW
TIME


400
500
Smithfield St.
Environment
Experience
Economics
Smithfield St. Layouts
Current
Destination
Local
Connector
INFO
VIEW
TIME
EDIT


400
500
Smithfield St.
Smart Street
Show Utility Lines
Smart Signals
Smart Street Lamps
Smart Digital Signage
Utilities
Bus Routes
BRT
Automobile
Traffic
Environment
Experience
Economics
INFO
VIEW
TIME
EDIT


400
500
Smithfield St.
Environment
Experience
Economics
Frank & Seder Update
Dimensions
725,000 sq. ft.
420 ft. tall
Division (29)
20 stories Office
8 stories Parking
1 stories Retail
Occupancy Est. 6000
Edit
Current Style
Updated Style
INFO
VIEW
TIME
EDIT

P4 video

Continuing the work…

3D/Data Visualization Research Project

Phase I

Research and Benchmarking 3D

funded by the Deloitte Foundation

3D Visualization Examples >

Utilizing AR in Community Meetings - City of Nashville

Photo Source: Micah Taylor

The MetroGIS group at the Metro Government of Nashville & Davidson County has experimented with a variety of software and technologies to better engage and share with the public. MetroGIS has used 3D visualizations after finding that the visualizations produced more feedback and faster decisions. Much of the modeling is done using CityEngine, which allows for easy manipulation of zoning, development proposals, and the creation of videos and other interactive visualizations. MetroGIS has transferred its CityEngine model into Unity using Vuforia, a software development kit, to create an augmented reality experience. The resulting application allows a person to hover their smart phone over a 2D printout of the city and see the 3D model on their phone. Tapping the screen switches between the various scenarios. While less immersive than a virtual reality experience, the only necessary hardware for the viewer is their phone as opposed to a headset. This reduces costs and allows easier interaction.

This project used

- CityEngine
- Unity
- Vuforia

Note: the case was conducted through the interview with Micah Taylor at Metro Government, Nashville & Davidson County.

Heinz College and Master of Urban Design students and faculty

+ Pittsburgh City Planning

Software Matrix

Phase I reserach was conducted in summer 2017, all the information and content were collected through interviews from June to Augest, 2017. As such, all software listed in the alphabtically listed matrix were selected based on the usage of each software in architecture firms, city planning departments and universities.

Note: the table on this page is best viewed using Chrome, Safari, or Firefox browsers.

Software Name	CAD	BIM	GIS	Rendering	Animation	VR	AR	Other
3D Studio Max	✓			✓	✓	with Plugin	with Plugin	
ArcGIS Pro			✓					Point Cloud Data/ Photogrammetry
ArcGIS Online: 3D Scene Viewer			✓					
ArcGIS Online: Story Maps			✓					
AutoCAD	✓			✓				
Cesium								
CityEngine	✓		✓		✓			
CityPlanner	✓							
CyberCity								Point Cloud Data/ Photogrammetry
Enscape				✓	✓	✓	✓	
Infraworks	✓	✓	✓	✓	✓			

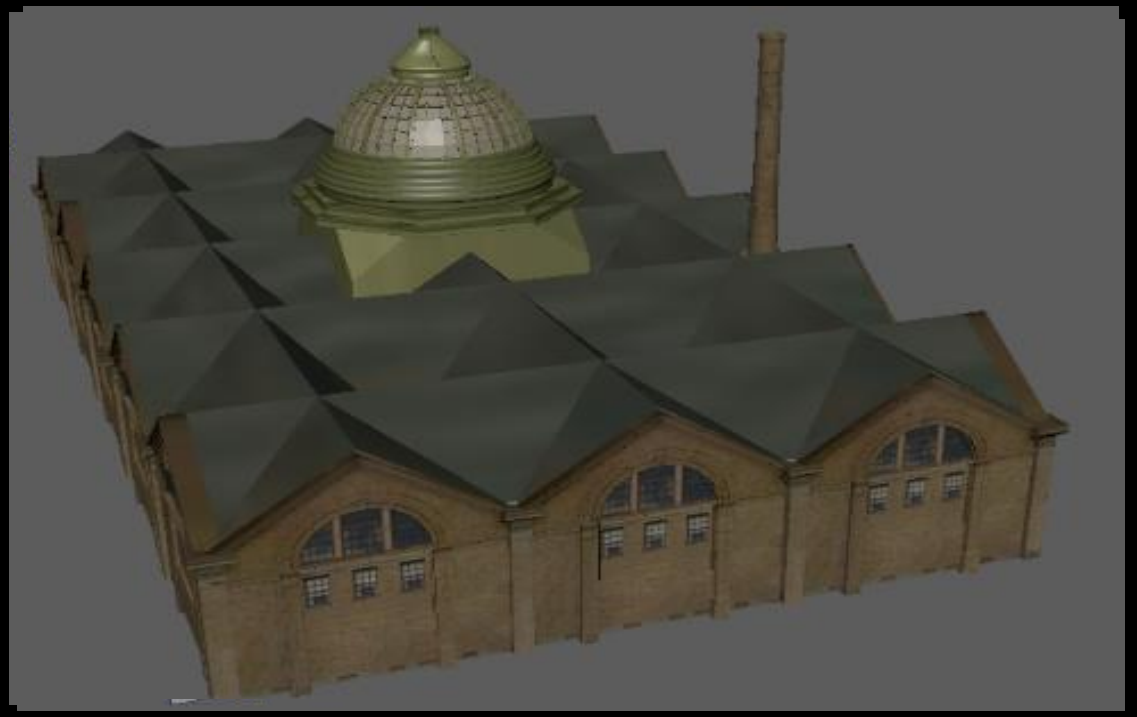
Phase II

Virtual Reality Demonstration Project

funded by the Heinz Endowments

Entertainment Technology Center, Architecture, Heinz College students and faculty

+ Pittsburgh City Planning



COLOR-CODED VIEW

TELEPORTATION

TIME OF DAY

USAGE TYPE

Phase III

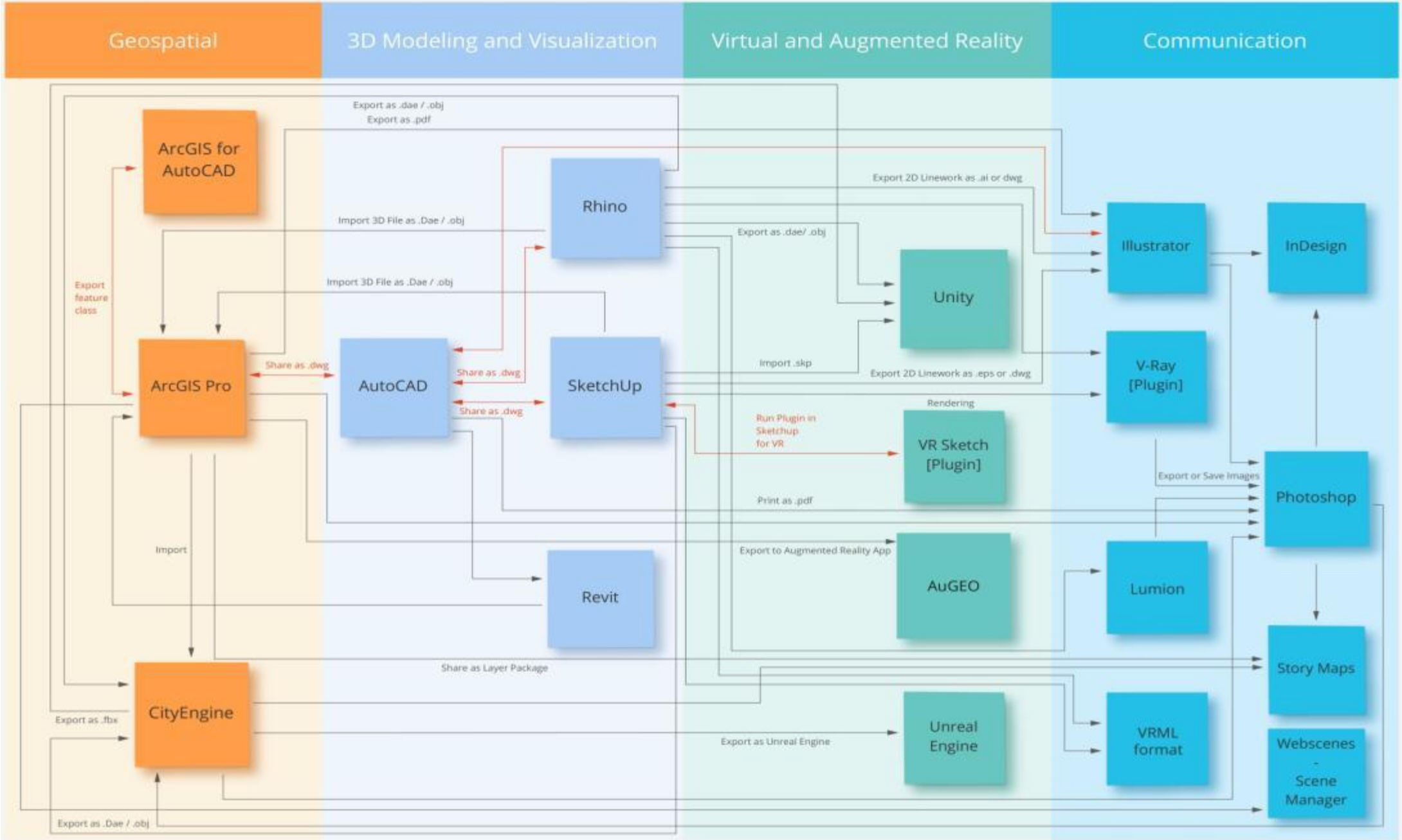
3D Field Testing

funded by the Heinz Endowments

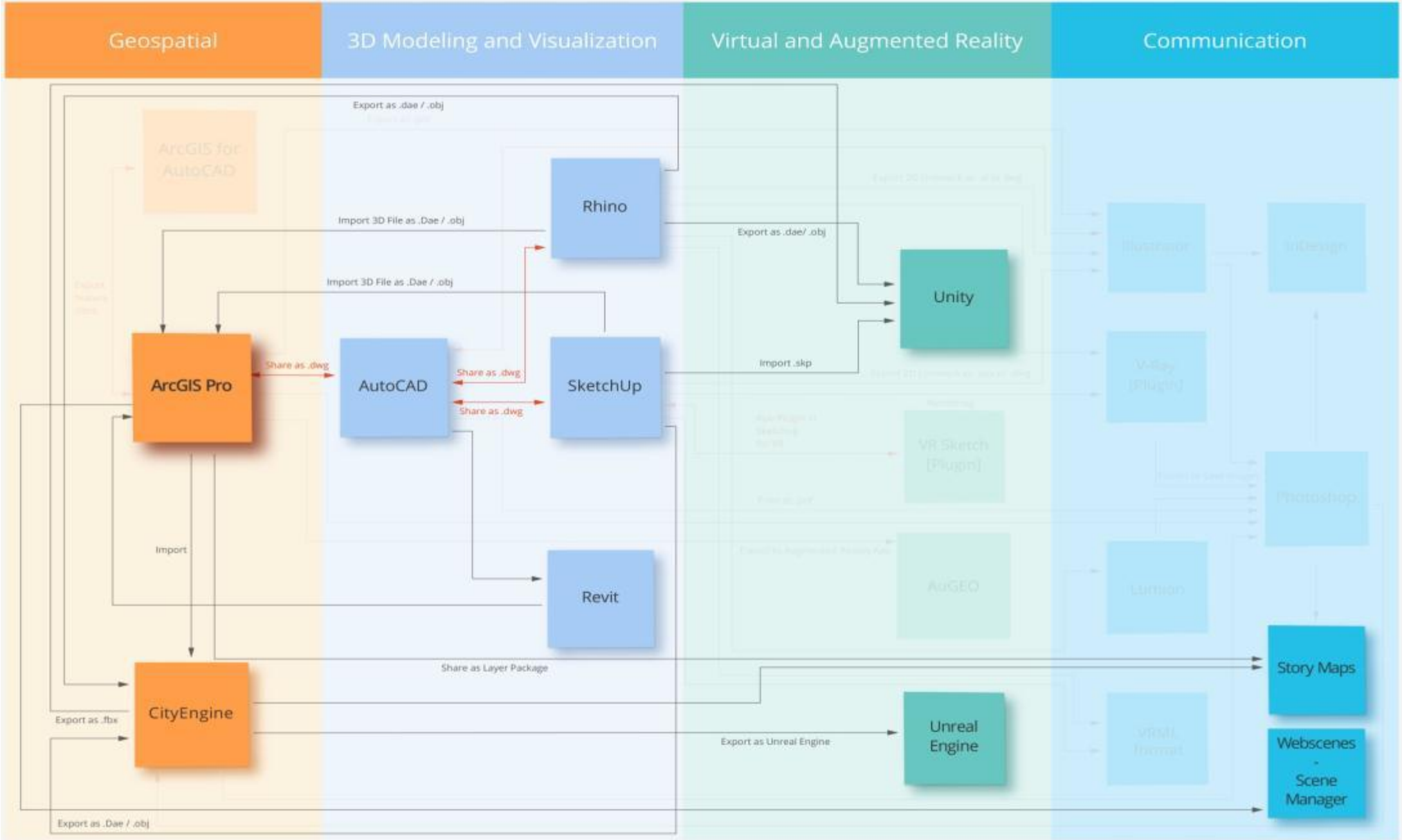
Master Urban Design students

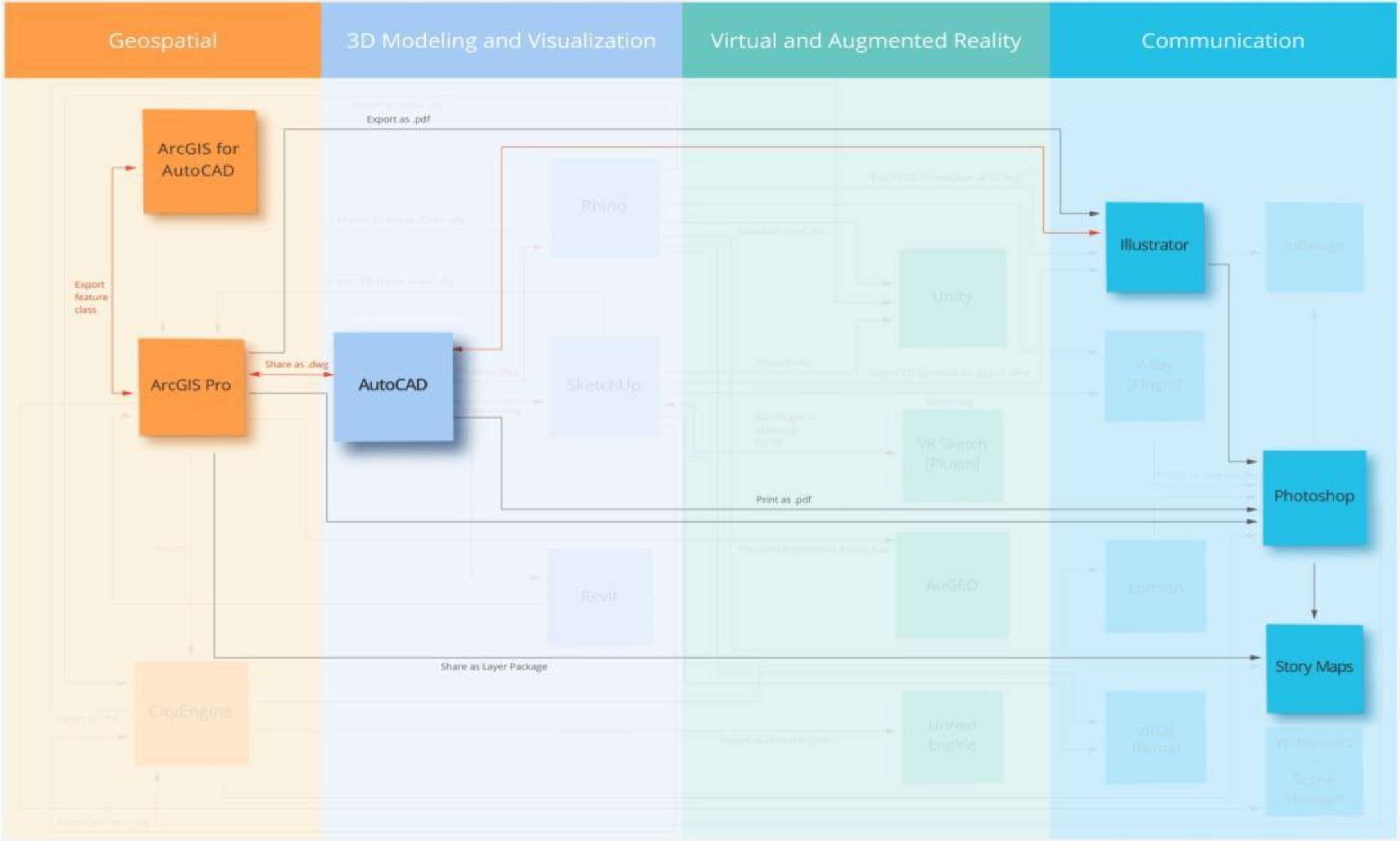
+ Pittsburgh City Planning

Workflows



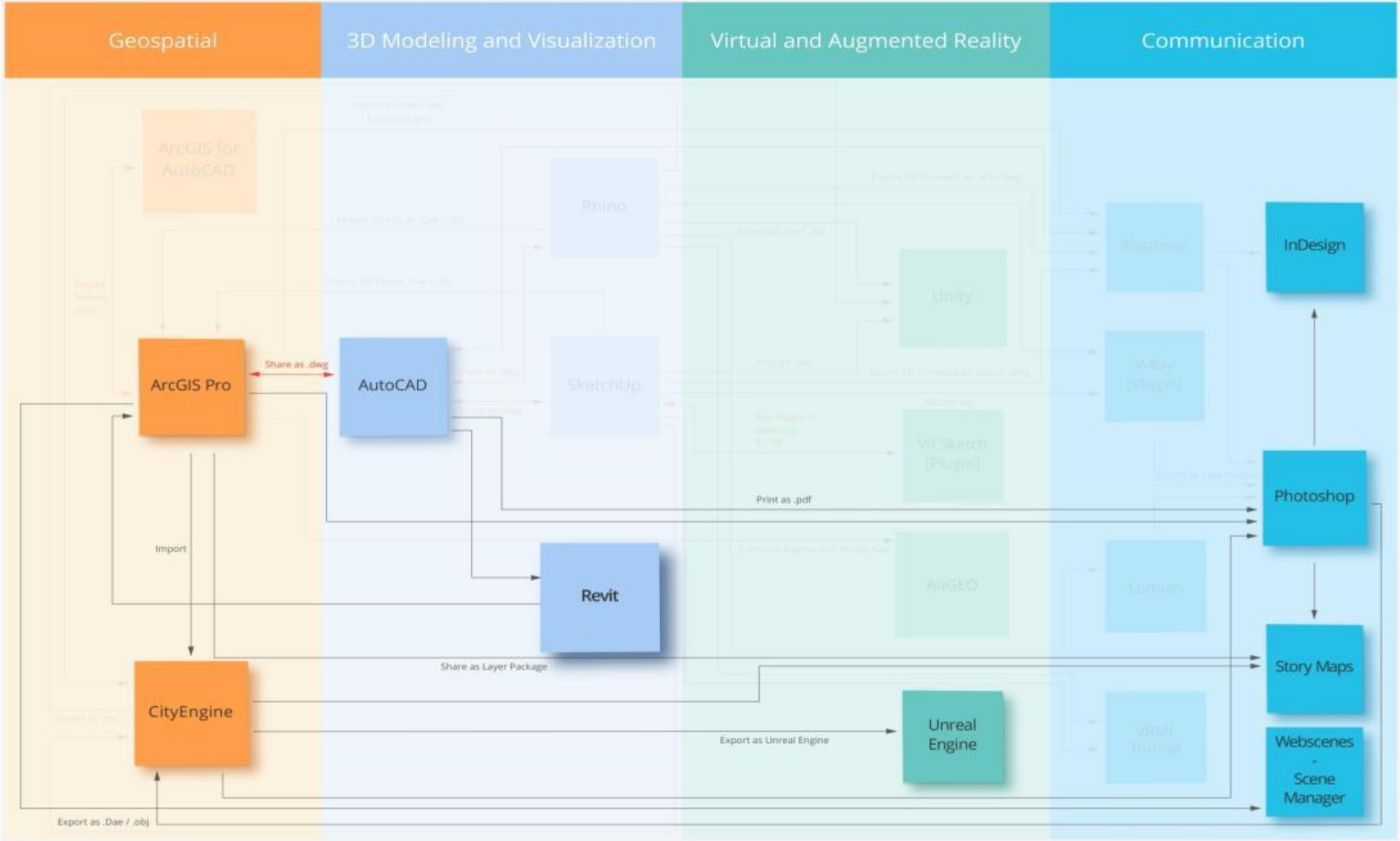
Workflow Overview

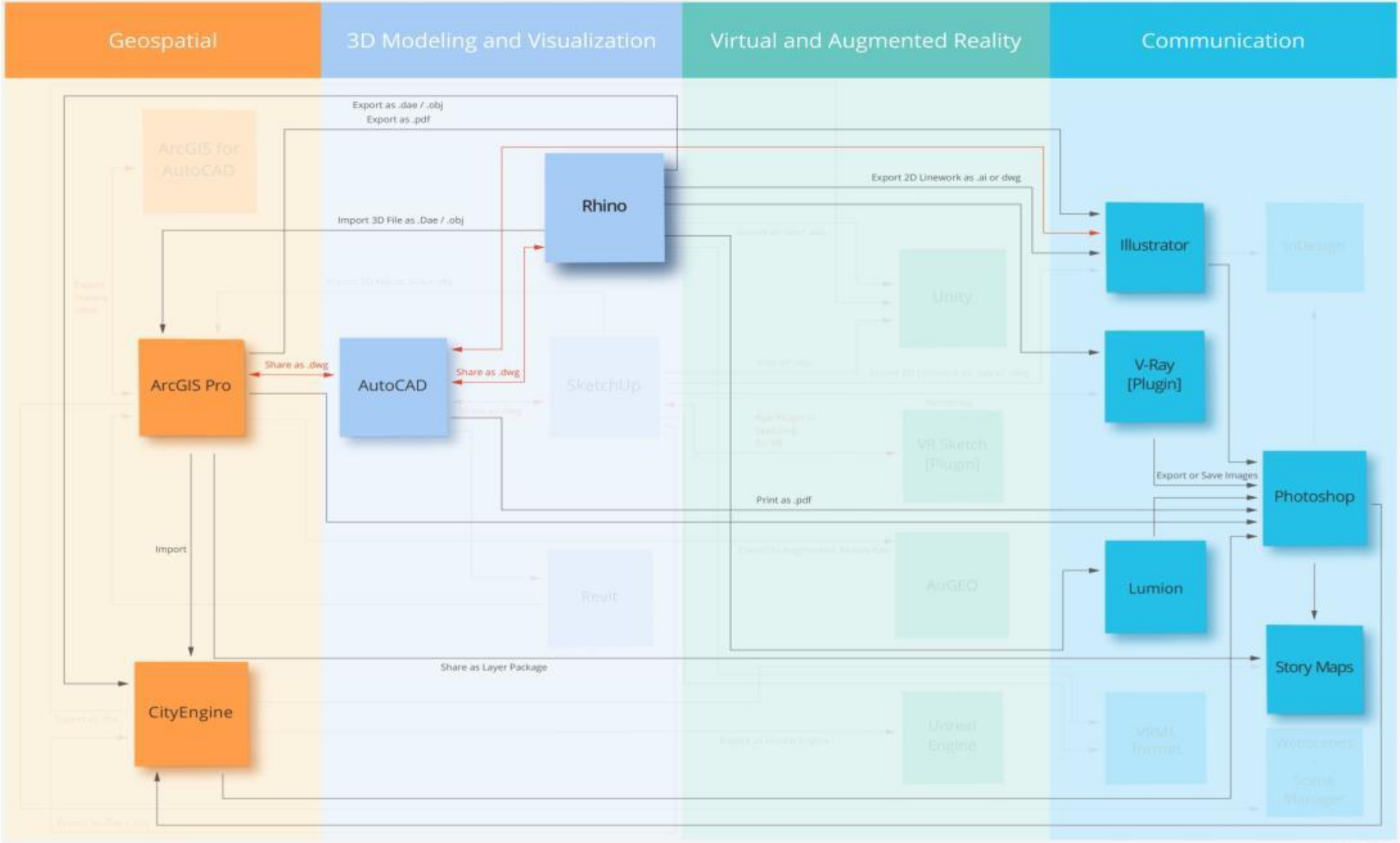




AutoCAD

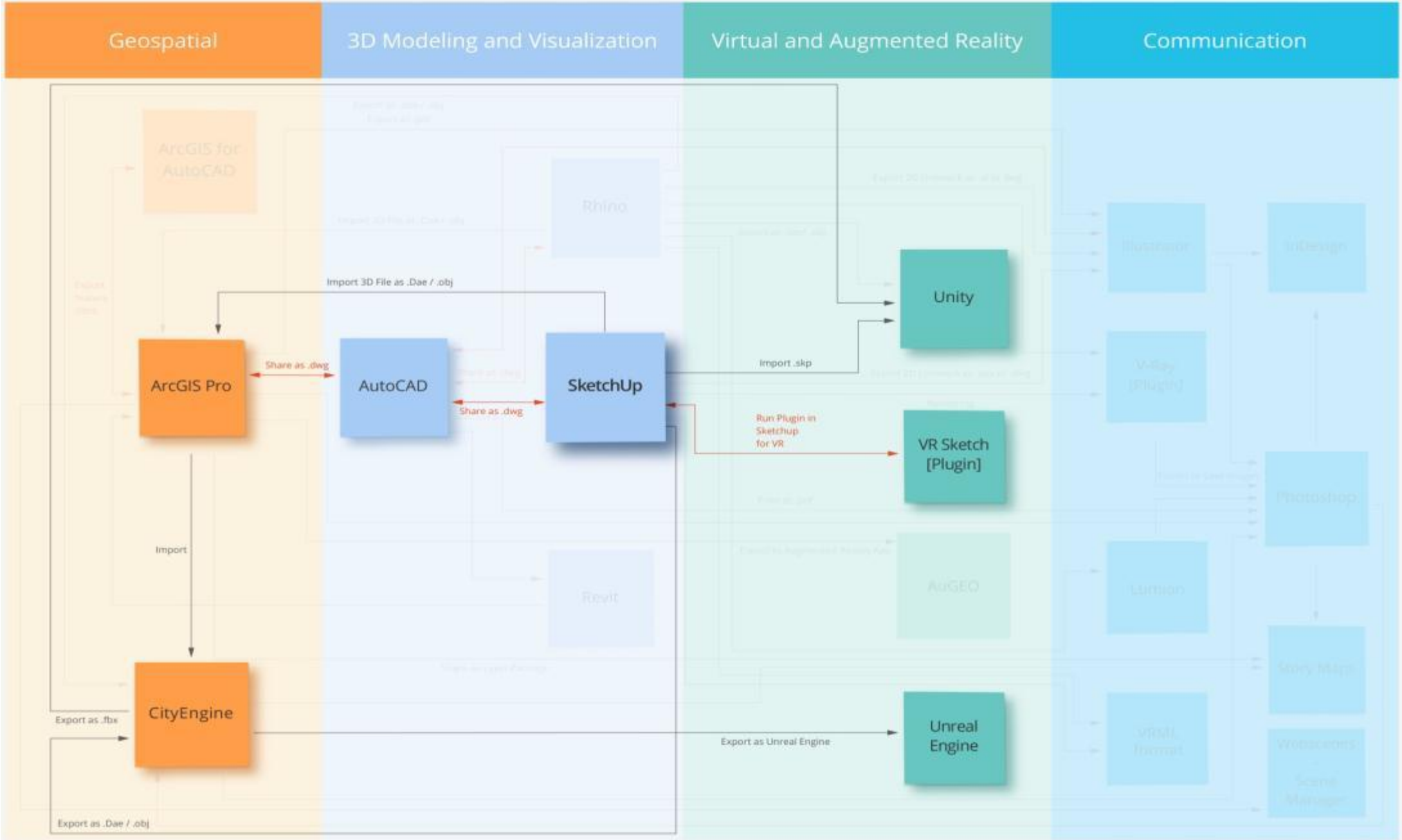
 REMAKING CITIES INSTITUTE |



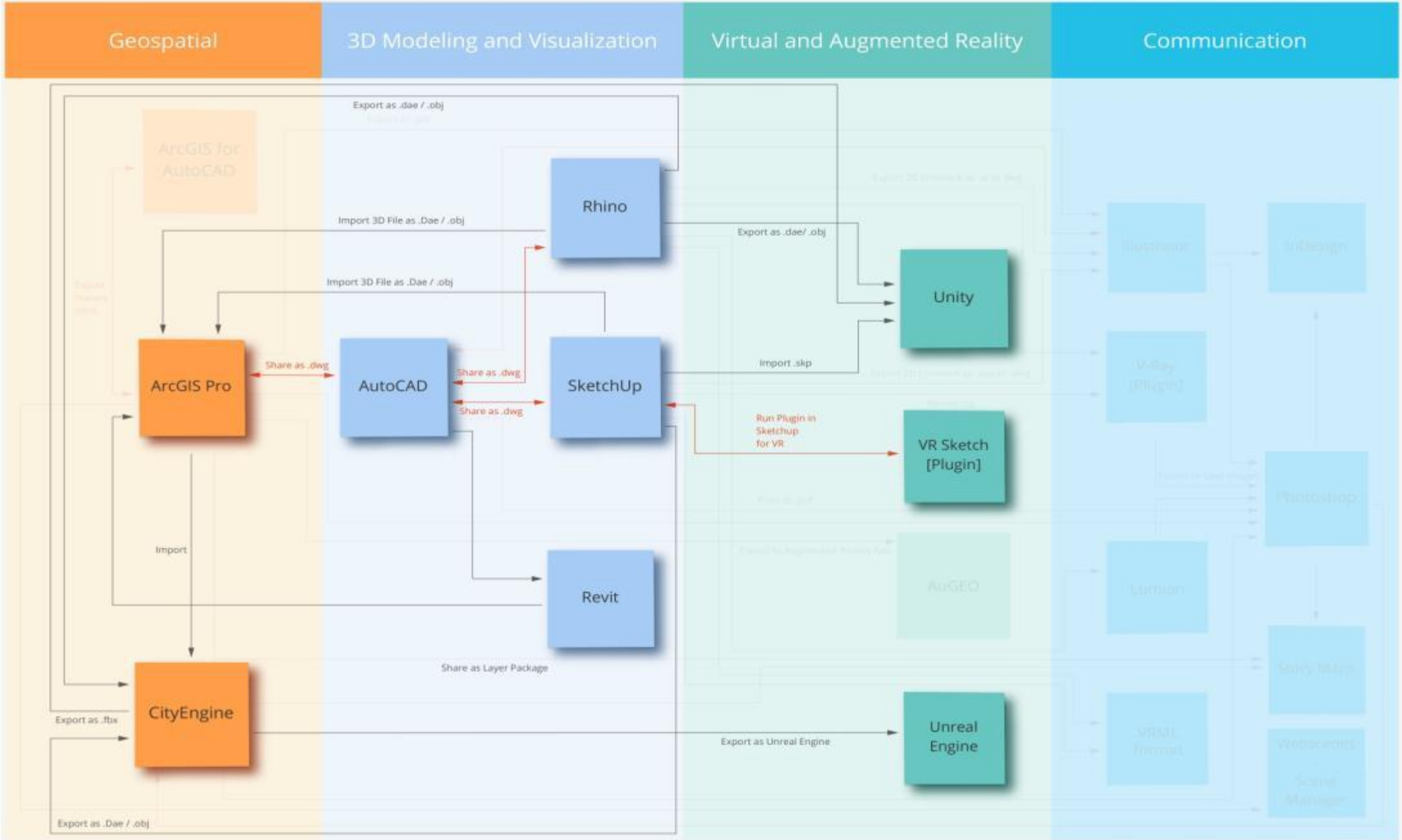


Rhinoceros

 REMAKING CITIES INSTITUTE |



SketchUp Pro



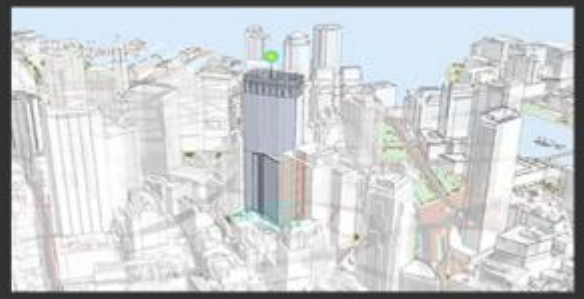
VR Visualization

Future plans

ArcGIS Urban

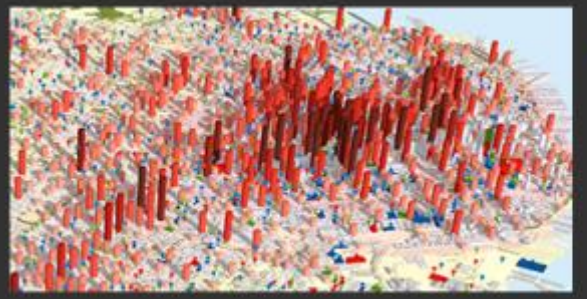
Improve planning productivity

Streamline the creation and sharing of zoning and land-use plans directly in a web browser in 3D.



Visualize projects citywide

Visualize, track, and review development projects throughout their life cycle.



Communicate Trends

Report on citywide performance indicators and communicate trends to public and private stakeholders.

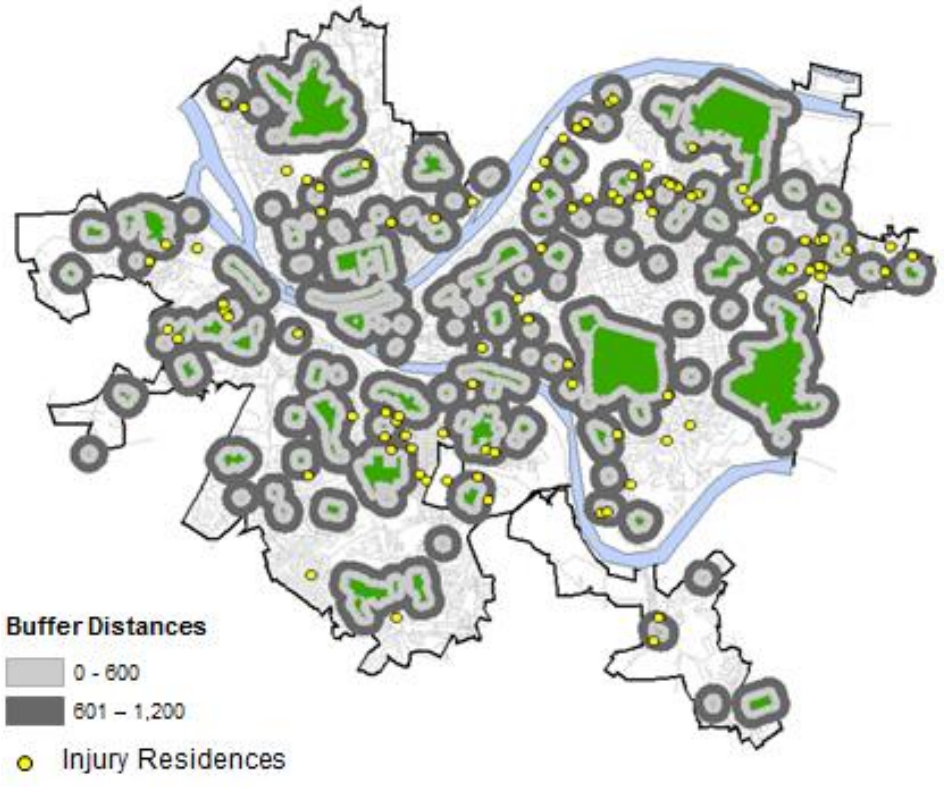
Increase community engagement

Simple community involvement to gain early buy-in through online comments and surveys.

Urban Design and the Innovation Cooridor

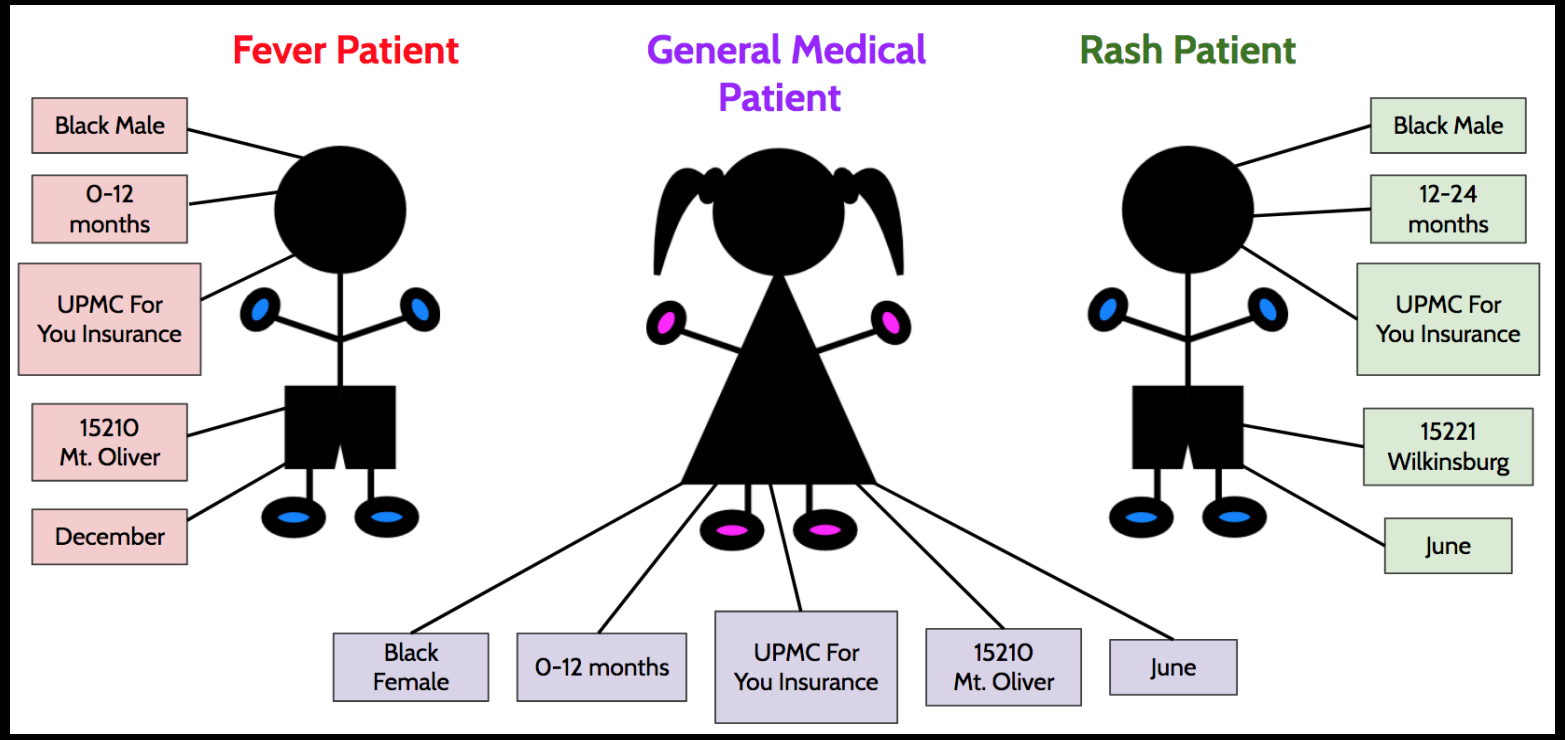
Healthy Cities

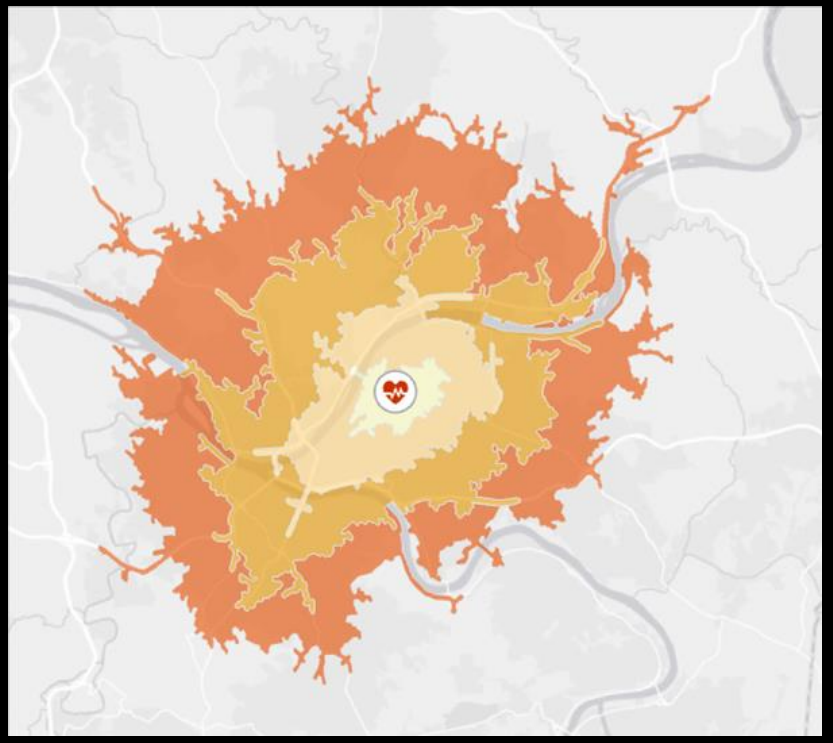
pedestrian accidents



childhood obesity

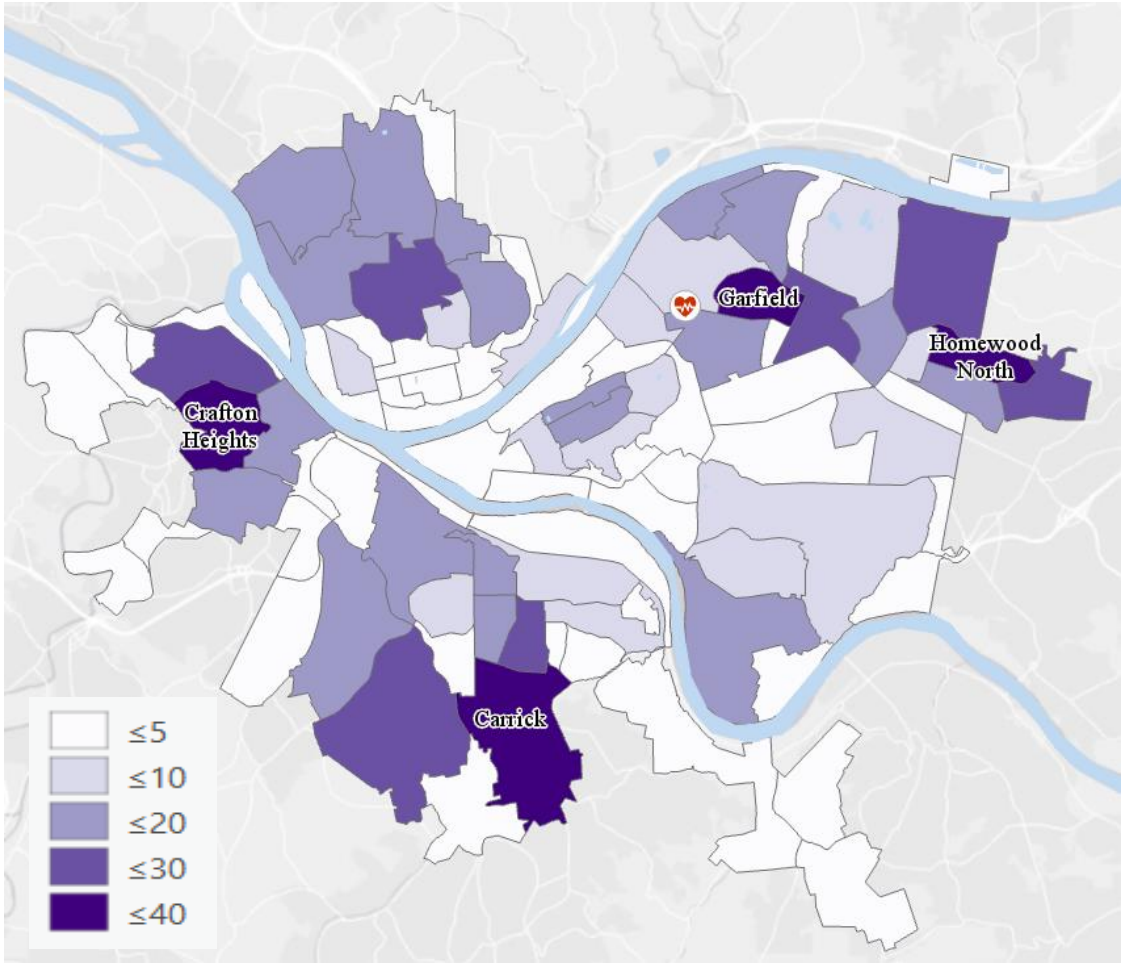
Emergency Room Visits

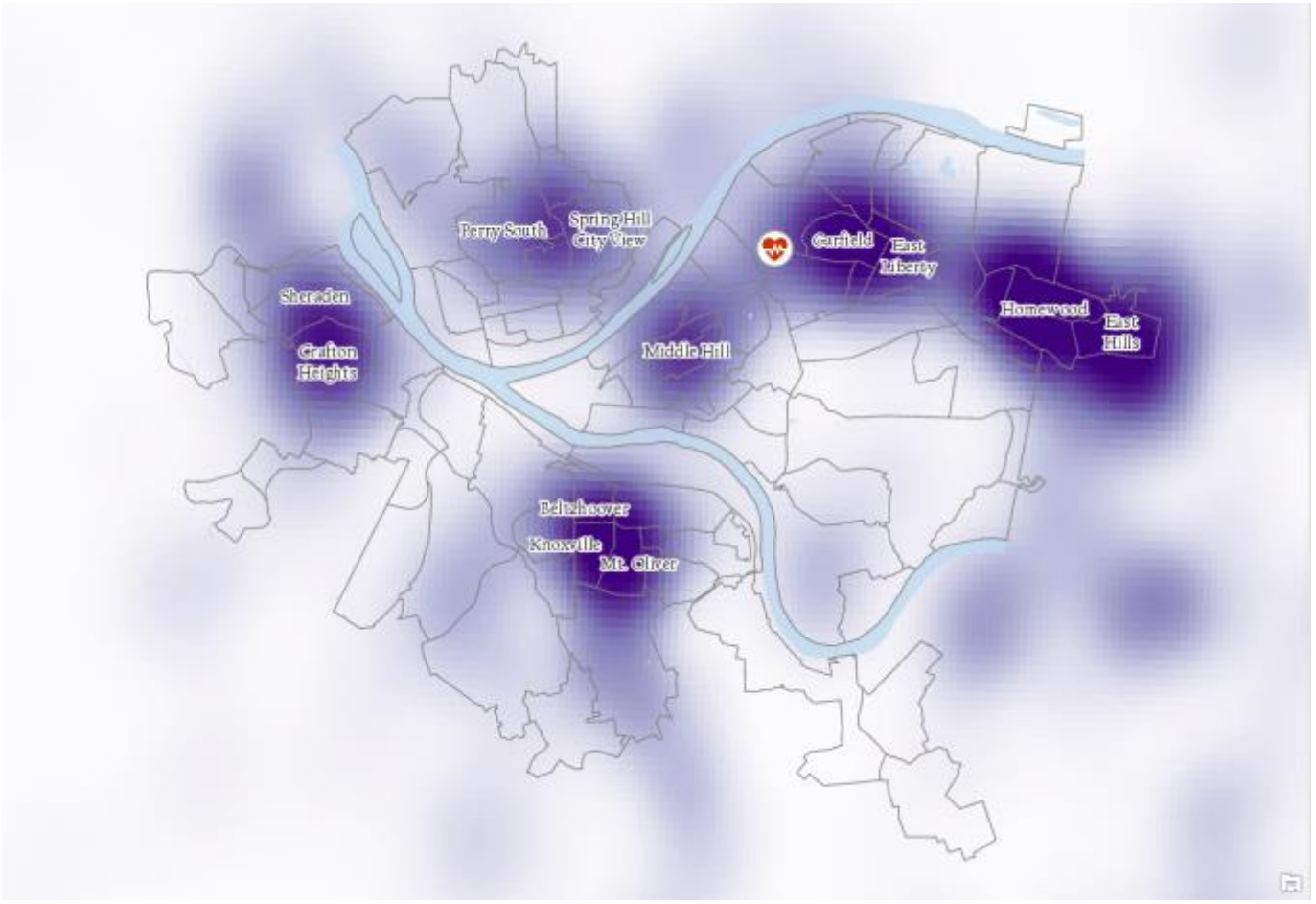




Travel Time (Minutes)	Number of Patients
0 – 5	70
5 – 10	193
10 – 15	303
15 – 20	457

Machine Learning and GIS





Encounters By Neighborhood

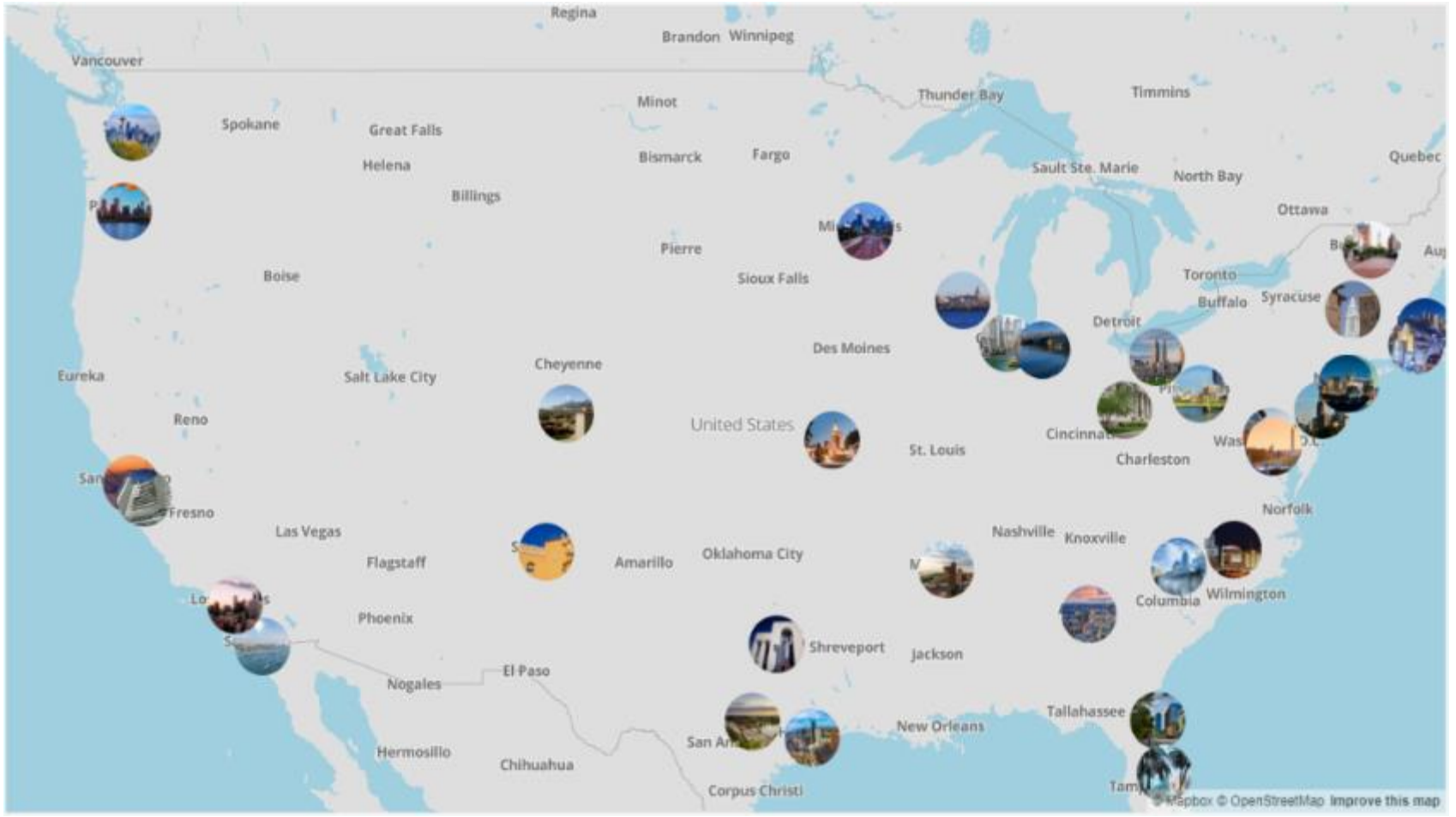
Chief Complaint	Count of Encounters
Fever	702
General Medical	460
Respiratory Problems	256

Beyond Pittsburgh

METROLAB NETWORK

2015

45 cities
6 counties
61 universities
focused on civic innovation



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BRISTOL CITY COUNCIL
University of Glasgow
Policy Scotland
Glasgow CITY COUNCIL
UNIVERSITY OF LIVERPOOL
LIVERPOOL CITY REGION COMBINED AUTHORITY
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