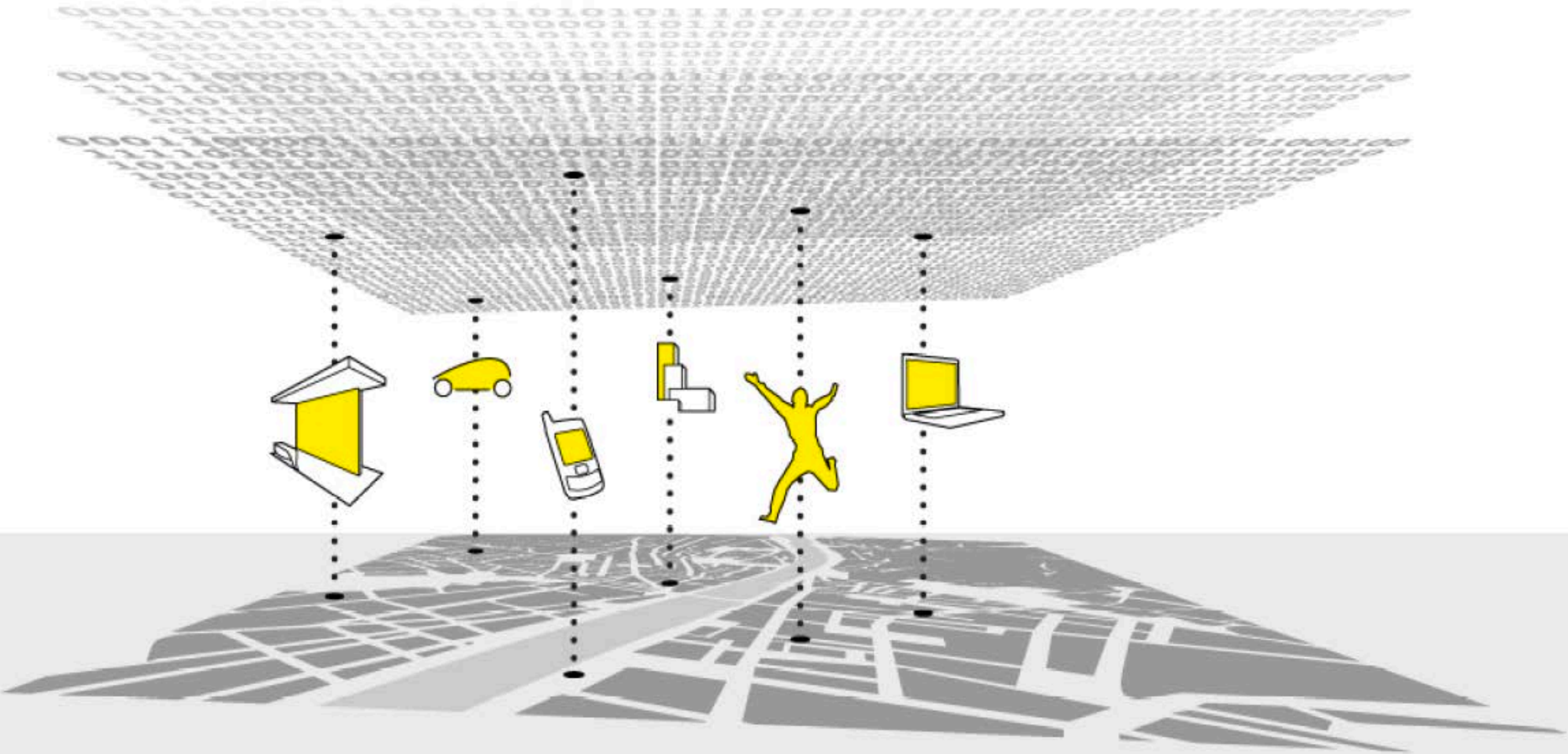
Vienna, March 30nd, 2016

ILP MIT European Conference

HERE ARE SOME THOUGHTS, LORD MAYOR...

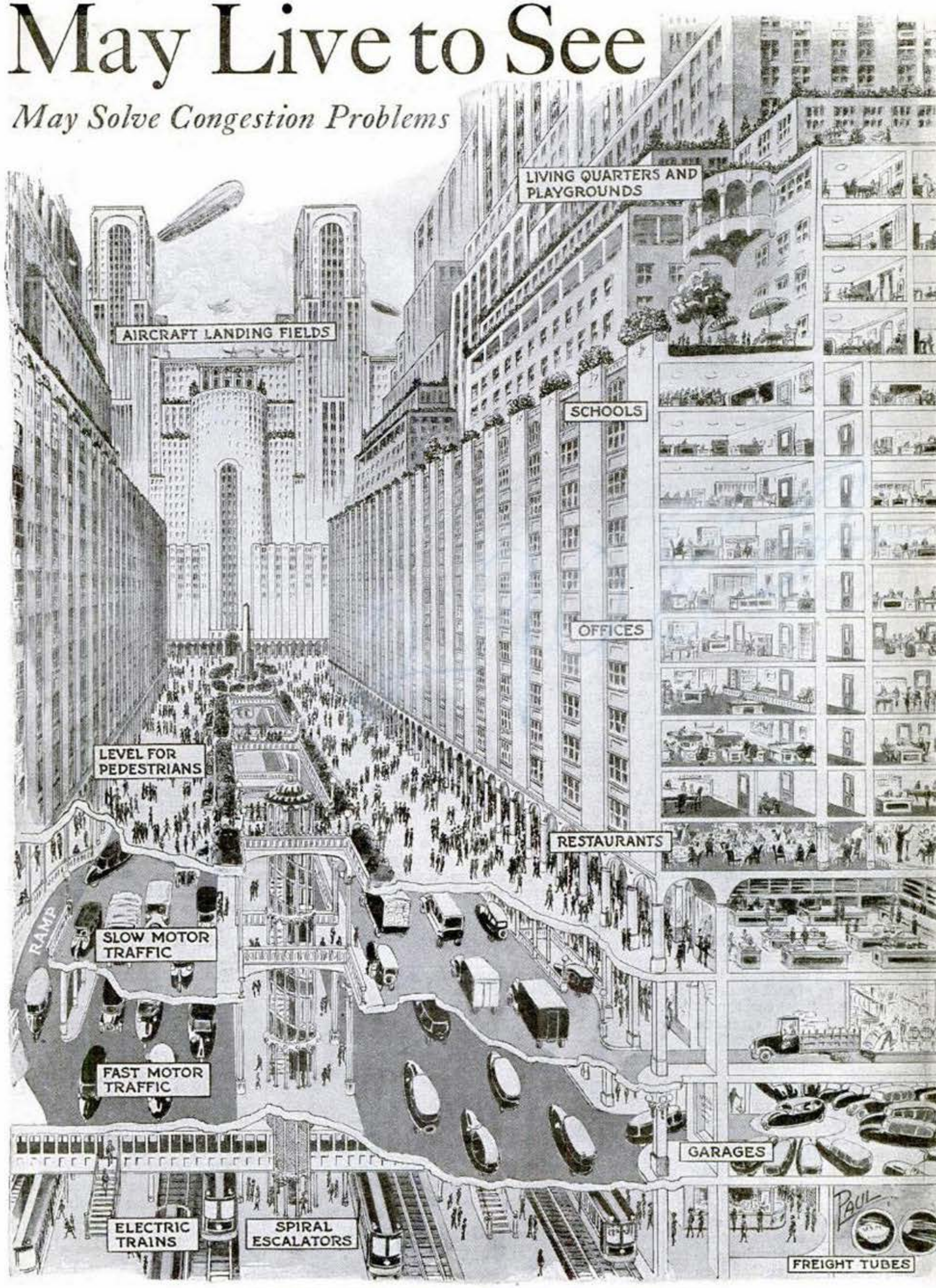
Carlo Ratti
Partner, Carlo Ratti Associati
Professor of the Practice of Urban Technologies, MIT



1. MOBILITY...

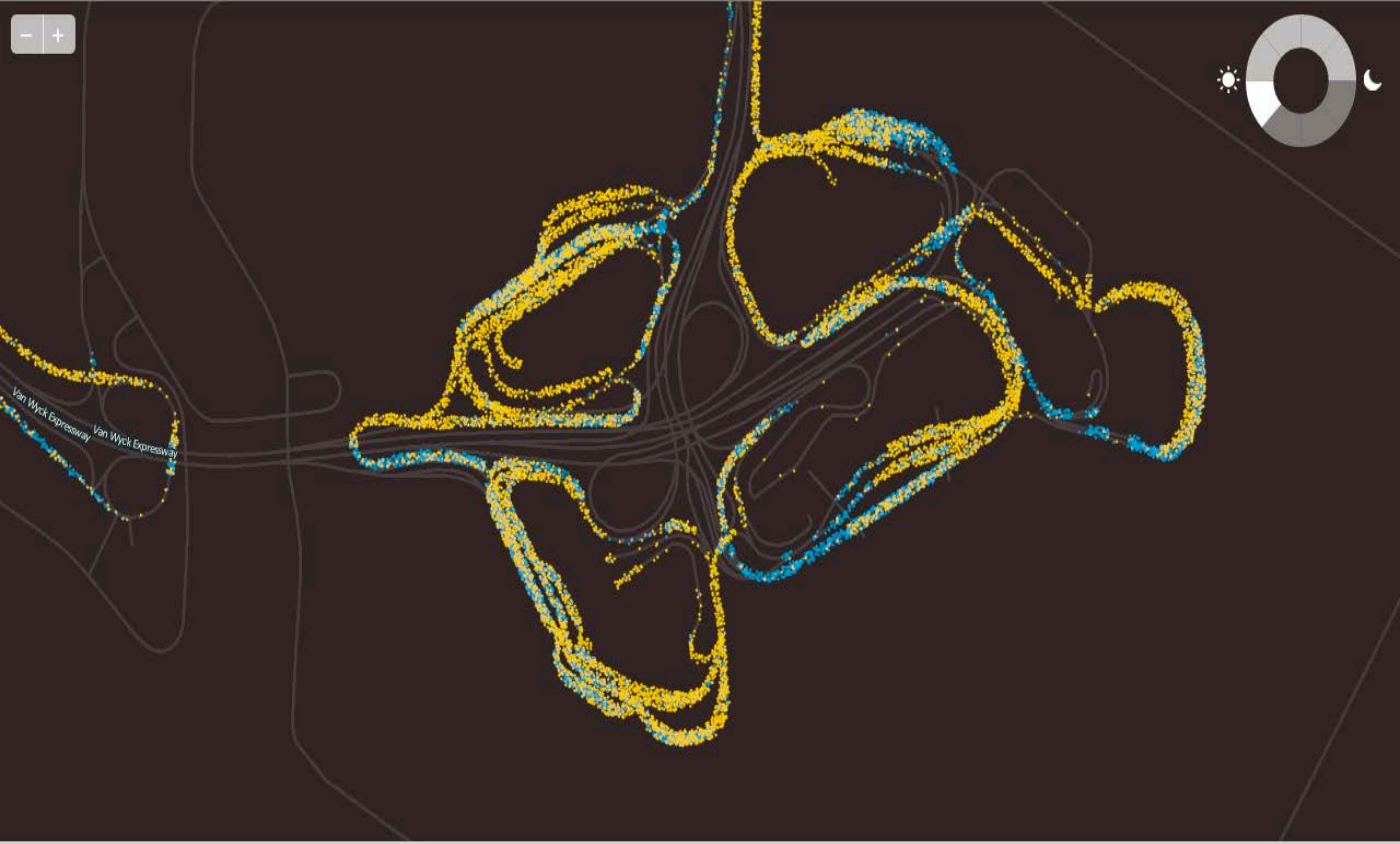
May Live to See

May Solve Congestion Problems



How You May Live and Travel in the City of 1950

Future city streets, says Mr. Corbett, will be in four levels: The top level for pedestrians; the next lower level for slow motor traffic; the next for fast motor traffic, and the lowest for electric trains. Great blocks of terraced skyscrapers half a mile high will house offices, schools, homes, and playgrounds in successive levels, while the roofs will be aircraft landing-fields, according to the architect's plan



hubcab

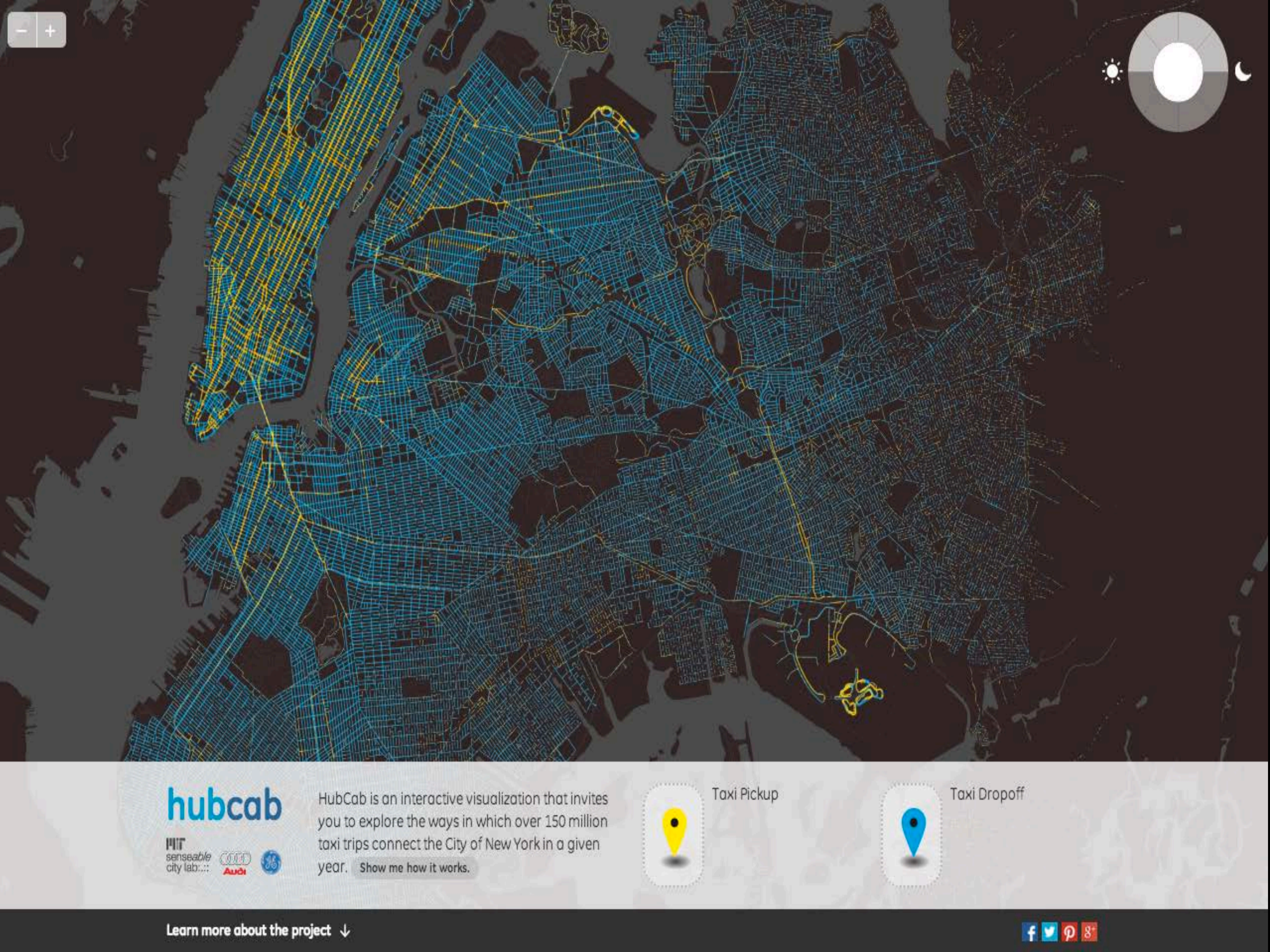
MIT senseable city lab Audi

HubCab is an interactive visualization that invites you to explore the ways in which over 150 million taxi trips connect the City of New York in a given year. Show me how it works.

Taxi Pickup

Taxi Dropoff

Learn more about the project ↓


hubcab
MIT senseable city lab
Audi
HubCab is an interactive visualization that invites you to explore the ways in which over 150 million taxi trips connect the City of New York in a given year. Show me how it works.
Taxi Pickup
Taxi Dropoff
Learn more about the project

Sharing benefits
3,160,172 $
1,052,627 mi
445,261 kg
225k
214k
West 57th Street
West 42nd Street
West 34th Street
West 14th Street
East 14th Street
Lincoln Tunnel
Queensboro Bridge lower level
Queens-Midtown Tunnel
Long Island Expressway
FDR Drive
hubcab
HubCab is an interactive visualization that invites you to explore the ways in which over 150 million taxi trips connect the City of New York in a given year.
Show me how it works.
Taxi Pickup
Reset
West 15th Street
Total Pickups: 1069
Average duration: 12.4 min
Average distance: 3 mi
Taxi Dropoff
Reset
East 54th Street
Total Dropoffs: 1053
Average duration: 10.2 min
Average distance: 2.38 mi
Learn more about the project

Quantifying the benefits of vehicle pooling with shareability networks

Paolo Santi[a,b], Giovanni Resta[b], Michael Szell[a,1], Stanislav Sobolevsky[a], Steven H. Strogatz[c], and Carlo Ratti[a]

[a]Senseable City Laboratory, Massachusetts Institute of Technology, Cambridge, MA 02139; [b]Istituto di Informatica e Telematica del Consiglio Nazionale delle Ricerche, 56124 Pisa, Italy; and [c]Department of Mathematics, Cornell University, Ithaca, NY 14853

Edited* by Michael F. Goodchild, University of California, Santa Barbara, CA, and approved July 25, 2014 (received for review March 3, 2014)

Taxi services are a vital part of urban transportation, and a considerable contributor to traffic congestion and air pollution causing substantial adverse effects on human health. Sharing taxi trips is a possible way of reducing the negative impact of taxi services on cities, but this comes at the expense of passenger discomfort quantifiable in terms of a longer travel time. Due to computational challenges, taxi sharing has traditionally been approached on small scales, such as within airport perimeters, or with dynamical ad hoc heuristics. However, a mathematical framework for the systematic understanding of the tradeoff between collective benefits of sharing and individual passenger discomfort is lacking. Here we introduce the notion of shareability network, which allows us to model the collective benefits of sharing as a function of passenger inconvenience, and to efficiently compute optimal

At the basis of a shared taxi service is the concept of ride sharing or carpooling, a long-standing proposition for decreasing road traffic, which originated during the oil crisis in the 1970s (6). During that time, economic incentives outbalanced the psychological barriers on which successful carpooling programs depend: giving up personalized transportation and accepting strangers in the same vehicle. Surveys indicate that the two most important deterrents to potential carpoolers are the extra time requirements and the loss of privacy (7, 8). However, the lack of correlations between socio-demographic variables and carpooling propensity (8), the design of appropriate economic incentives (9), and recent practical implementations of taxi-sharing systems in New York City (http://bandwagon.io) give ample hope that many social obstacles might be overcome in newly emerging "sharing economies" (10, 11).

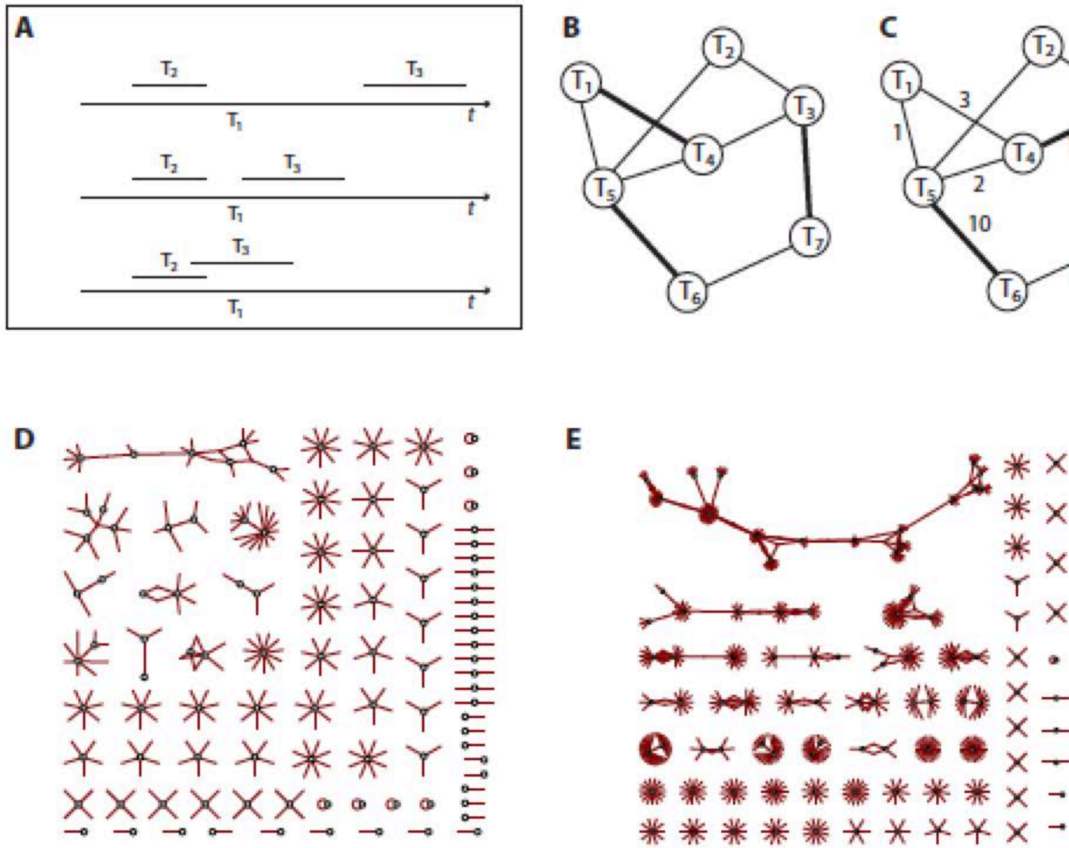
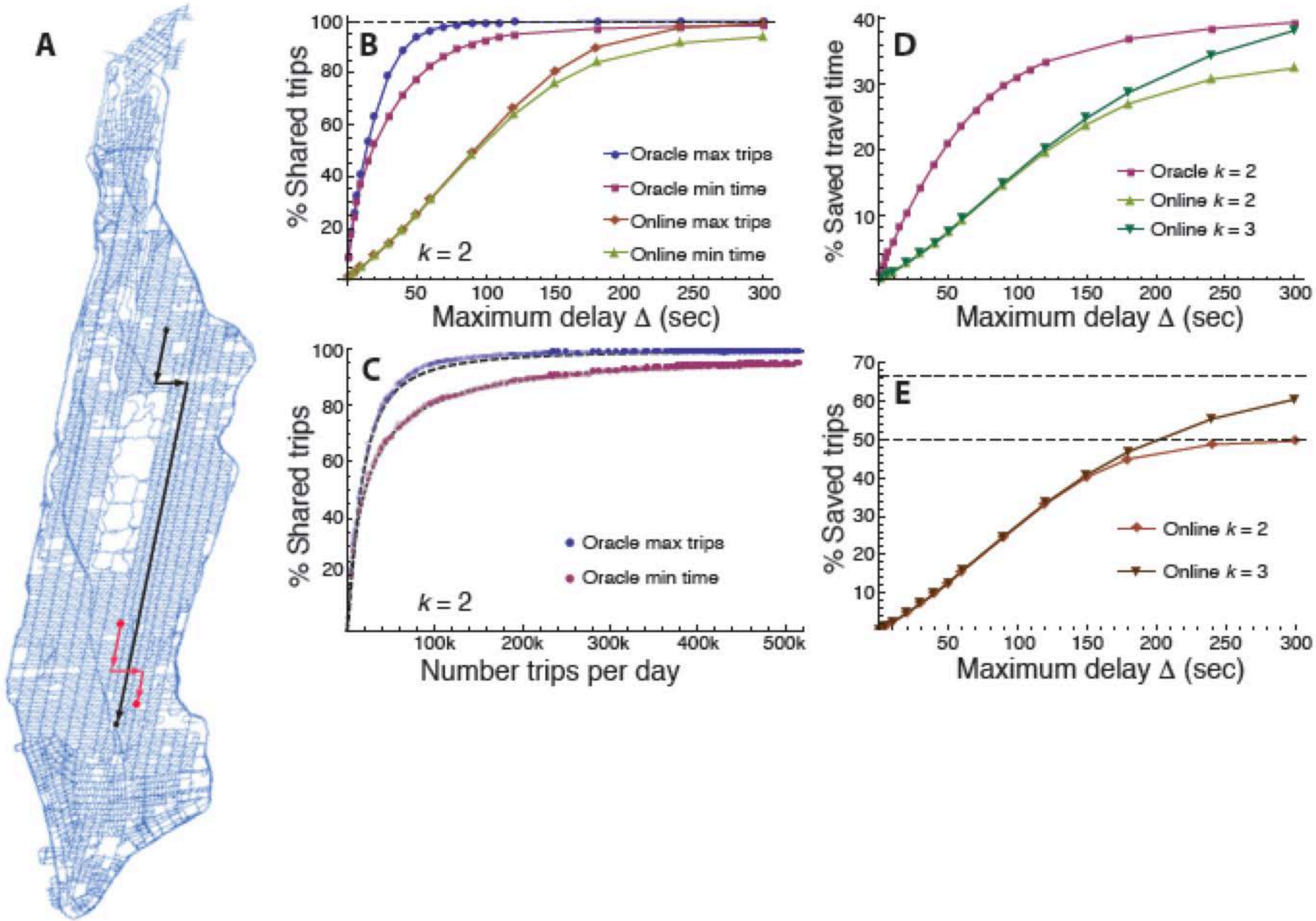
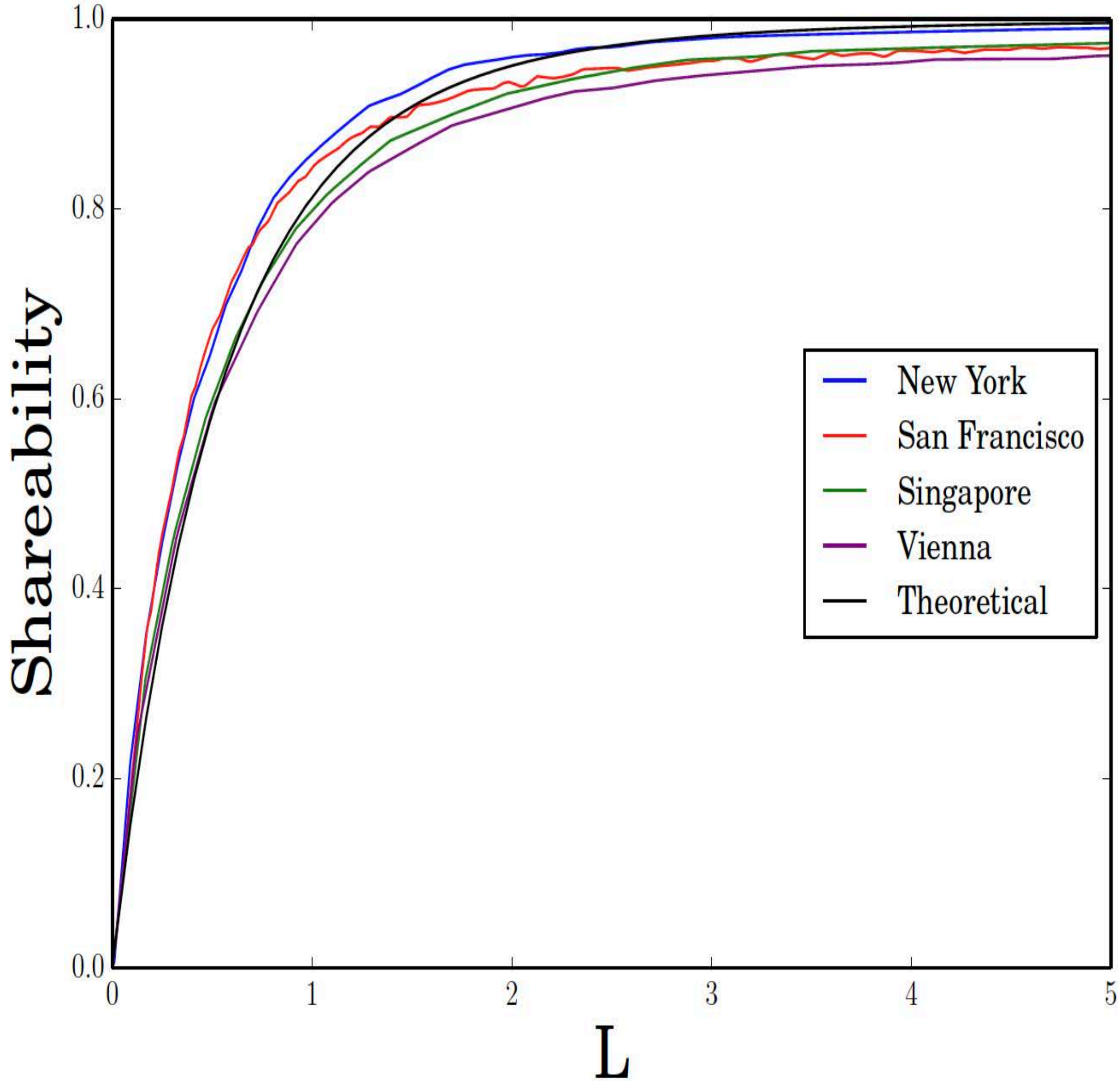
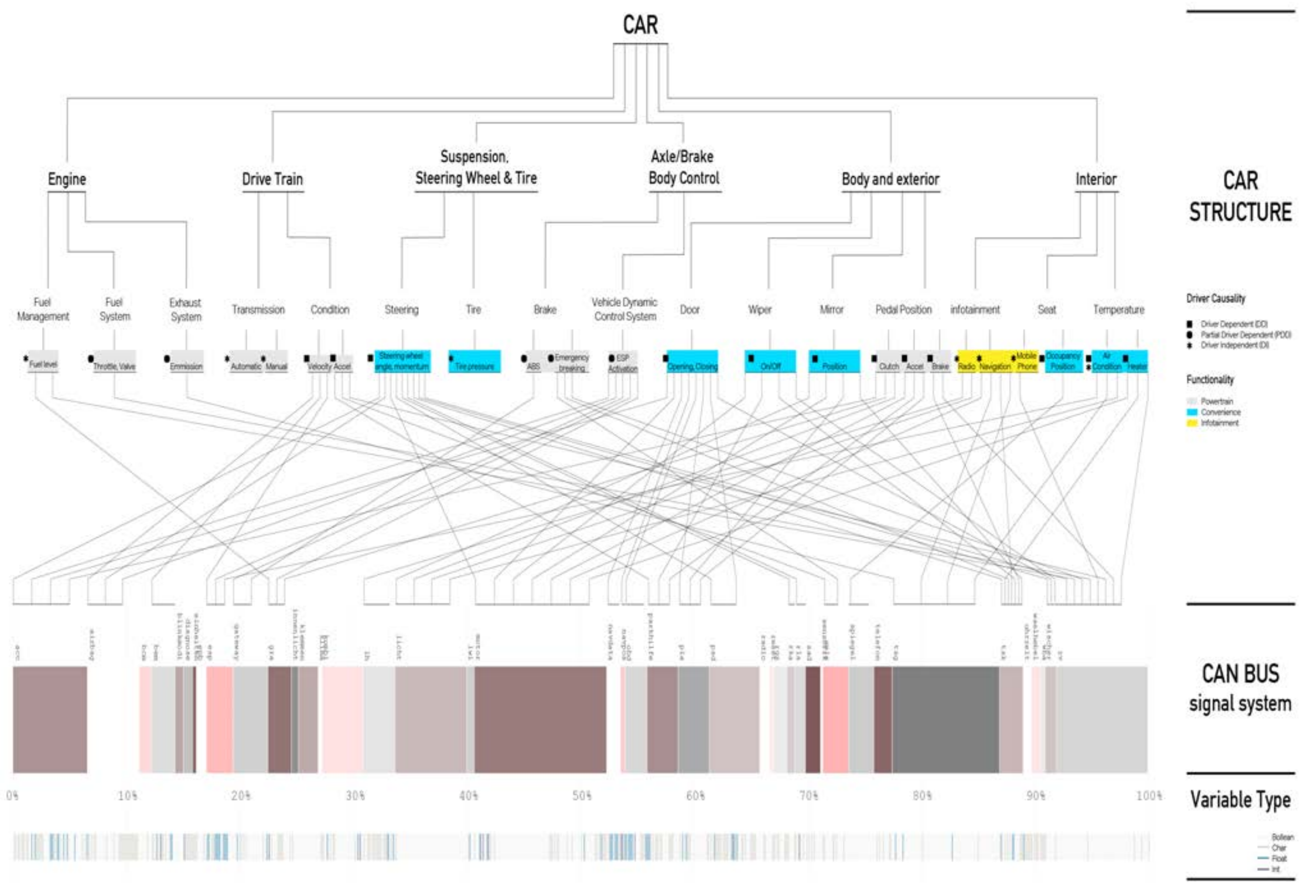


Figure 1: **Shareability networks.** **(A)** Trip sharing model and taxi capacity. Each of the three cases involves three trips T_1, T_2, and T_3 to be shared, but ordered differently in time t. The top case corresponds to a feasible sharing according to our model with $k = 2$, and the trips can be accommodated in a taxi with capacity ≥ 2. The middle case corresponds to a model with $k = 3$ since three trips are combined; notice that the three trips can be combined in a taxi with capacity two since two of the combined trips are non-overlapping. The bottom case corresponds to $k = 3$, but here a taxi capacity ≥ 3 is needed to accommodate the combined trips. **(B)** Example of maximum matching *(4)* in a simple shareability network. The links belonging to the maximum matching are displayed in bold. **(C)** Example of maximum weighted matching *(4)*. **(D)** Exemplary subset of the shareability network corresponding to 100 consecutive trips for values of $\Delta = 30\,\text{sec}$ and **(E)** $\Delta = 60\,\text{sec}$, showing network densification effects and thus an increase of sharing opportunities with longer time-aggregation. Open links point to trips outside the considered set of trips. Isolated nodes are represented as self-loops. Node positions are not preserved across the networks.

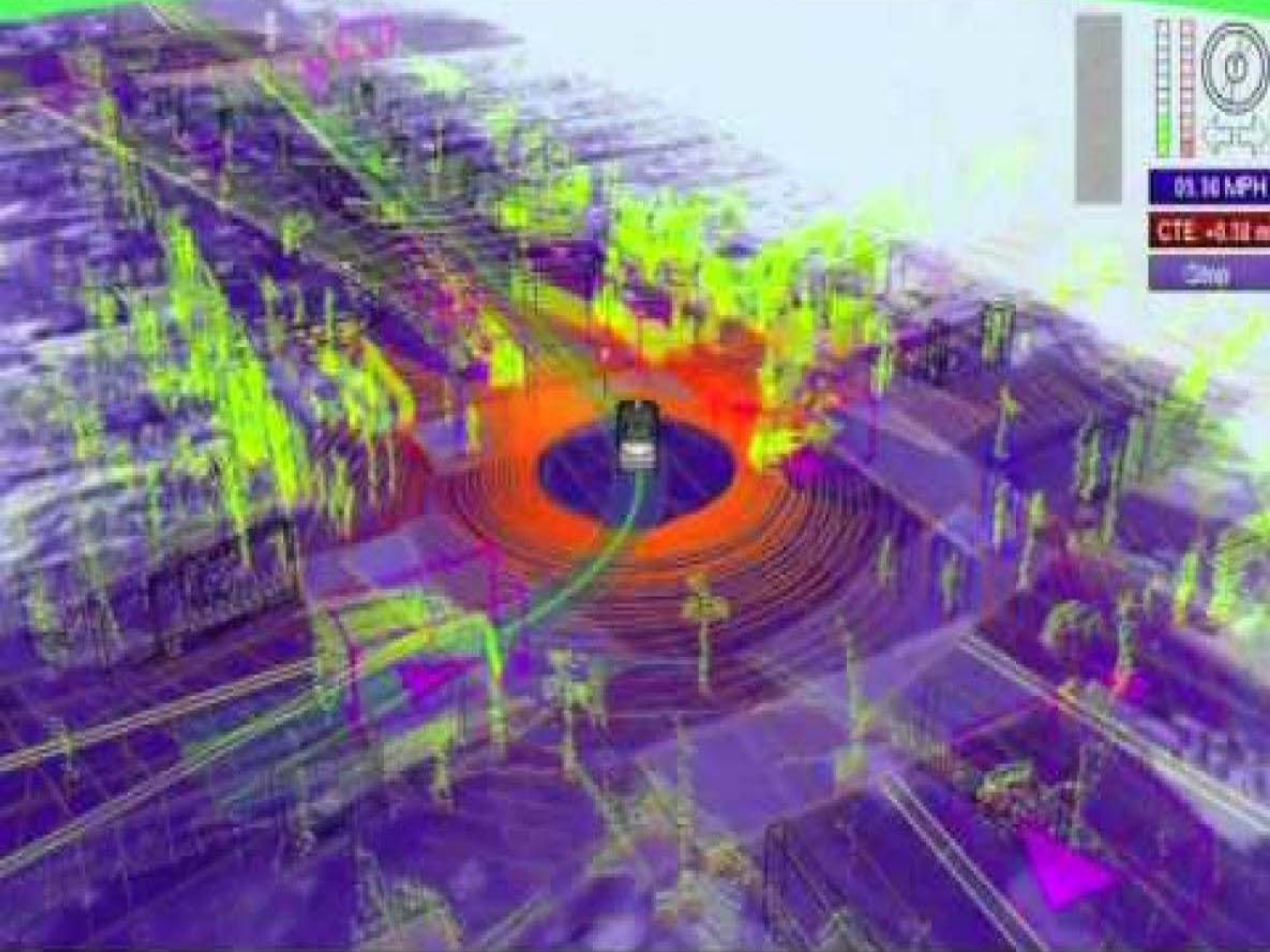

A
B
% Shared trips
Maximum delay Δ (sec)
Oracle max trips
Oracle min time
Online max trips
Online min time
k = 2
C
% Shared trips
Number trips per day
Oracle max trips
Oracle min time
k = 2
D
% Saved travel time
Maximum delay Δ (sec)
Oracle k = 2
Online k = 2
Online k = 3
E
% Saved trips
Maximum delay Δ (sec)
Online k = 2
Online k = 3



Shareability
L
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5
New York
San Francisco
Singapore
Vienna
Theoretical

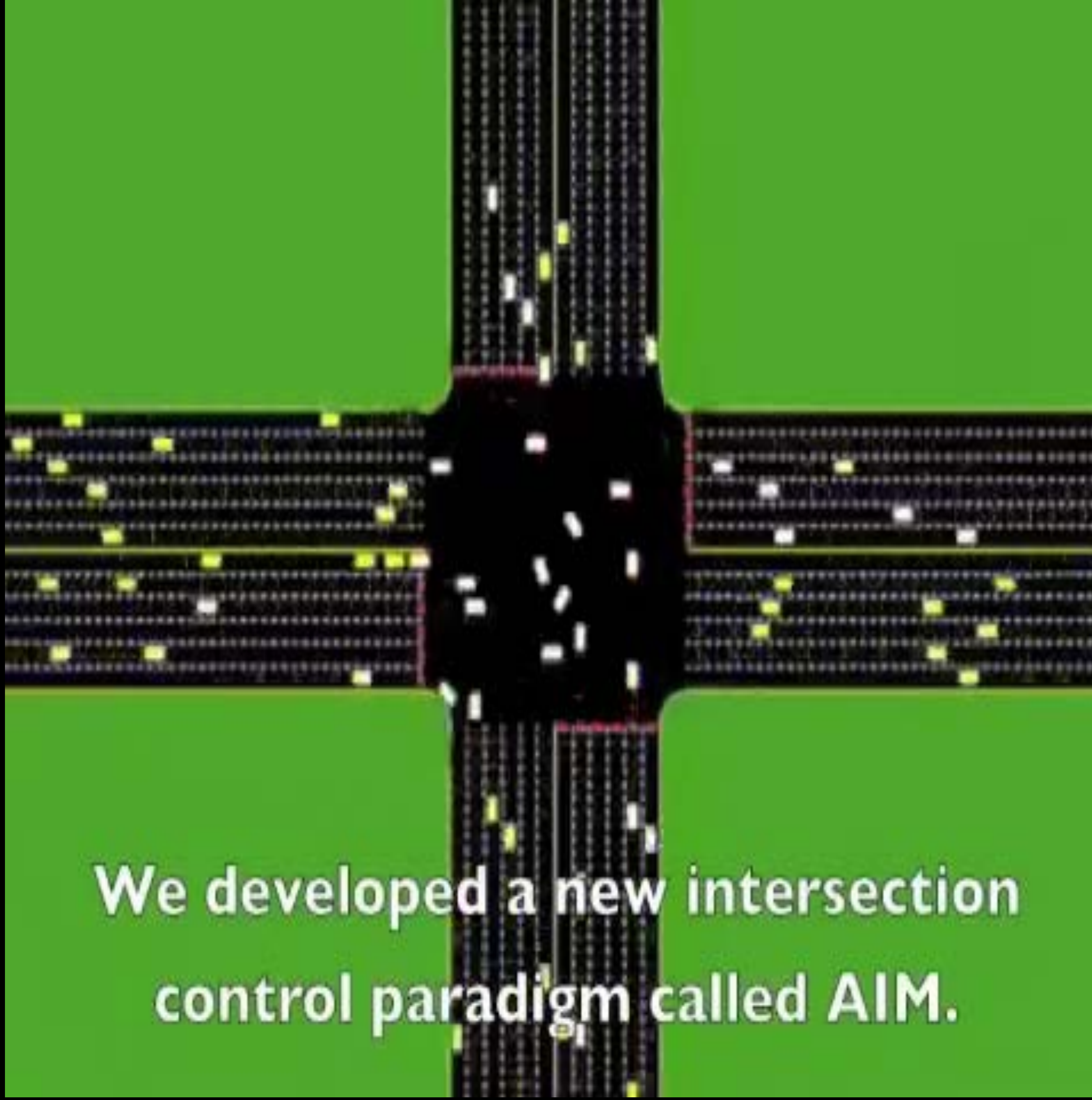


CAR
Engine
Drive Train
Suspension, Steering Wheel & Tire
Axle/Brake Body Control
Body and exterior
Interior
Fuel Management
Fuel System
Exhaust System
Transmission
Condition
Steering
Tire
Brake
Vehicle Dynamic Control System
Door
Wiper
Mirror
Pedal Position
infotainment
Seat
Temperature
Fuel level
Throttle, Valve
Emmission
Automatic
Manual
Velocity
Accel
Steering wheel angle, momentum
Tire pressure
ABS
Emergency breaking
ESP Activation
Opening, Closing
On/Off
Position
Clutch
Accel
Brake
Radio
Navigation
Mobile Phone
Occupancy Position
Air Condition
Heater
CAR STRUCTURE
Driver Causality
Driver Dependent (DD)
Partial Driver Dependent (PDD)
Driver Independent (DI)
Functionality
Powertrain
Convenience
Infotainment
CAN BUS signal system
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Variable Type
Boolean
Char
Float
Int




UBER
VOLVO
XC90

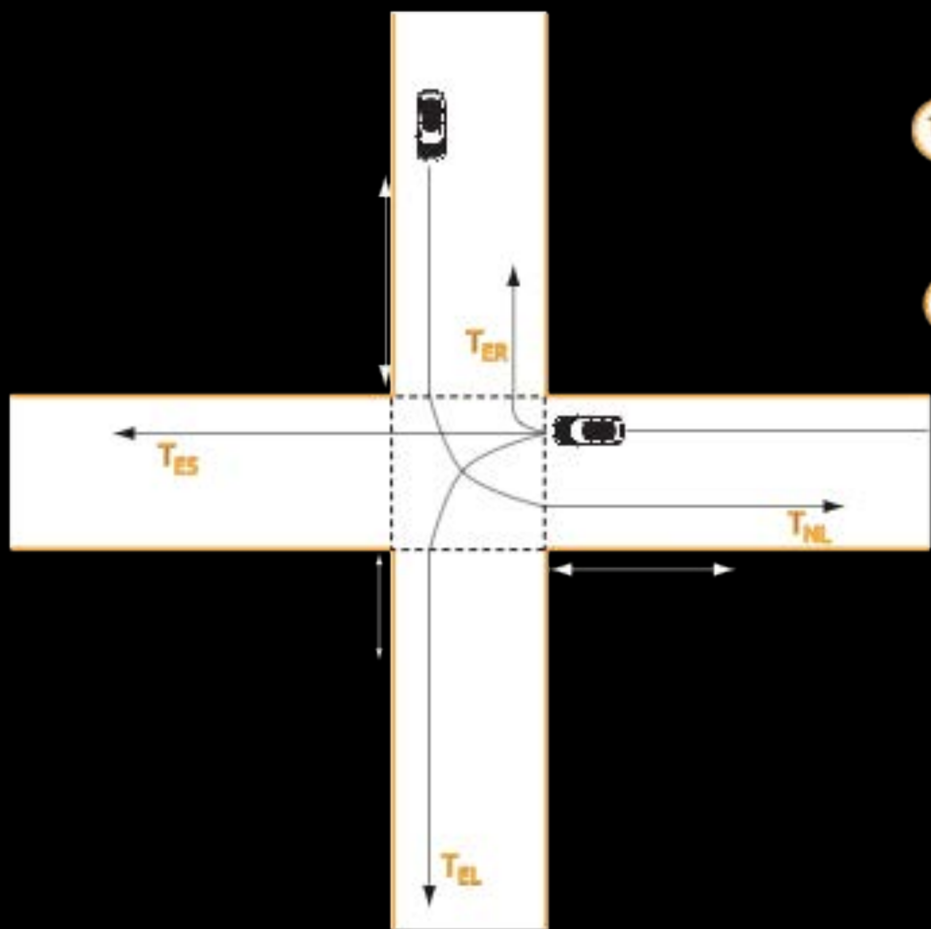

DRIVE
TO
RIGHT


We developed a new intersection
control paradigm called AIM.

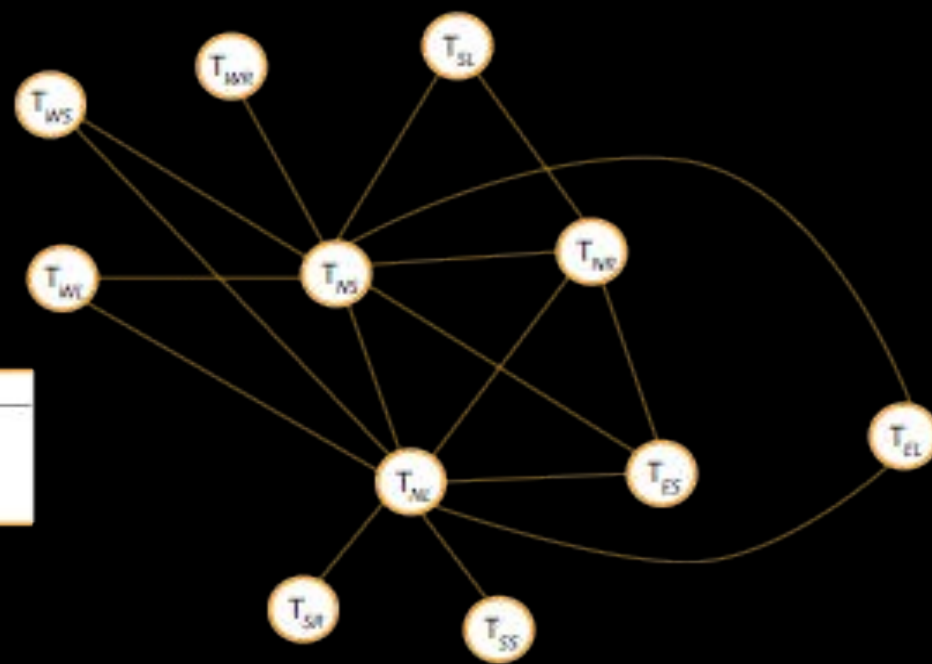
“In Milan, traffic lights are instructions.
In Rome, they are suggestions.
In Naples, they are Christmas decorations.”

Antonio Martino
Former Minister of Foreign Affairs (1994) and Minister of Defense (2001-2006)

Access to intersection based on Incompatibility Network and ....



Vehicle trajectories
(partial view)

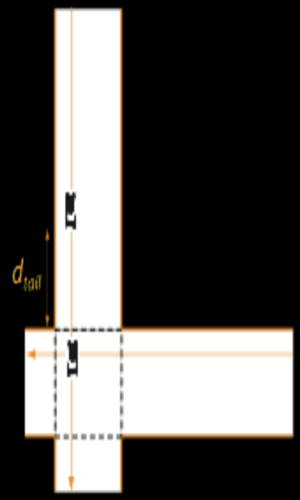


Incompatibility Network
(partial view)

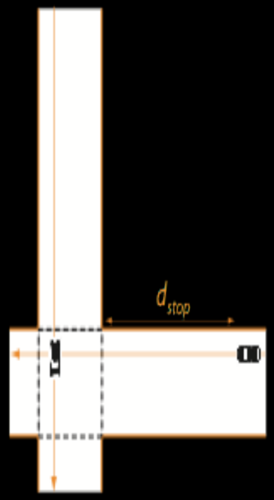
Access to intersection based on Incompatibility Network and safety constraints

Safety constraint

- based on tailgate distance (a.k.a. two seconds rule) for vehicles with compatible trajectories
- based on vehicle stopping distance for vehicles with incompatible trajectories



Typically, $d_{tail} < d_{stop}$



City Drive

2. WORKING SPACES...

Harvard Business Review

WORKSPACES

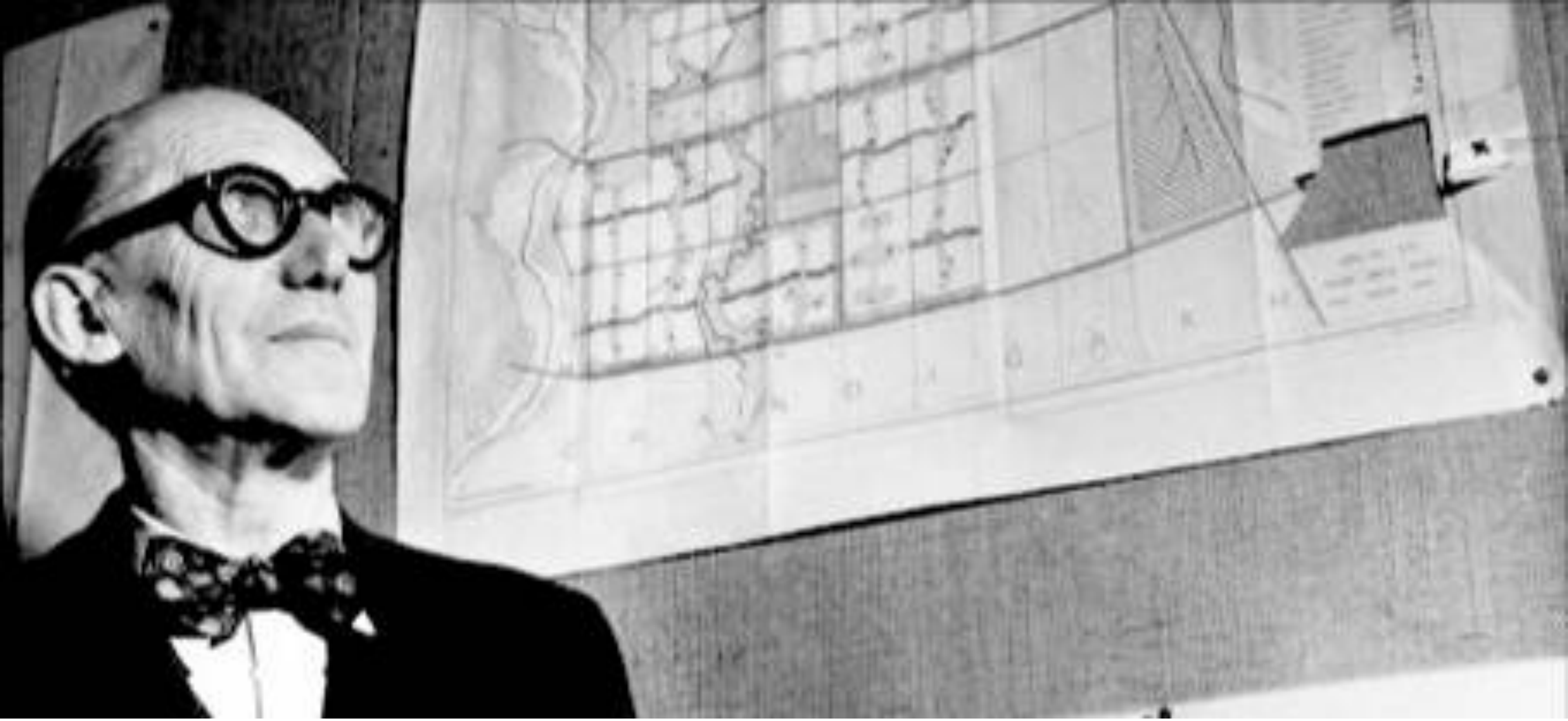
If Work Is Digital, Why Do We Still Go to the Office?

by Carlo Ratti and Matthew Claudel

APRIL 13, 2016

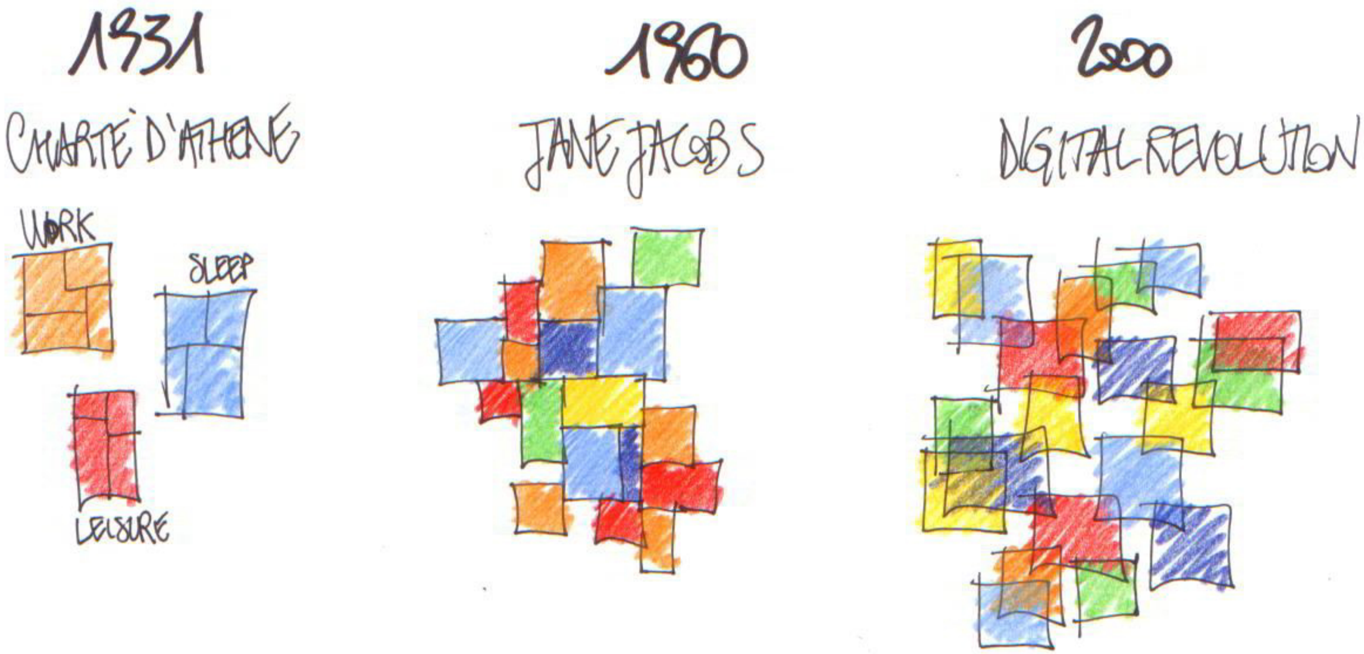
WHAT TO READ NEXT

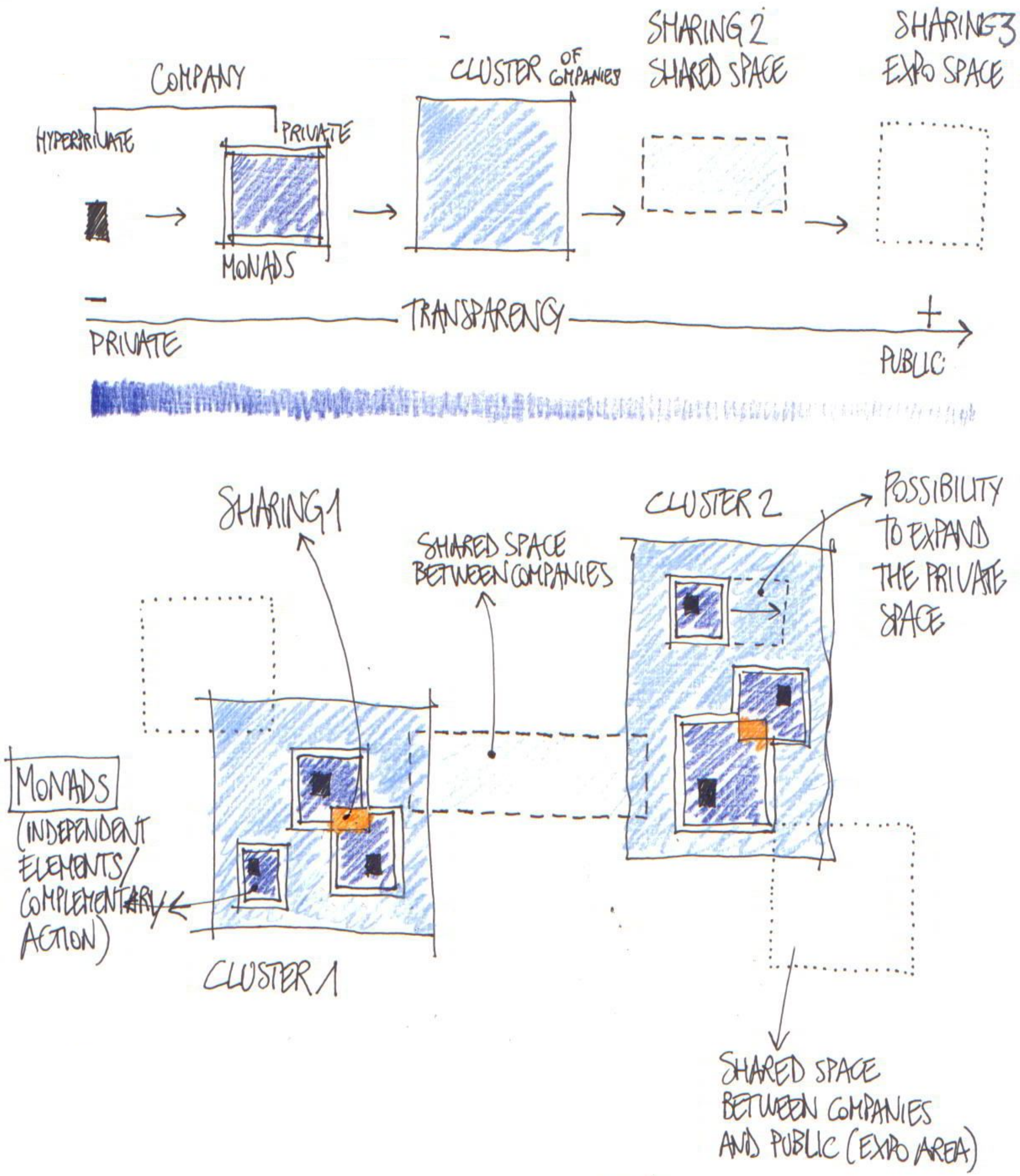
7 Factors of Great Office Design



Le Corbusier , Charte d'Athene 1931, IV CIAM

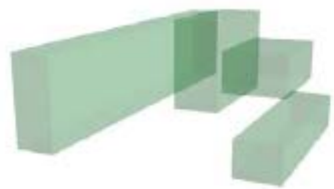
"The four keys to urban planning are the four functions of the city: dwelling, work, recreation (use of leisure time), transportation"


1931
CHARTE D'ATHENE
WORK
SLEEP
LEISURE
1960
JANE JACOBS
2000
DIGITAL REVOLUTION

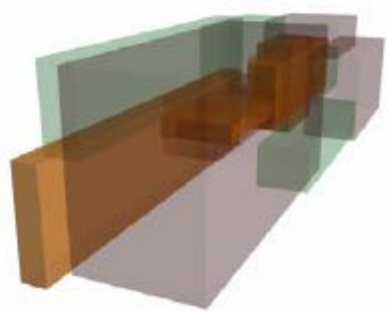

COMPANY
CLUSTER OF COMPANIES
SHARING 2
SHARED SPACE
SHARING 3
EXPO SPACE
HYPERPRIVATE
PRIVATE
MONADS
TRANSPARENCY
PRIVATE
PUBLIC
SHARING 1
SHARED SPACE BETWEEN COMPANIES
CLUSTER 2
POSSIBILITY TO EXPAND THE PRIVATE SPACE
MONADS
(INDEPENDENT ELEMENTS/ COMPLEMENTARY ACTION)
CLUSTER 1
SHARED SPACE BETWEEN COMPANIES AND PUBLIC (EXPO AREA)

Circulation

Private

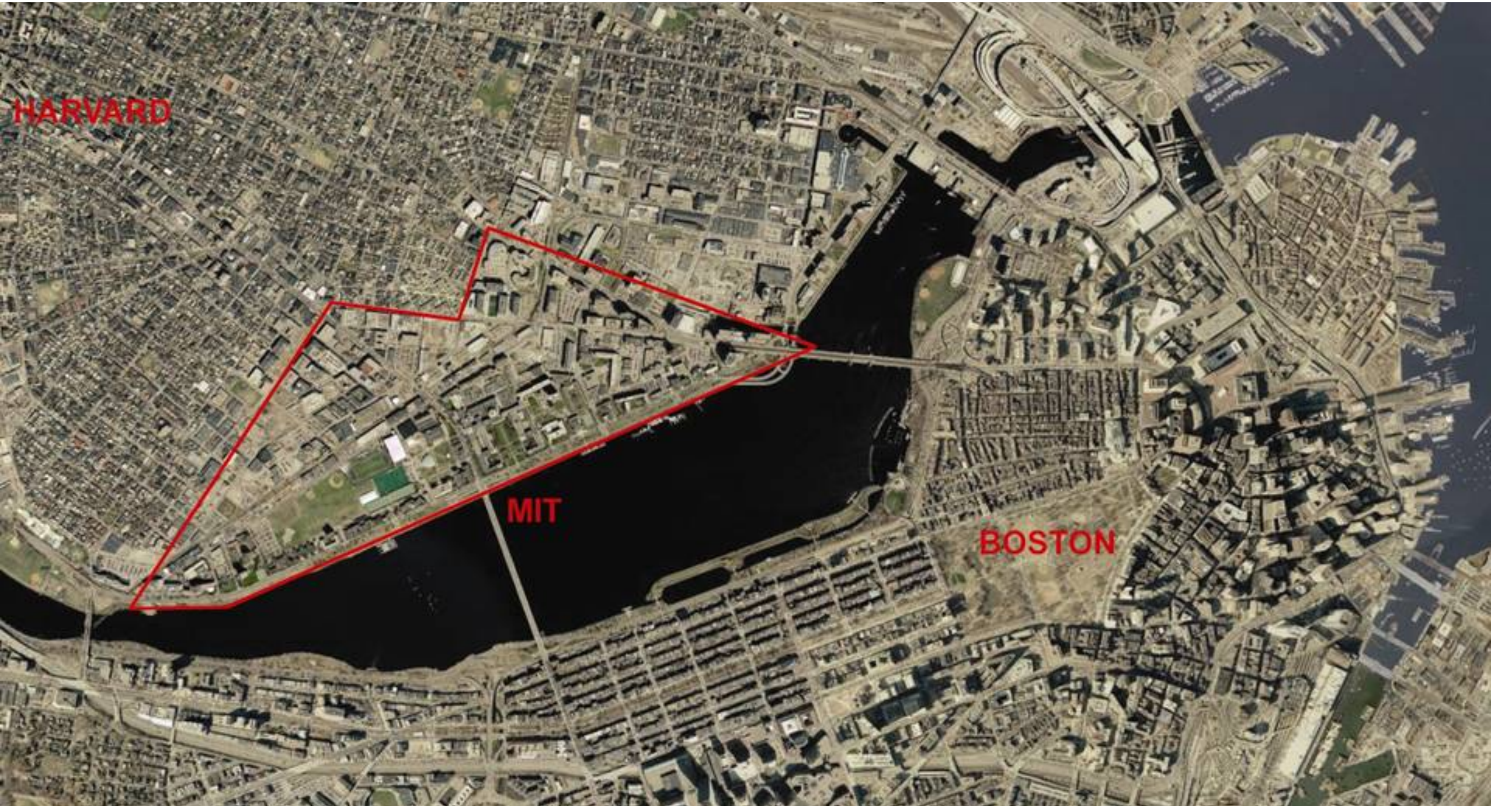


Open



Composite

MIT campus
Location: Boston, MA
Area: 168 acres
People: 10,320 students and 9, 414 total employees
Buildings: over 190

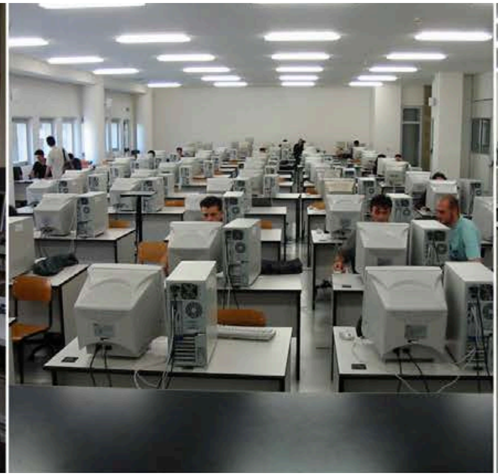


WiFi™

ZONE

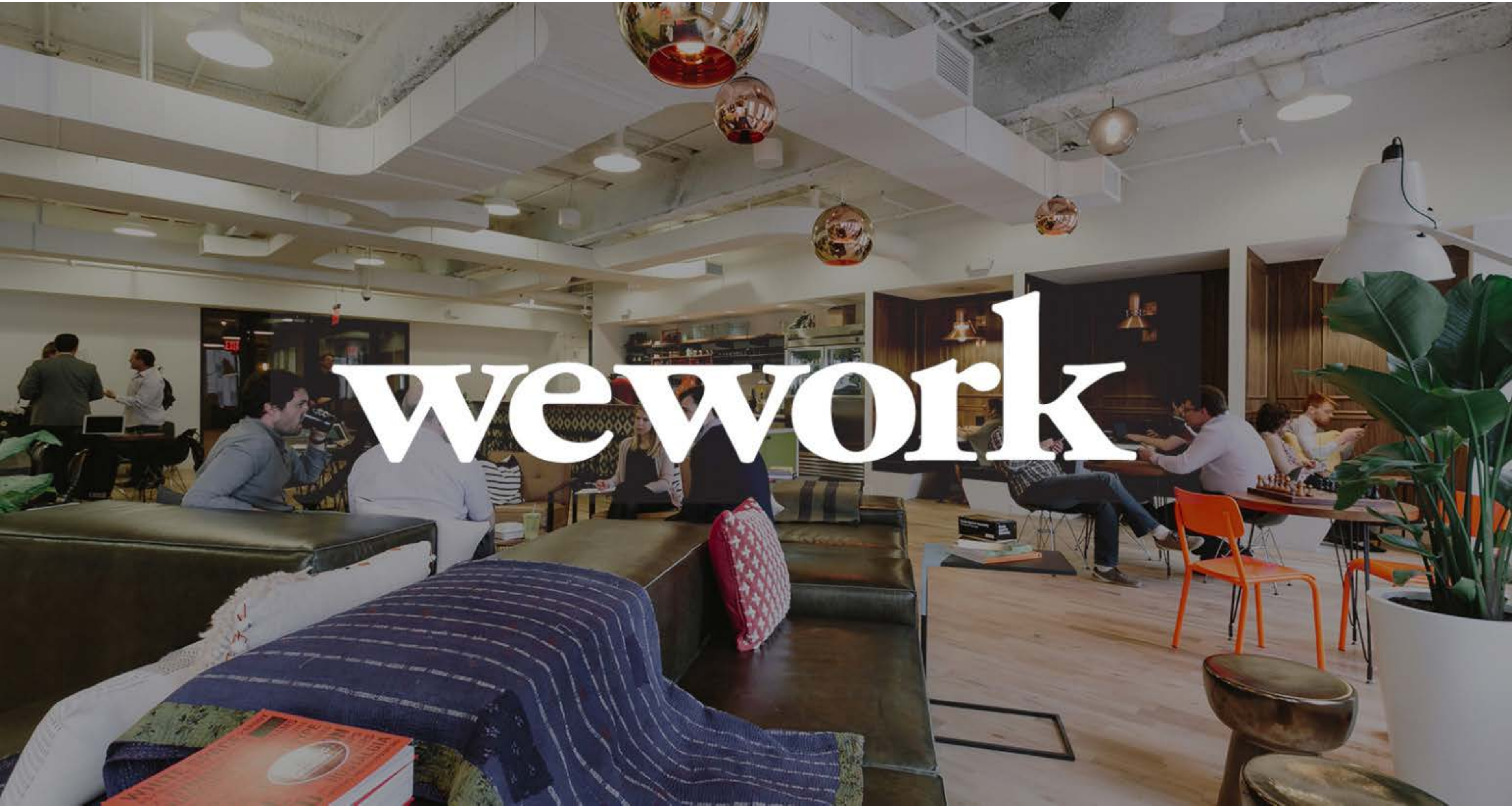
Before

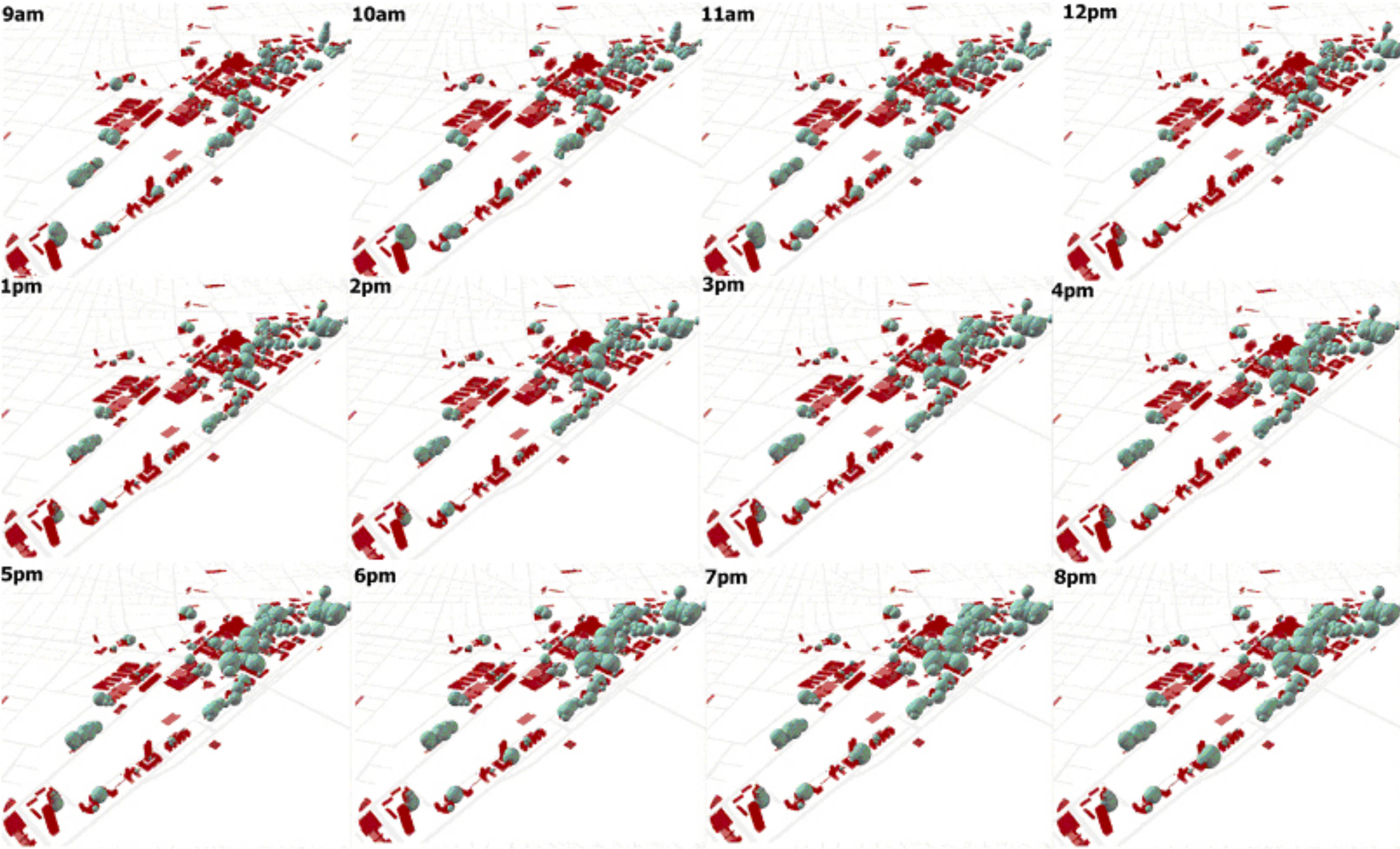
After

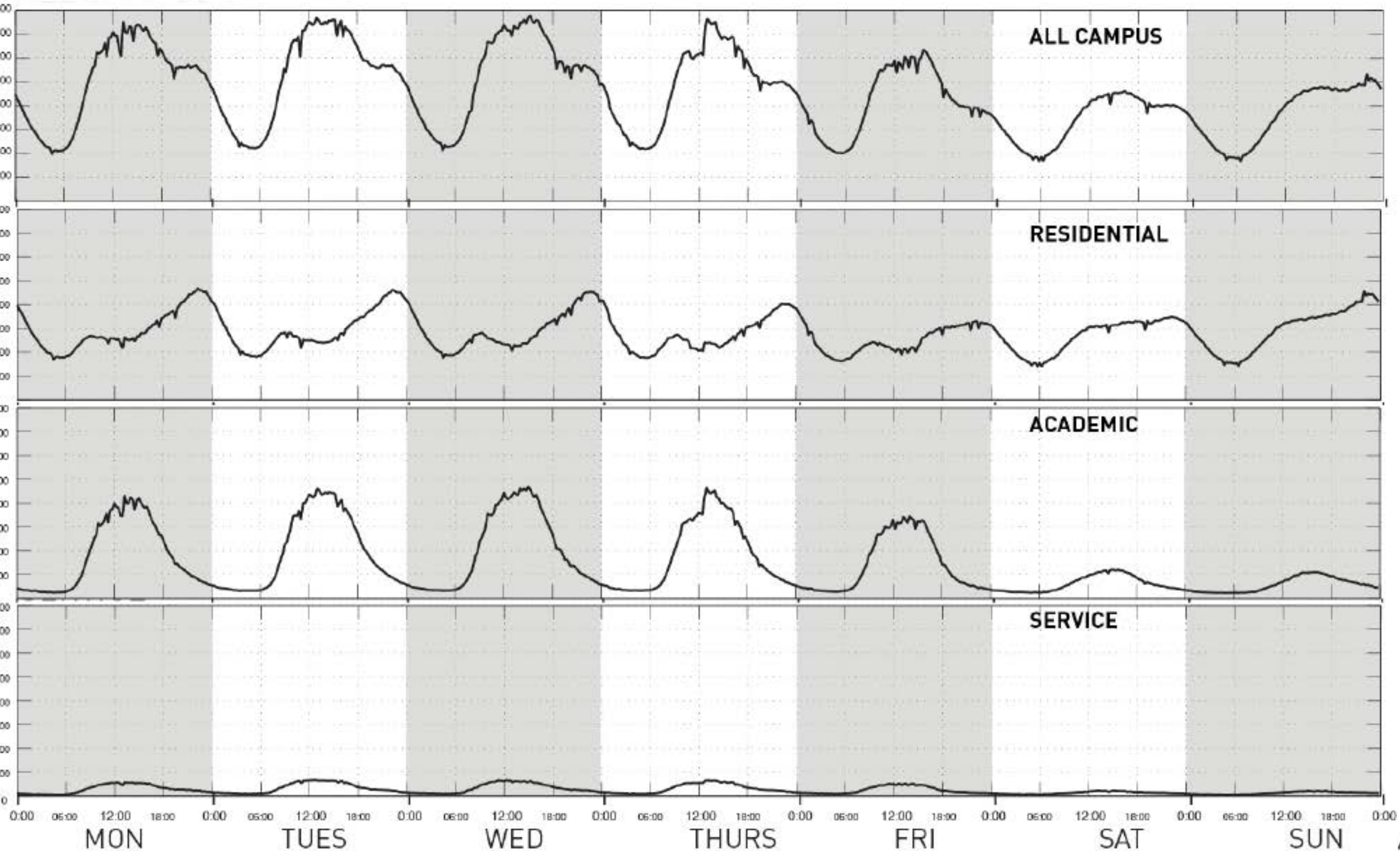





wework

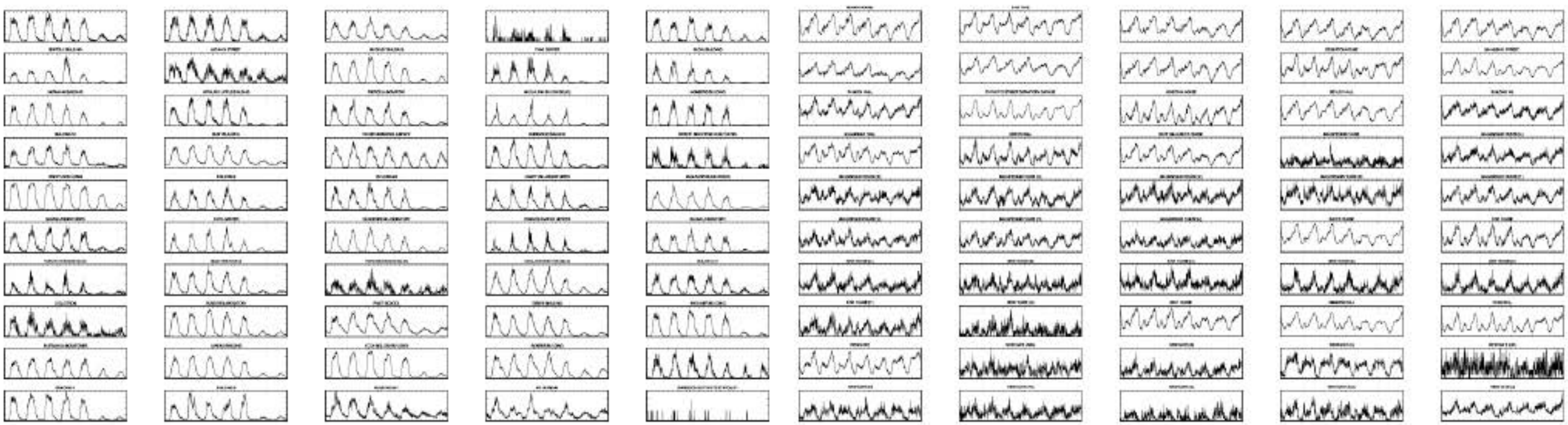

9am
10am
11am
12pm
1pm
2pm
3pm
4pm
5pm
6pm
7pm
8pm

Summary slide of the signals from the three program types discussed earlier - compared to the signature of the entire campus. The user number is the average weekly number of people connecting to the internet via WiFi.

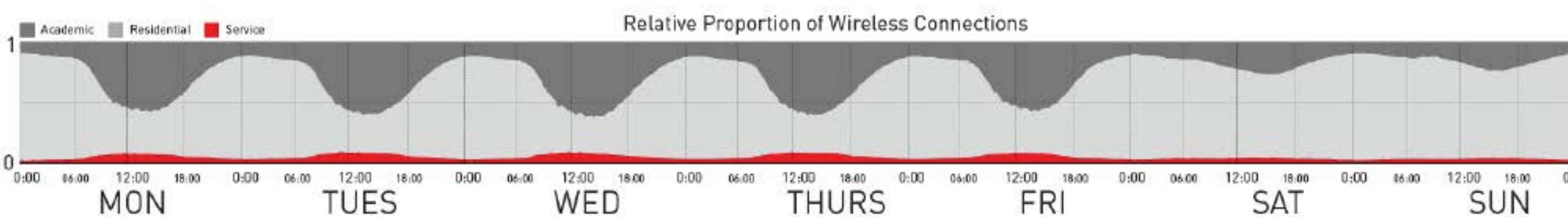


3. MIT CAMPUS

The average weekly WiFi signals from individual buildings give us a fingerprint of each building. Can these be correlated (calibrated?) to the type of people living in particular dorms? Do physicists have different WiFi usage than chemists?



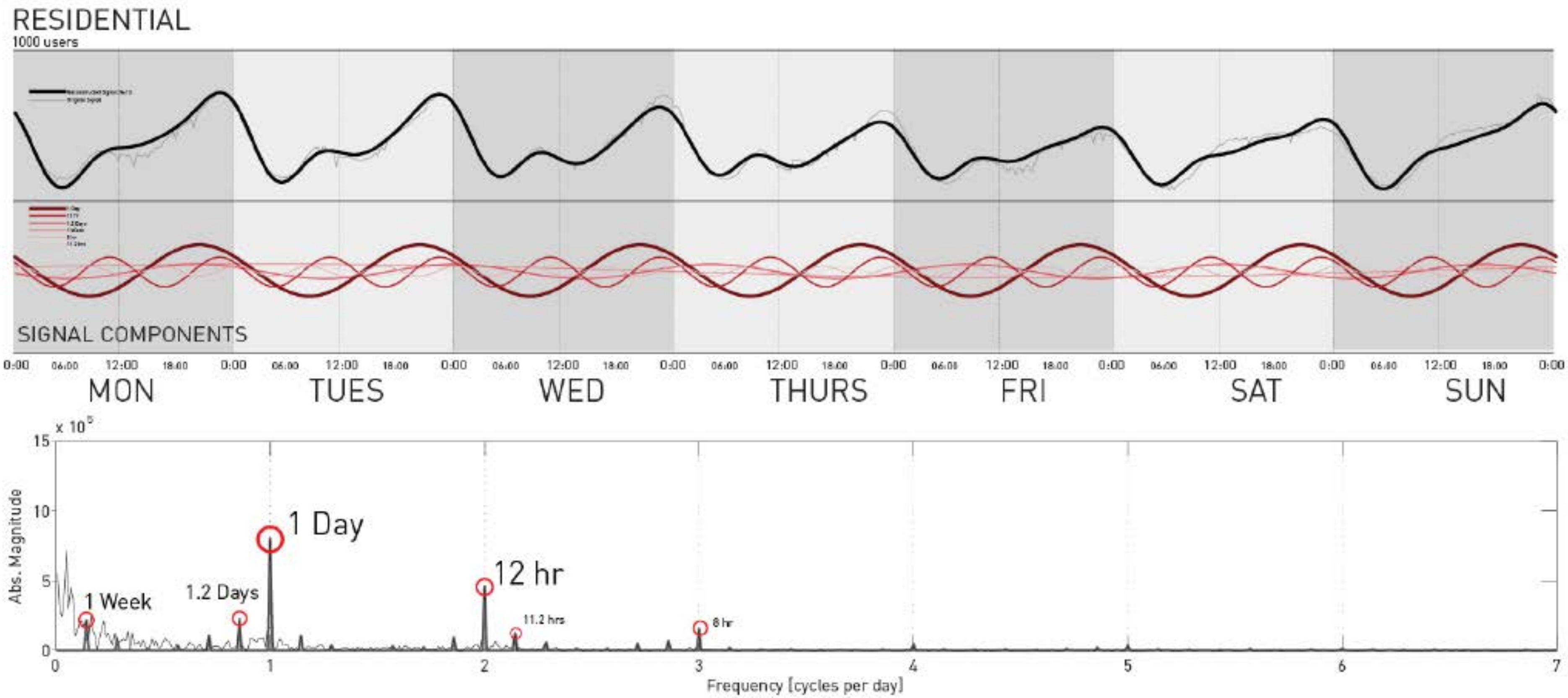
Calculating the average relative proportions of total WiFi connections among the three program types (academic/residential/service) over the course of a week revels characteristic WiFi behavior in the three program types. Although the service building WiFi use is much lower than the two other program types, in general, the service and academic buildings show a similar increase in WiFi use during normal daylight hours, while the residential use increases at night. This difference diminishes during the weekend.



3.1 MIT FFT

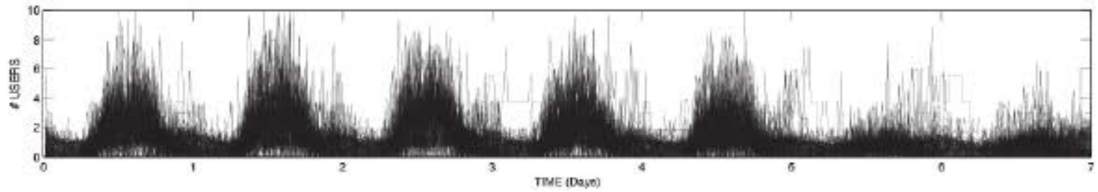
Taking an FFT of the average weekly time series allows us to separate the WiFi signatures into individual components. Shown below are the original signature, the reconstructed signature, the six frequencies used to reconstruct the synthetic time series, and the spectral graph of the original time series. The thickness and color of the individual components are a function of the magnitude of the frequency shown in the lowermost plot. The primary frequencies for residential buildings correspond to periods of 1 day, 12 hours, 1.2 days, 8 hours, and 1 week. The diurnal cycle is as expected for people who sleep at night and work during the day. The 12hr and 8hr periods correspond to daily activities such as going to class and accessing the internet in the evening. Note the largest WiFi signal comes just before midnight. Since these are mostly students in dorms, it is not surprising.

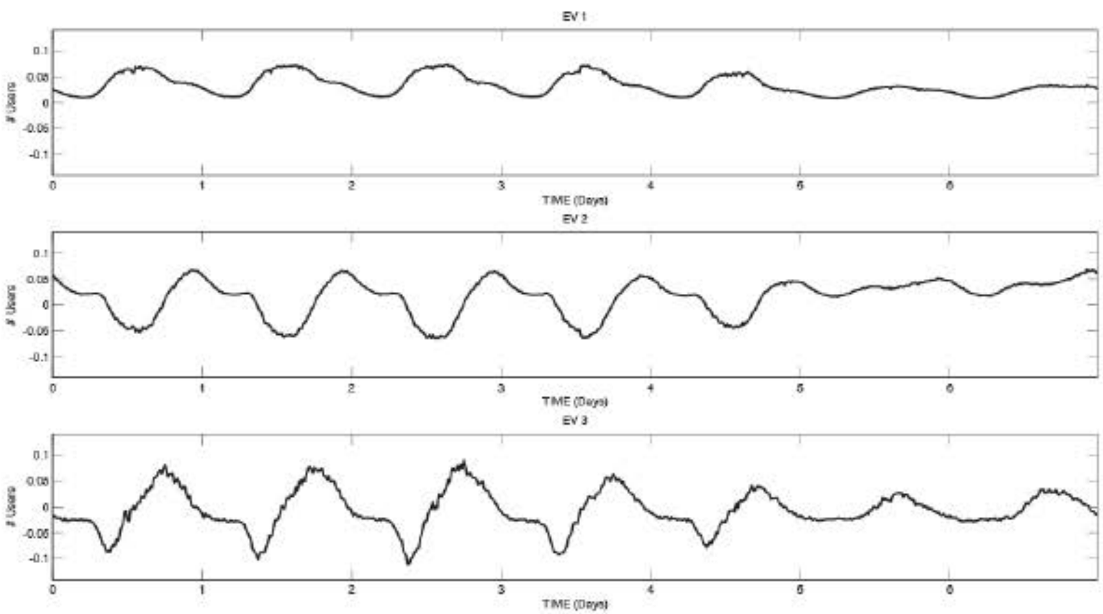
As can be seen below, the FFT technique is ideal for characterizing and extracting fundamental components of periodic behavior. Is a city periodic? I would say yes - it is governed by cycles and thus, unlike the eigenvector technique which is more interested in canonical forms (periodic or not), tends to make a ot of intuitive sense for urban analysis.

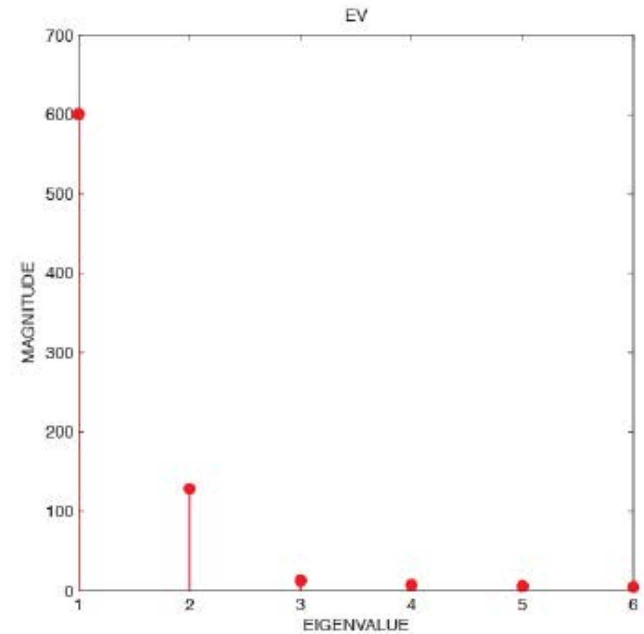


3.2 MIT EIGENVECTOR ANALYSIS AND K-MEAN CLUSTERING

The test of seeing whether WiFi antennas in Simmons Hall could be grouped according to very localized usage patterns was partially successful - there are still many uncertainties about the accuracy of the results - so it was decided to use all of the antennas on the MIT campus to determine the 14 week average signal and then calculate the eigenvectors /eigenvalues and k-mean clustering. Shown below are the results of the eigenvector analysis.







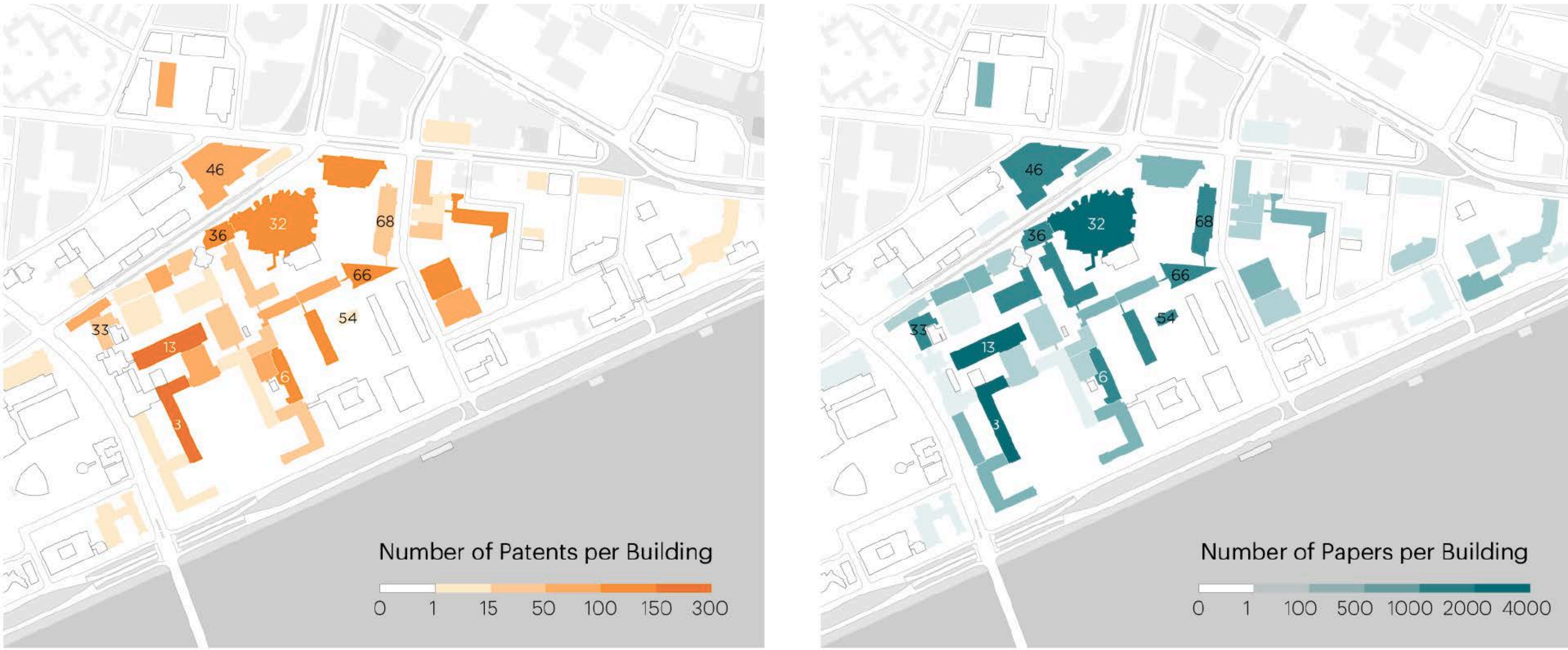


Figure 4. Patent and paper output per building between 2004 and 2014. On these choropleth maps, buildings are color coded by output volume and labeled with their name (the facility code). Colors are assigned using a Jencks algorithm with five buckets.

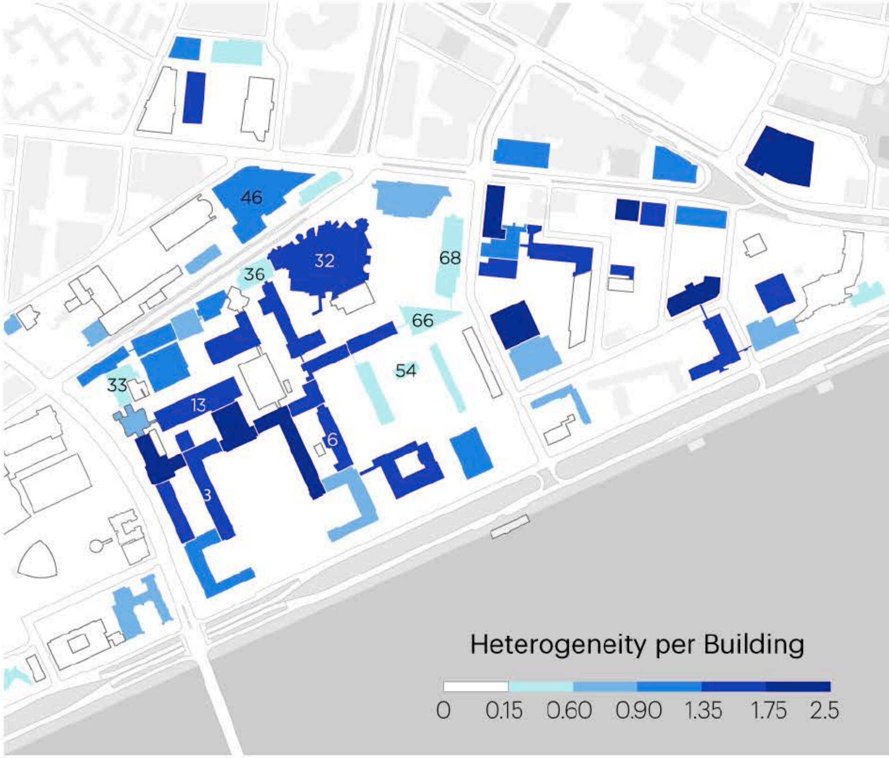


Figure 7. MIT campus buildings, coded according to heterogeneity, as calculated using the Shannon measure of information entropy. This shows variation in faculty departmental affiliations per building. Values range from 0 to 2.5, classified with a Jencks algorithm. Buildings are labeled by name (facility code).

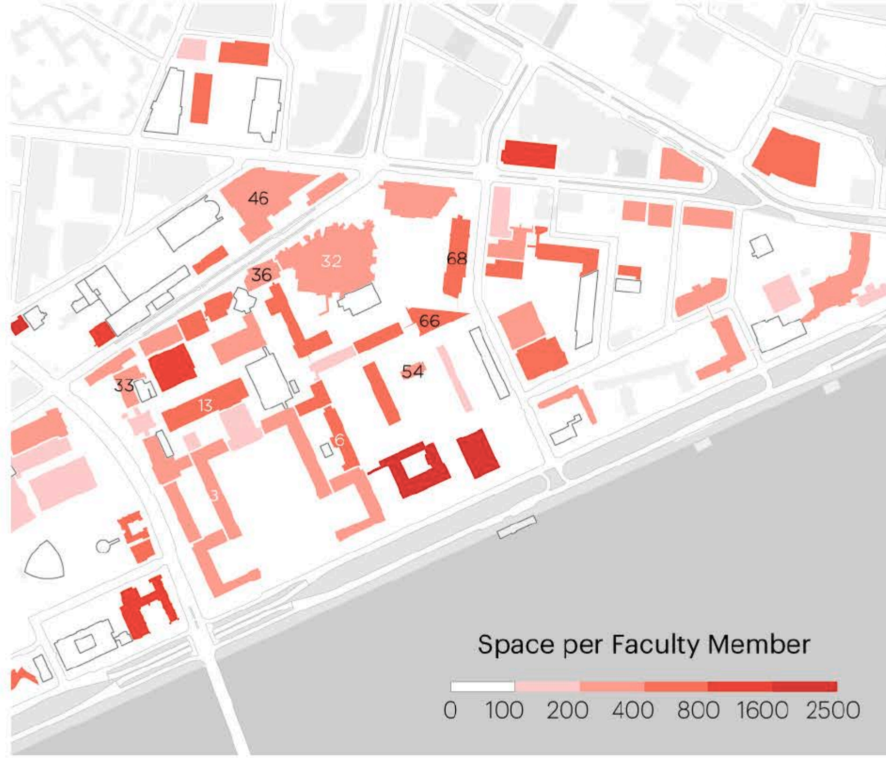
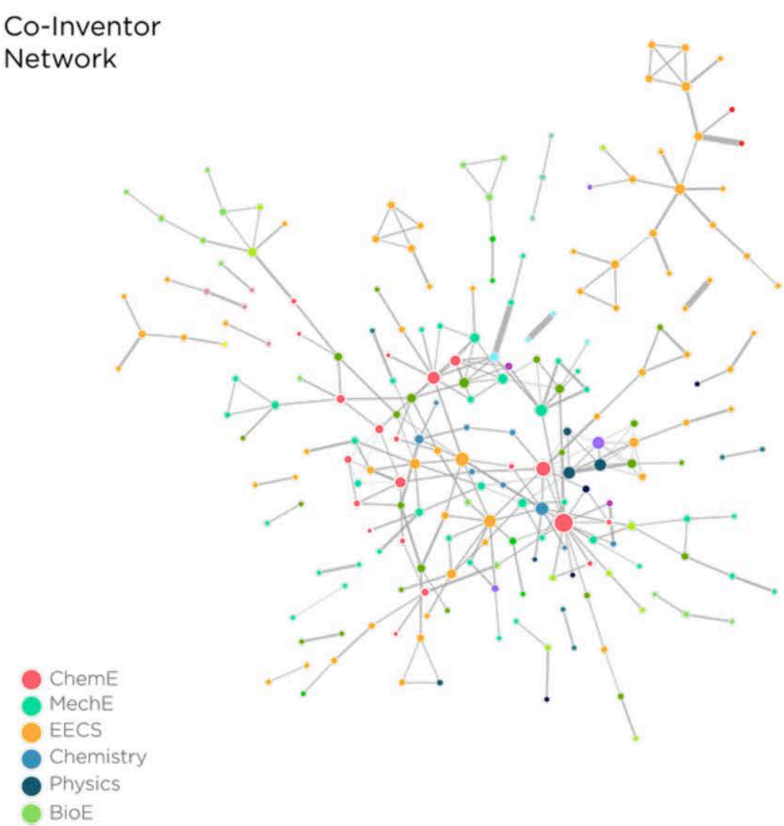
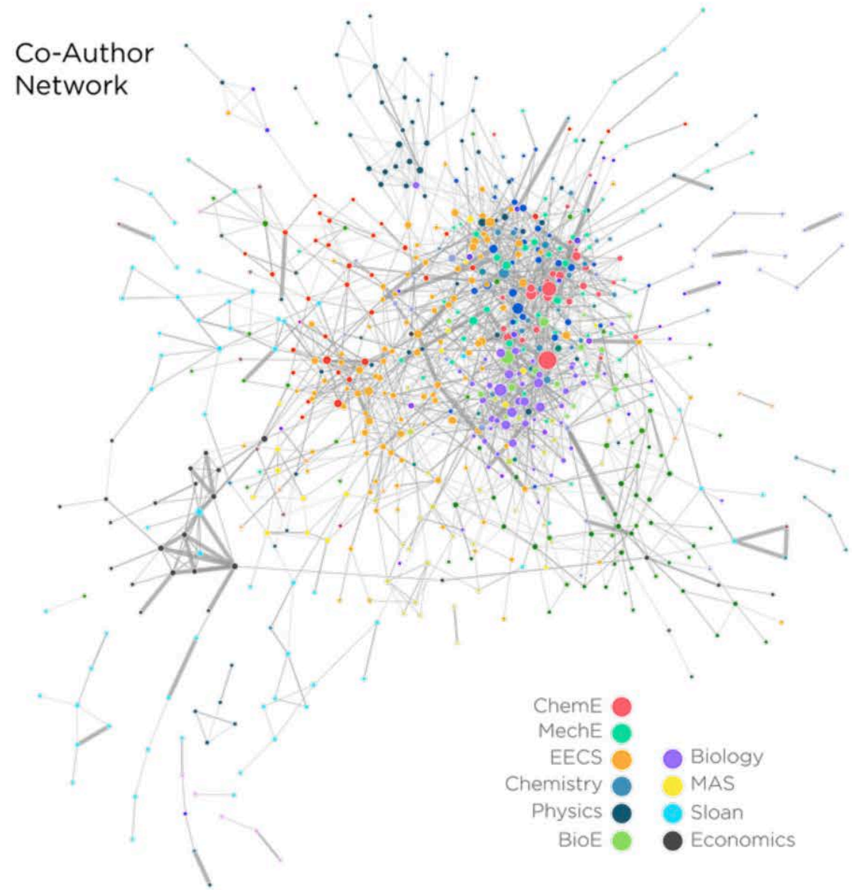


Figure 8. MIT campus buildings, coded according the average total area of lab and office space per faculty member. There is a distribution of values from 145ft^2 to 2,065ft^2 allocated per faculty member. Buildings are labeled by name (facility code).


Co-Inventor Network
ChemE
MechE
EECS
Chemistry
Physics
BioE

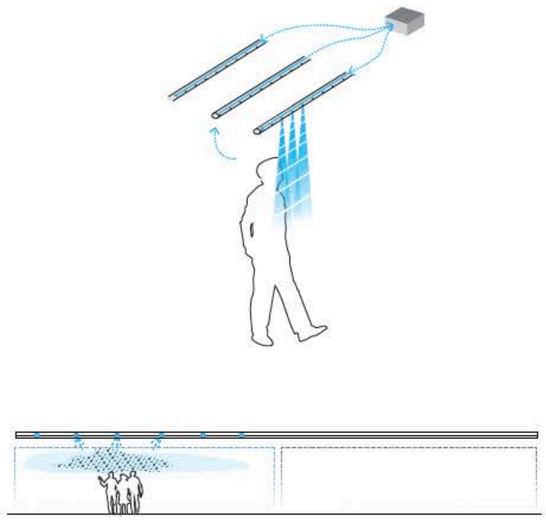

Co-Author Network
ChemE
MechE
EECS
Chemistry
Physics
BioE
Biology
MAS
Sloan
Economics


passion
working
space
MAGICS
tag
tag


passion working space
tag
PULL

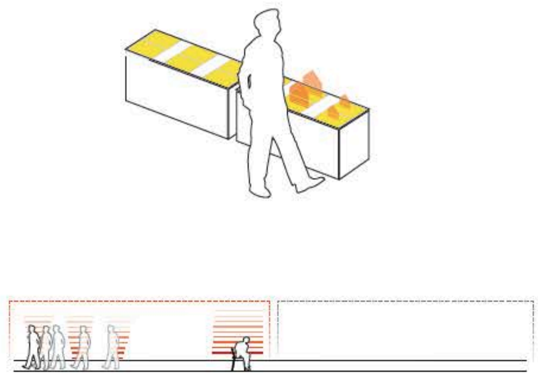

tag


23°
23°
22°
22°
21°
20°
20°
22.5°C



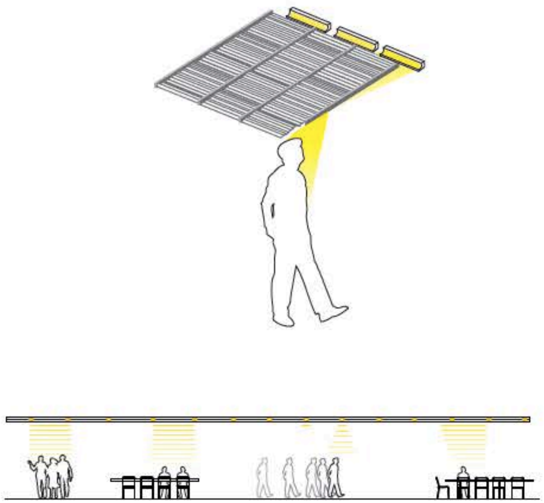
RAFFRESCAMENTO (VENTILAZIONE)

L'impianto di ventilazione è progettato per garantire il rinnovo d'aria fisiologico negli ambienti con un controllo basato sulla concentrazione di CO_2. Il sistema serve diversi settori di ventilazione, provvedendo al ricambio d'aria soltanto in quelli effettivamente occupati.



RISCALDAMENTO

Gli ambienti saranno equipaggiati con ventilconvettori silenziati integrati e saranno mantenuti ad un livello di temperatura di base (ad esempio 15°C in inverno e 30°C in estate). Il sistema sarà sensibile ai bisogni e alla localizzazione dell'utente, regolando i terminali in modo da mantenere, soltanto nella zona climatica dell'utente, la temperatura dedicata.



ILLUMINAZIONE

Sitema illuminante che riconosce la posizione dell'utente e lo segue attraverso lo spazio per garantire ottimi livelli di visibilità dove richiesti.

Contents lists available at SciVerse ScienceDirect

Energy and Buildings

journal homepage: www.elsevier.com/locate/enbuild

ENERNET: Studying the dynamic relationship between building occupancy and energy consumption

Claudio Martani*, David Lee, Prudence Robinson, Rex Britter, Carlo Ratti

Senseable City Laboratory, Massachusetts Institute of Technology (MIT), USA

ARTICLE INFO

Article history:
Received 17 November 2011
Received in revised form
22 December 2011
Accepted 24 December 2011

ABSTRACT

With cities accounting for approximately two thirds of the global demand for energy, there is significant scope to optimize energy usage of cities, in particular by improving the use of the built form. Large non-domestic buildings are increasingly the focus of attention, due to their substantial demands and associated environmental impacts such as CO_2 emissions. Various approaches have been adopted to address building energy efficiency, with more recent studies relating consumption patterns to human

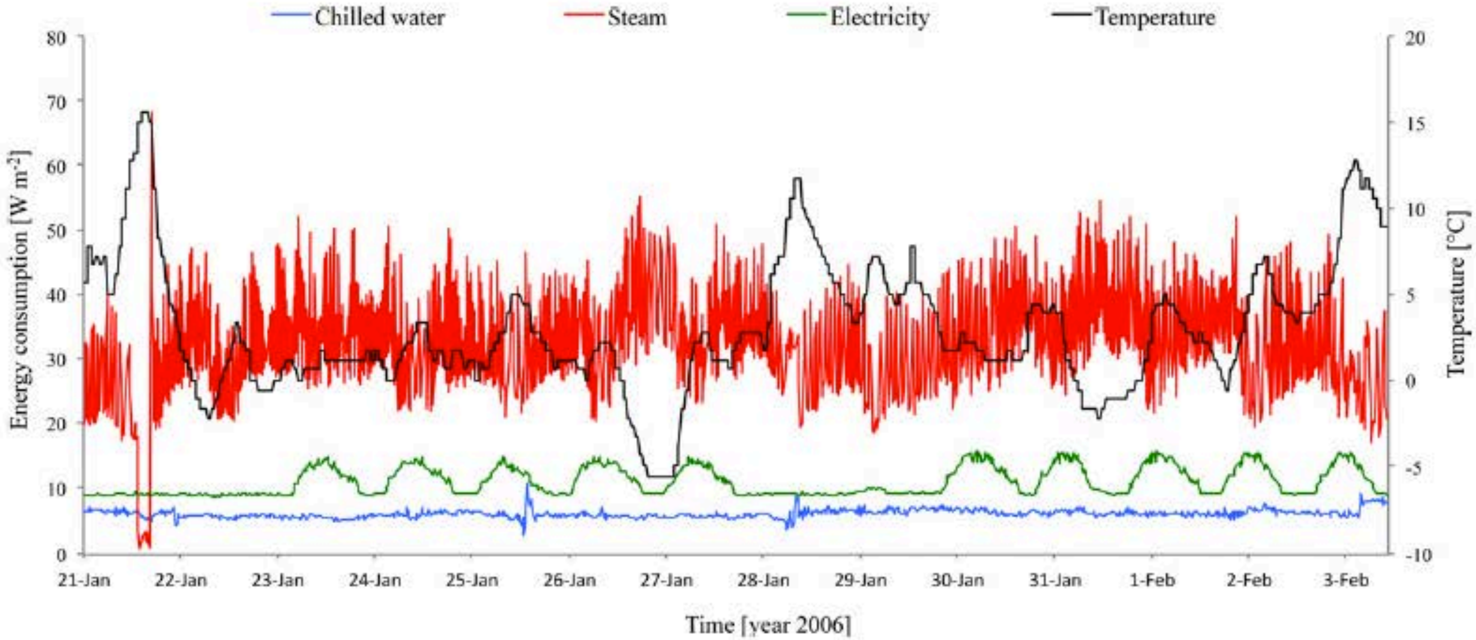
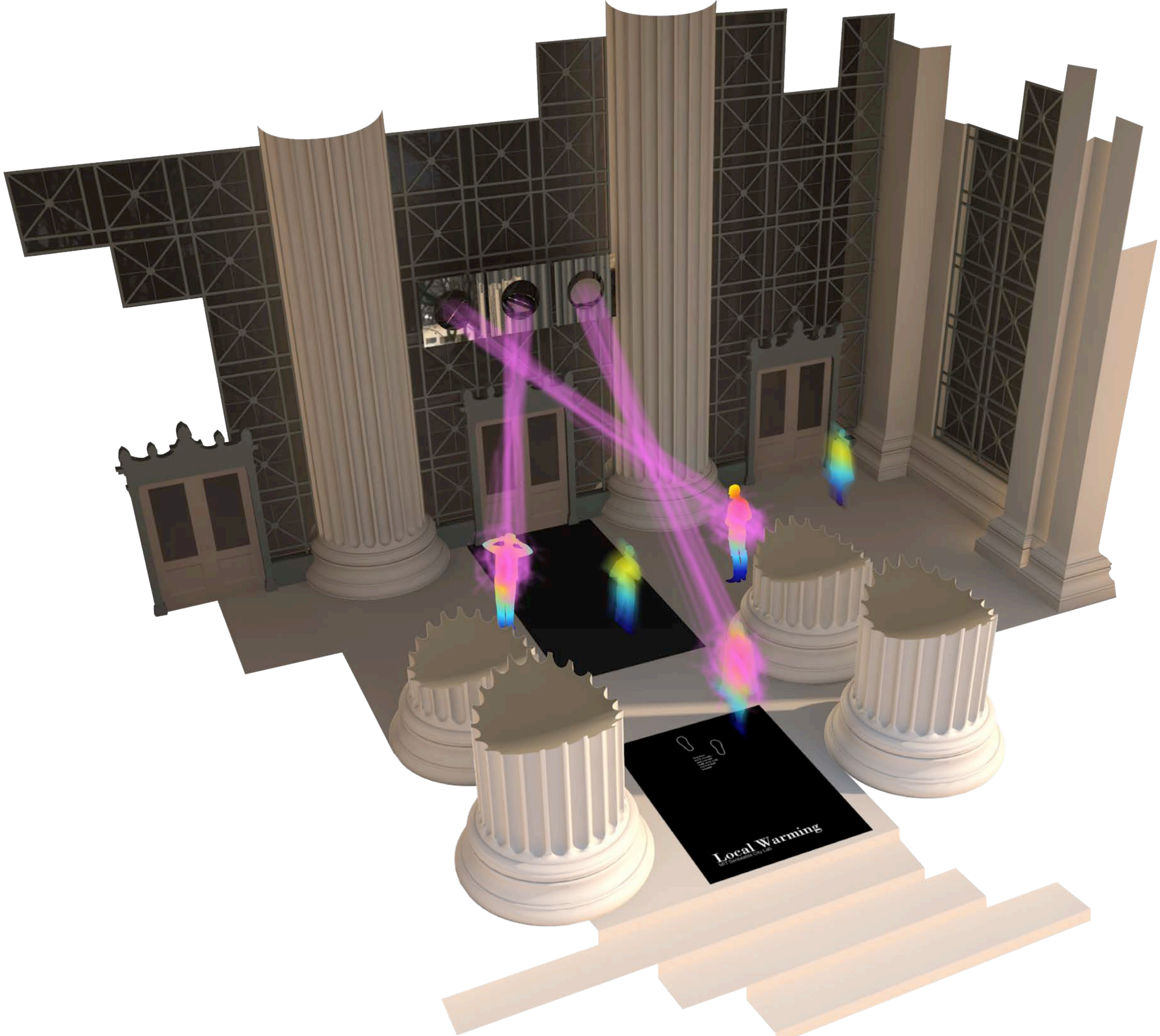


Fig. 2. Time series of energy consumption (steam, chilled water and electricity in W m^{-2}) for E52 over 21st January–3rd February 2006 [18], alongside external air temperature (°C) [16].

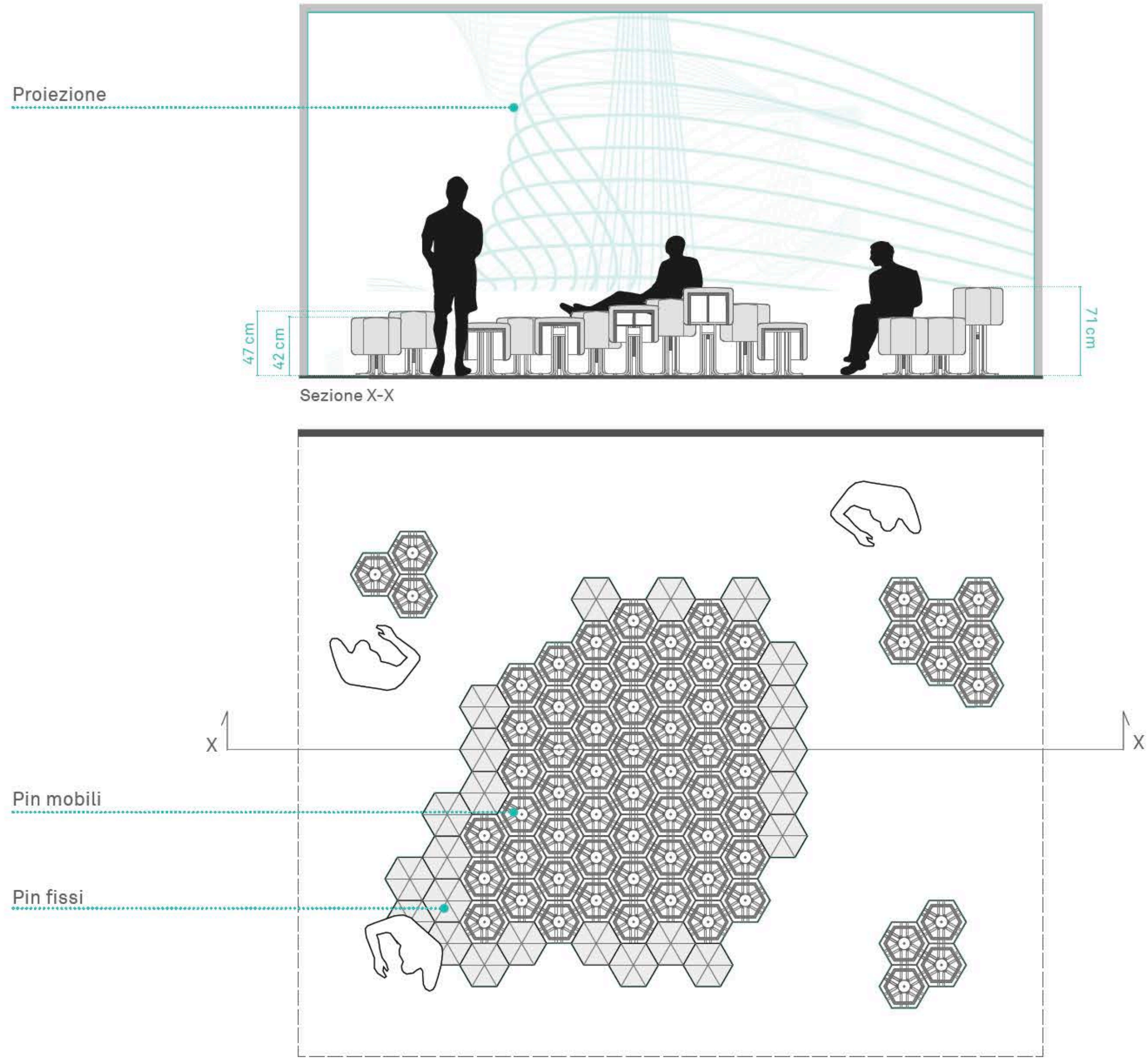
Lo•cal Warm•ing ['lōkəl'wôrming]

noun

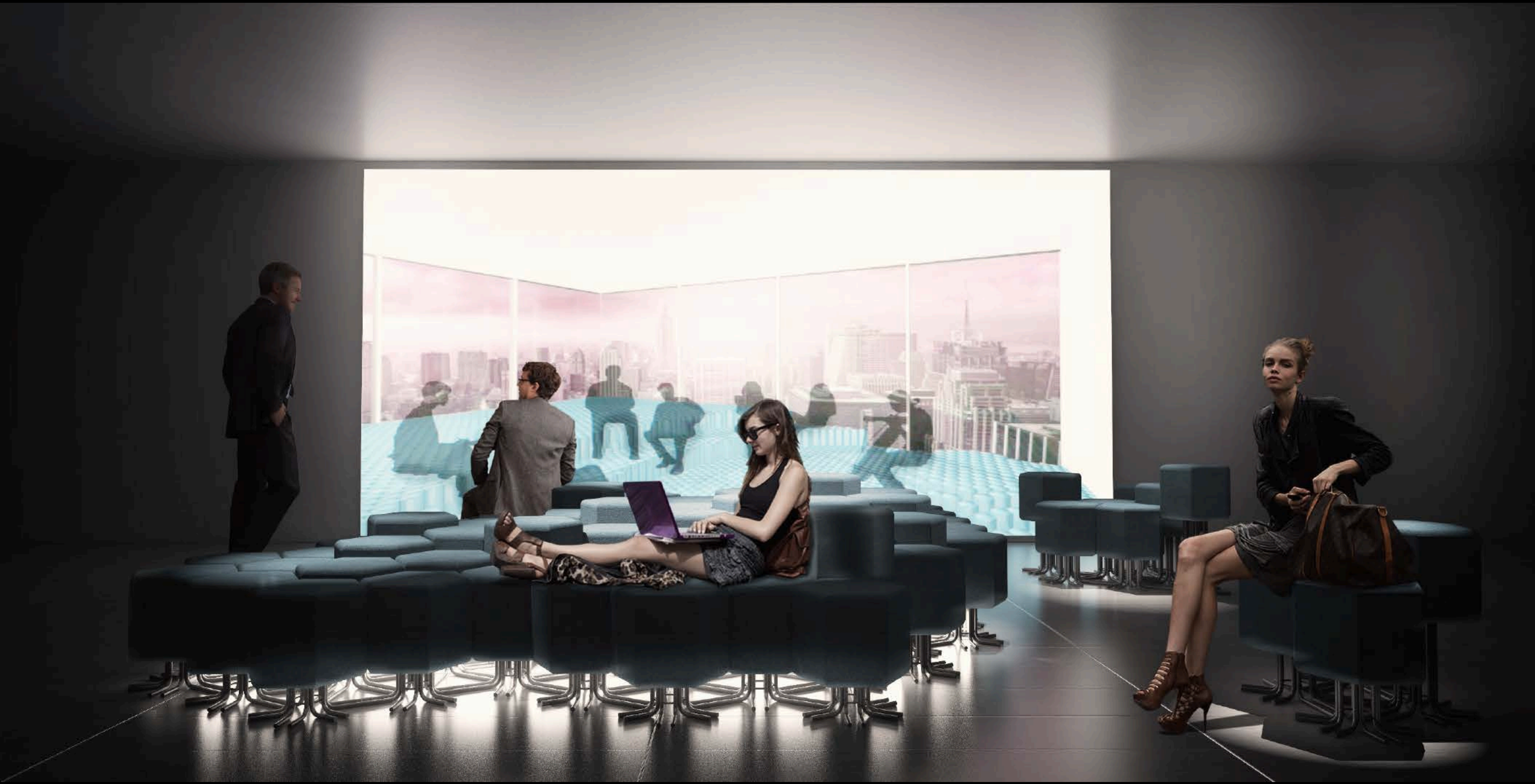
a research project by the MIT Senseable City Laboratory that dynamically controls highly localized heating: It is a system that puts the heat where the people are.


Local Warming
MIT Senseable City Lab

vitra.



Pin mobili: 60
Pin fissi: 30
TOT. PIN: 90
Dimensioni stanza: 5x6 m



3. SHOPPING SPACES...

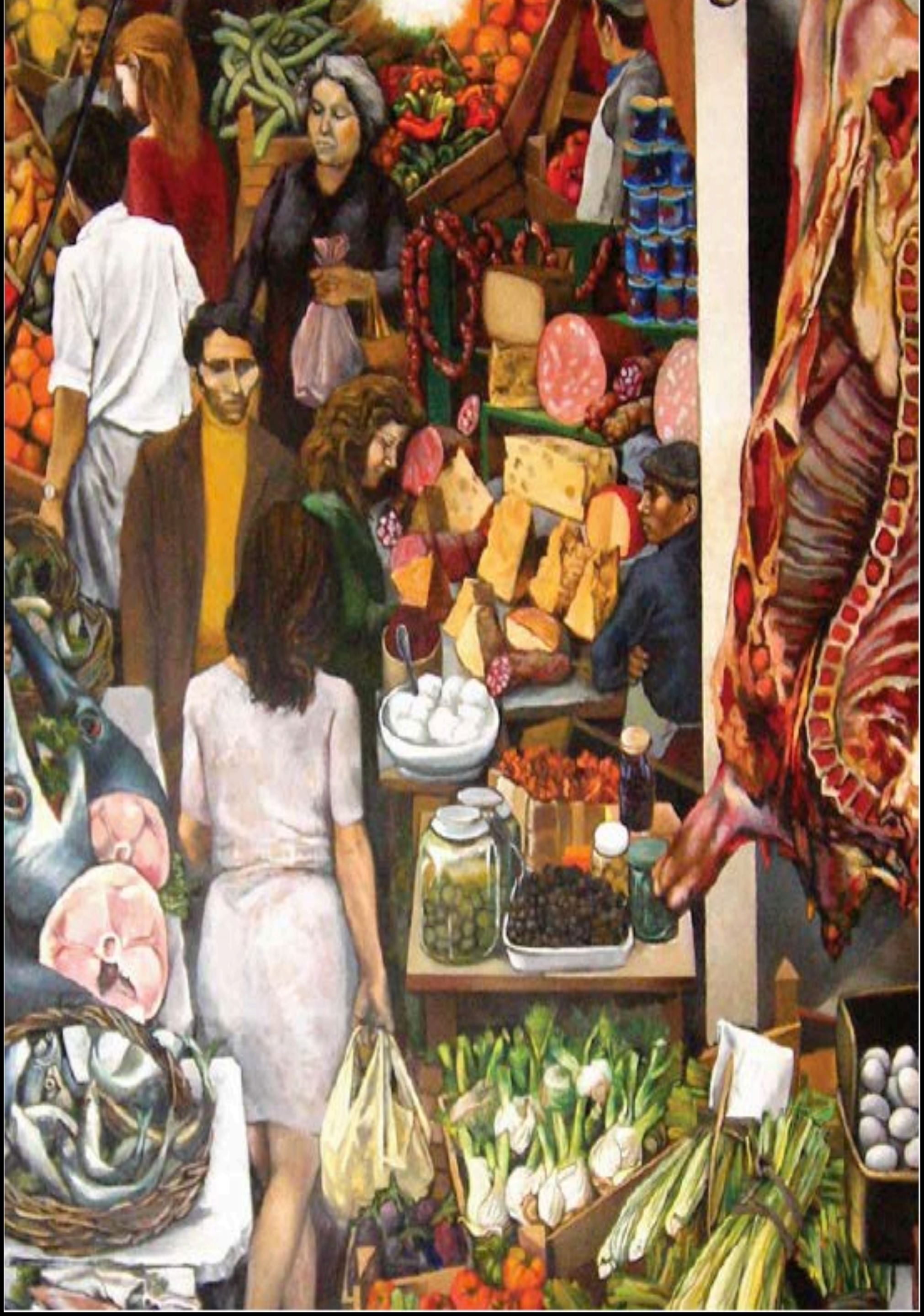
Future Food District
Expo 2015, Milan


Chex
Kix
Fresh Step
ALLEY CAT
Friskies

“Behind every cheese there is a pasture of a different green under a different sky. This shop is a museum: Mr. Palomar, visiting it, feels as he does in the Louvre, behind every displayed object the presence of the civilization that has given it form and takes form from it”

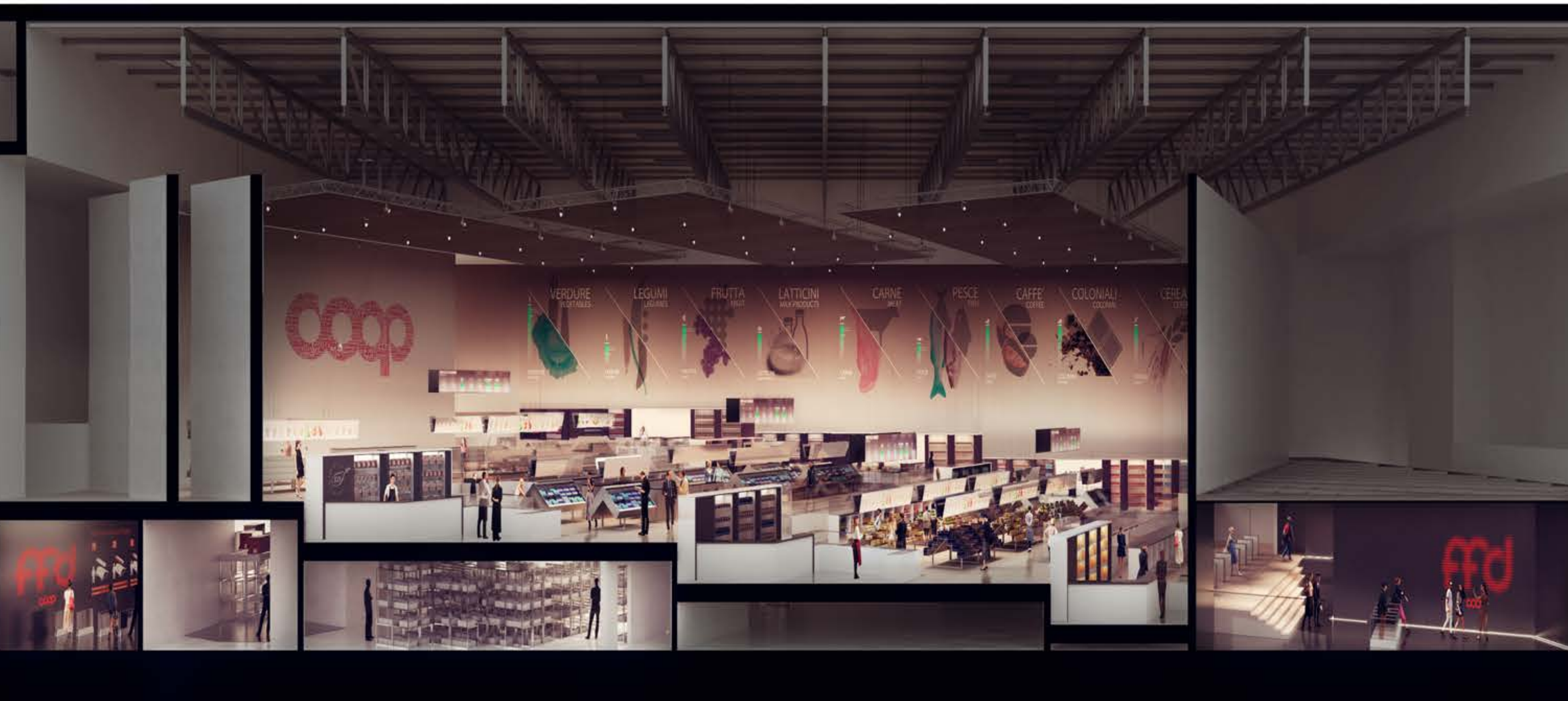
Italo Calvino, Mr. Palomar


구 · 신당 · 봉화산
6
₩1,170
₩2,400
Cold



Exposition table layout


Mela
Golden
1.97 € / Kg
coop


VERDURE
VEGETABLES
LEGUMI
LEGUMES
FRUTTA
FRUIT
LATTICINI
MILK PRODUCTS
CARNE
MEAT
PESCE
FISH
CAFFE'
COFFEE
COLONIALI
COLONIAL


casse
cash counters
VINO
wine
L'ESSENZA
DELLE OLIVE
L'ESSENZA DELLE OLIVE
CARNE e PESCE
meet and fish
321
21.090
Sales
Franciacorta


PREPARATO DI ARANCIA
0,99 €
2,00 €
2,50 €


casse
cash counters
Il pane, il latte e il burro
sono di venerabile antichità.
Hanno il sapore del mattino
del mondo
Salame Di Suino Cinta Senese Artigiani Di Bottega Prz Vs
Gallo
Gran Gusto

Expo Filiera Latte E Derivati
95 Yogurt
Sales


Il pomodoro,
della terra,
P. Neruda


VIVI VERDE SPREMUTA 100% DI ARANCE ROSSE BIOLOGICA 750ML
VIVI VERDE 100% ORGANIC RED ORANGES JUICE 750ML
2.25 €
al L/per L
VALORI NUTRIZIONALI PER PORZIONE A.R. / NUTRITIONAL VALUES - R.I.
ENERGIA ENERGY
52.00 kcal
217.57 kj
3%
ZUCCHERI SUGAR
12.30 g
12%
GRASSI FATS
0.00 g
0%
AC. GRASSI SATURI SATURED FATS
0.00 g
0%
SALE SALT
0.00 g
0%
IMPATTO AMBIENTALE / CARBON FOOTPRINT
0.6 g/Kg
Co2


S Sicurezza
Aceto
Condimenti pronti
Convenienza
C Convenienza
[con·ve·niѐn·za]
coop
Salse

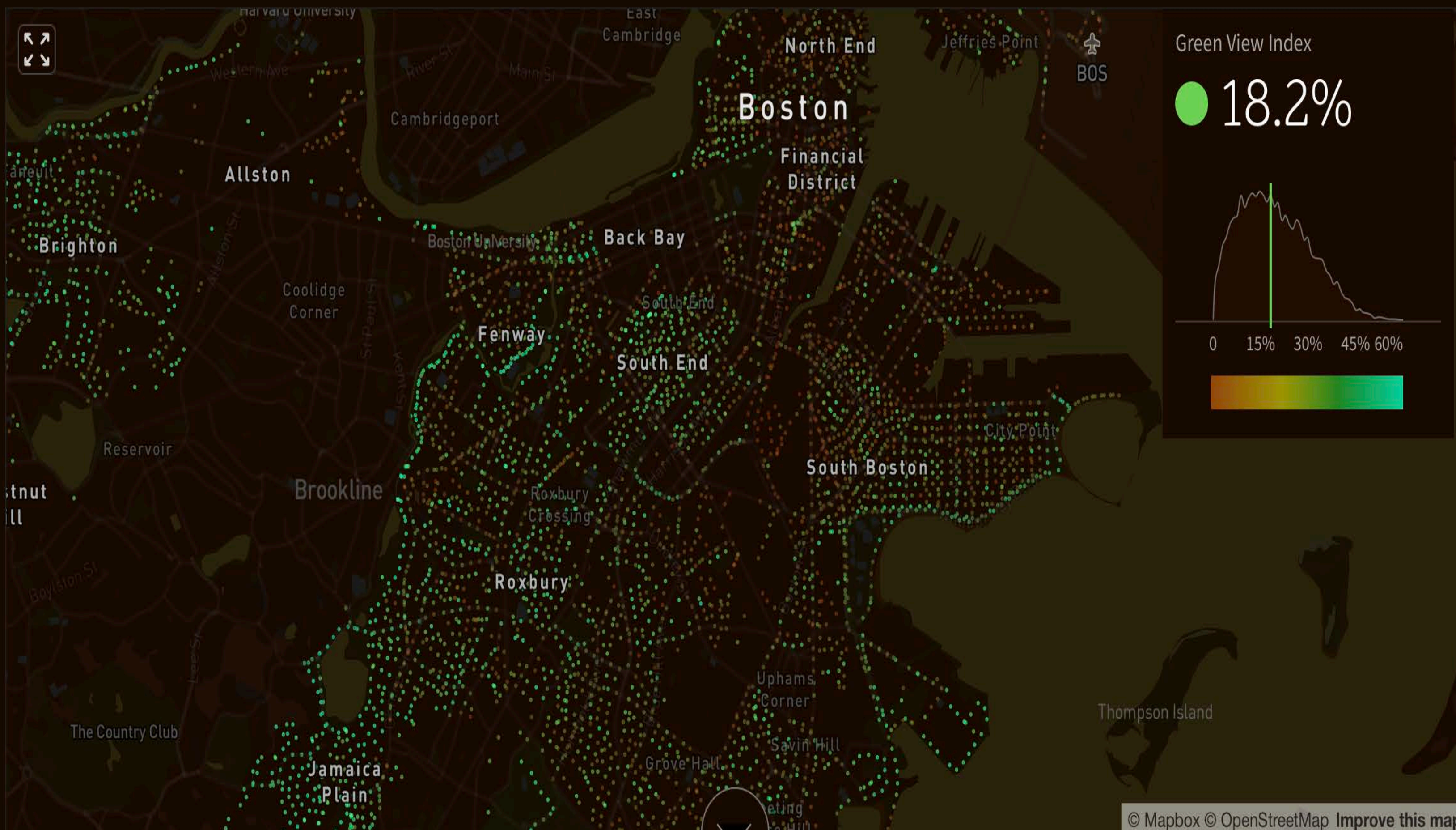

_R
Rispetto dell'ambiente

4. GREEN SPACES...

Treepedia Compare Cities Description

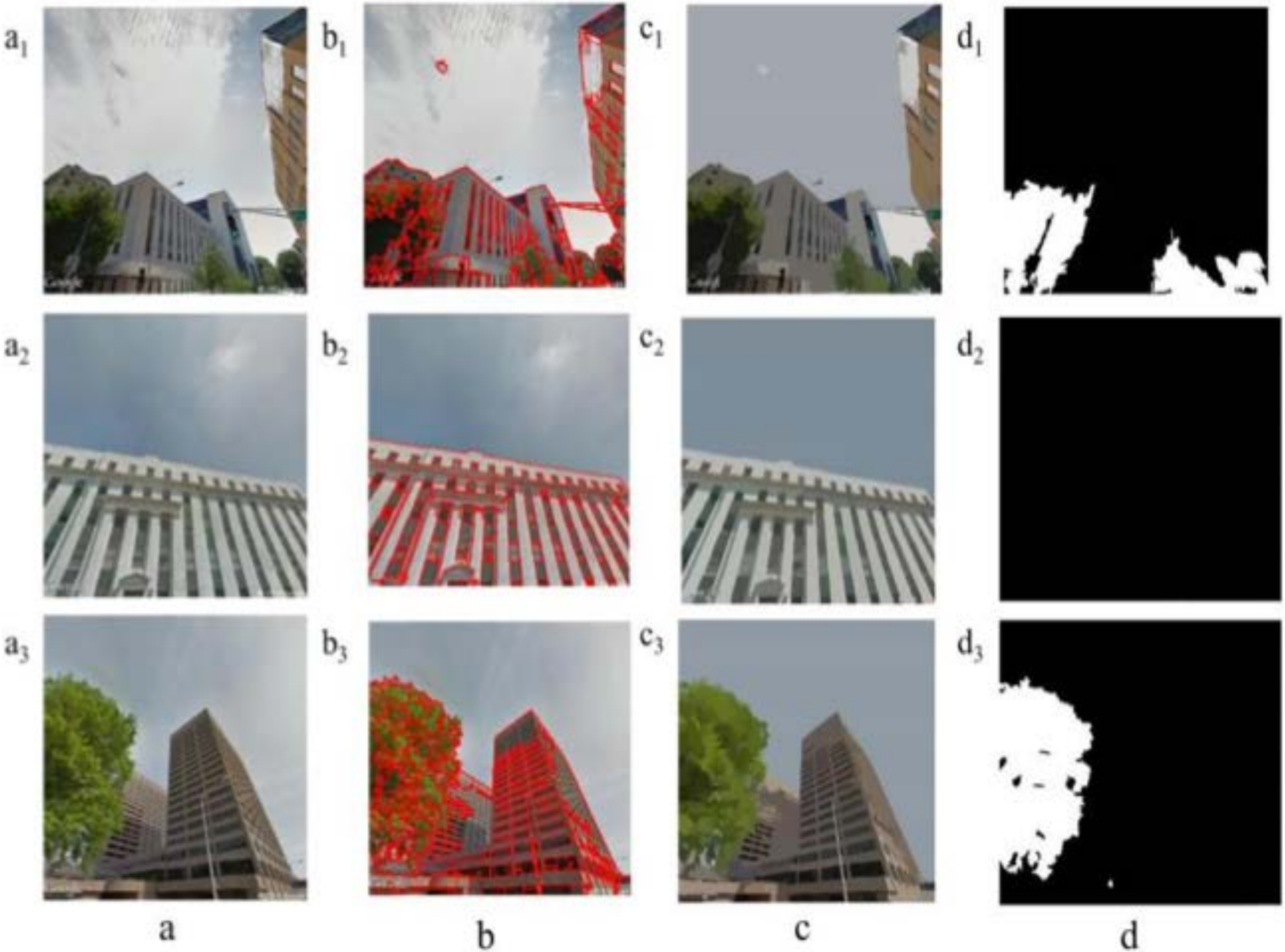
Exploring the Green Canopy in cities around the world

Boston

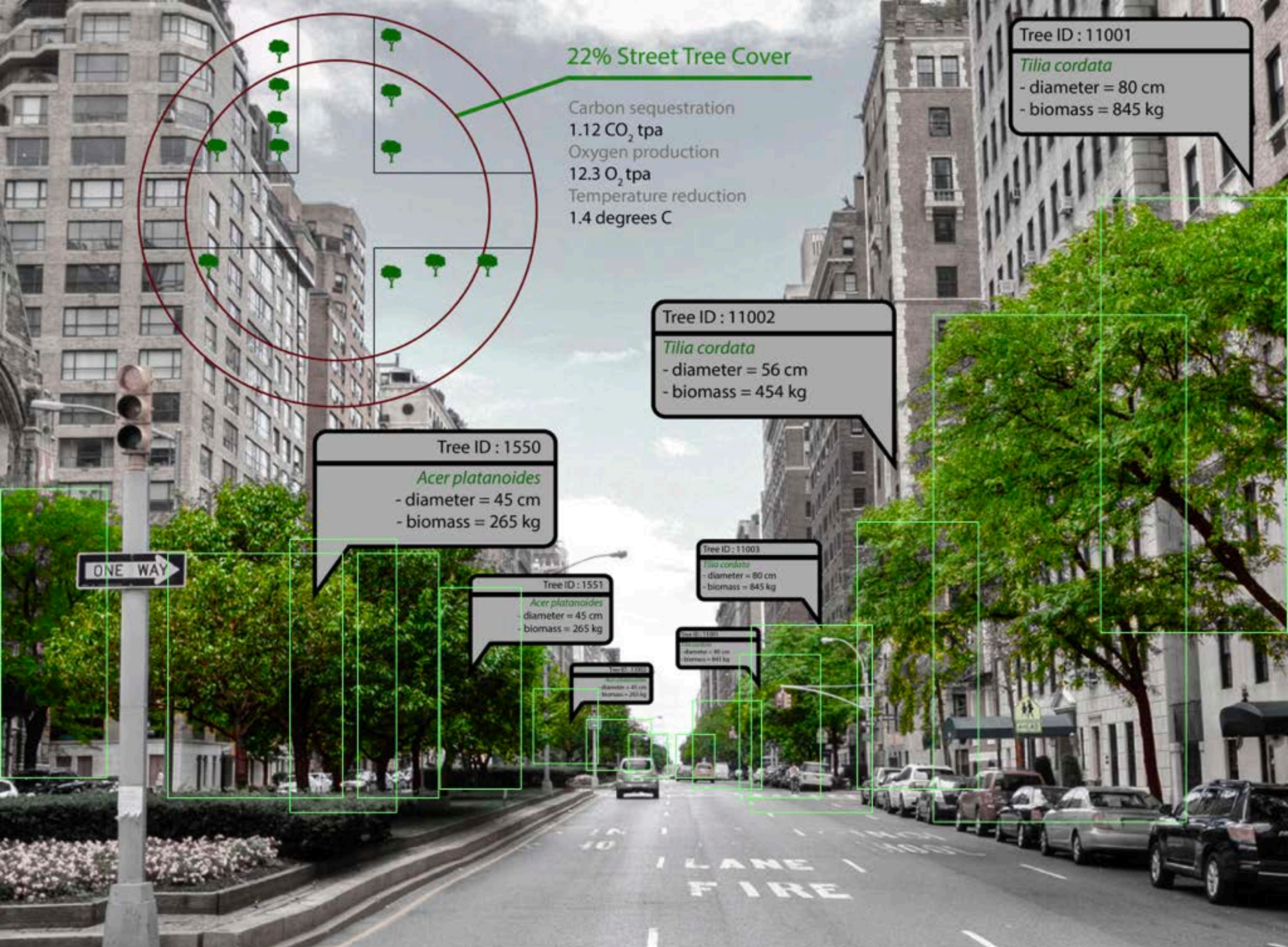


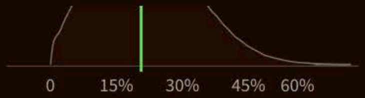
up to six GSV images are downloaded per point...

~500,000 images per city. London, UK we processed almost 1 million images!



a_1
b_1
c_1
d_1
a_2
b_2
c_2
d_2
a_3
b_3
c_3
d_3
a
b
c
d

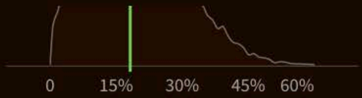

22% Street Tree Cover
Carbon sequestration
1.12 CO_2 tpa
Oxygen production
12.3 O_2 tpa
Temperature reduction
1.4 degrees C
Tree ID : 11001
Tilia cordata
- diameter = 80 cm
- biomass = 845 kg
Tree ID : 11002
Tilia cordata
- diameter = 56 cm
- biomass = 454 kg
Tree ID : 1550
Acer platanoides
- diameter = 45 cm
- biomass = 265 kg
Tree ID : 1551
Acer platanoides
- diameter = 45 cm
- biomass = 265 kg
Tree ID : 11003
Tilia cordata
- diameter = 80 cm
- biomass = 845 kg
ONE WAY
LANE
FIRE



Amsterdam

Green View Index 20.6%

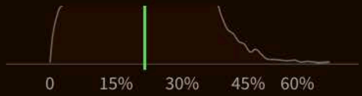
Population Density 4,908/km²



Boston

Green View Index 18.2%

Population Density 5,344/km²



Frankfurt

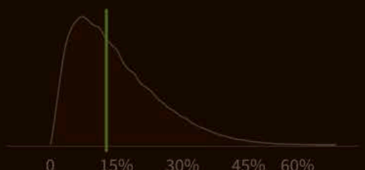
Green View Index 21.5%

Population Density 3,000/km²

Geneva

Green View Index 21.4%

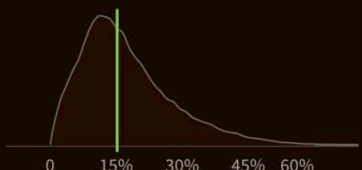
Population Density 12,000/km²



London

Green View Index 12.7%

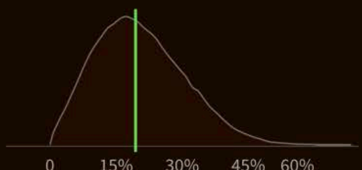
Population Density 5,518/km²



Los Angeles

Green View Index 15.2%

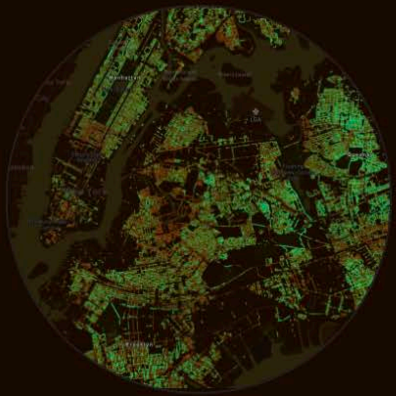
Population Density 3,198/km²

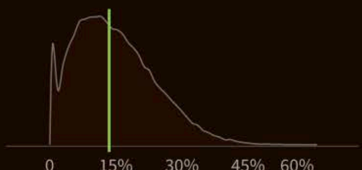


Miami

Green View Index 19.4%

Population Density 4,770/km²

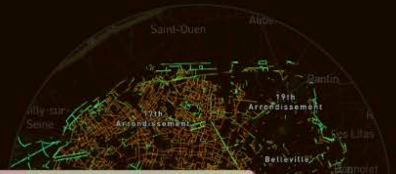




New York

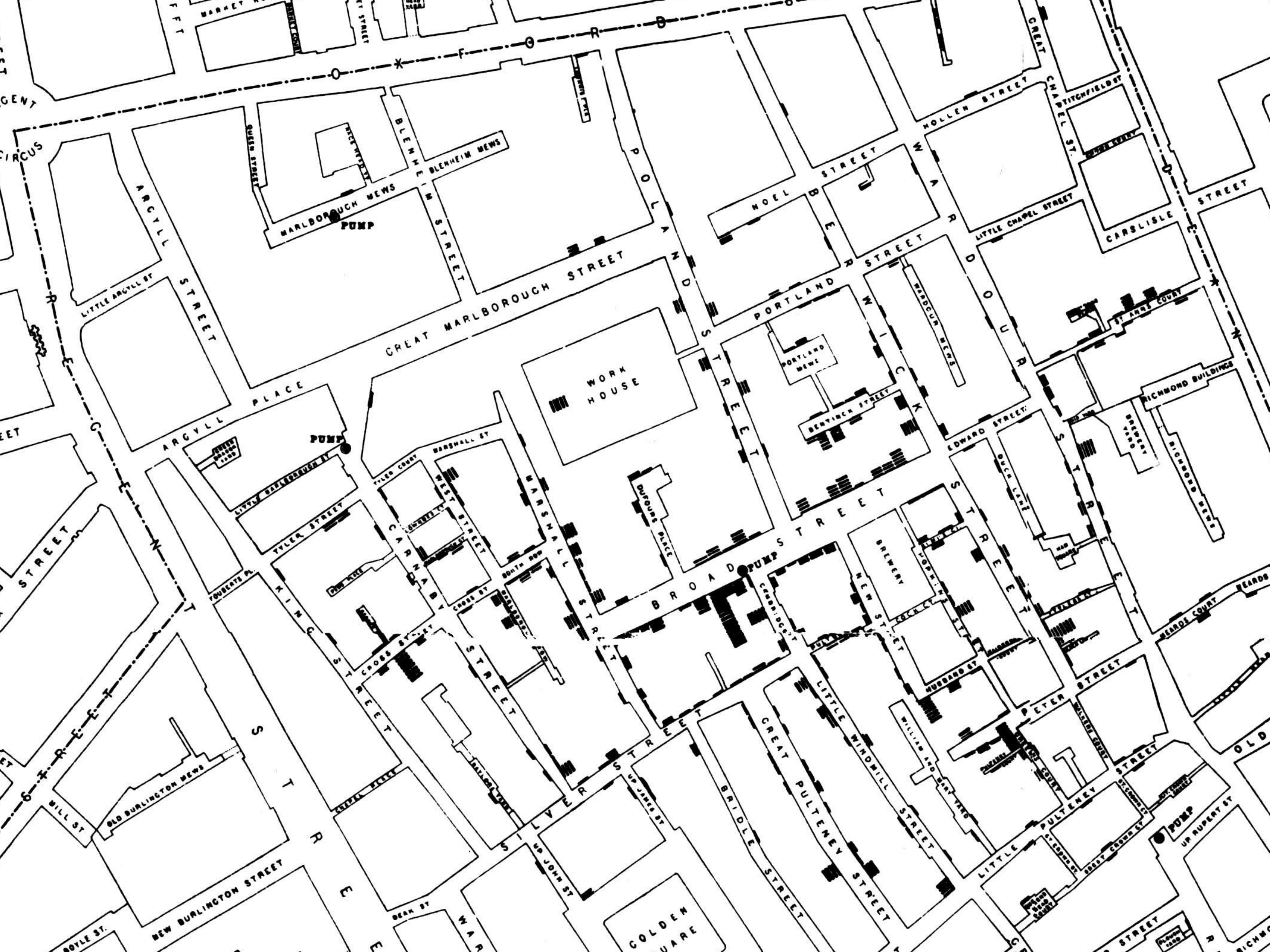
Green View Index 13.5%

Population Density 10,831/km²



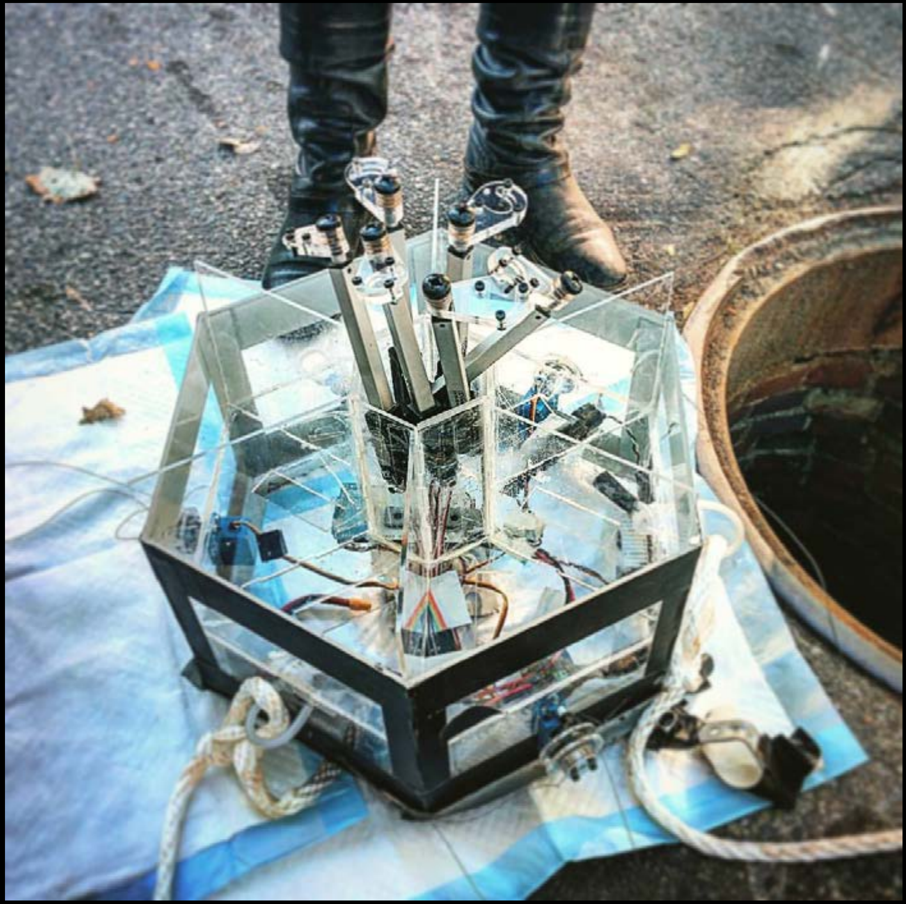
5. WATER...


WHAT IS IN OUR COLLECTIVE GUT?
E.COLI
CAFFEINE
NOROVIRUS
COCAINE
ESOMEPRAZOLE
BACTEROIDES



O X F O R D
REGENT CIRCUS
R E G E N T S T R E E T
ARGYLL STREET
LITTLE ARGYLL ST
ARGYLL PLACE
GREAT MARLBOROUGH STREET
MARLBOROUGH MEWS
PUMP
QUEEN STREET
BLENHEIM STREET
BLENHEIM MEWS
POLAND STREET
WORK HOUSE
NOEL STREET
BERWICK STREET
PORTLAND STREET
PORTLAND MEWS
WARDOUR STREET
WARDOUR MEWS
HOLLEN STREET
CHAPEL ST.
TITCHFIELD ST
LITTLE CHAPEL STREET
CARLISLE STREET
DEAN STREET
ST ANNS COURT
RICHMOND BUILDINGS
RICHMOND MEWS
BREWERY YARD
BENTINCK STREET
EDWARD STREET
DUCK LANE
PUMP
BROAD STREET
PUMP
DUFOURS PLACE
MARSHALL ST
MARSHALL STREET
TYLER COURT
WEST STREET
CARNABY STREET
TYLER STREET
FOUBERTS PL
KING STREET
CROSS STREET
CROSS ST
SOUTH ROW
CAMBRIDGE ST
NEW STREET
BREWERY
HOPKINS ST
HUSBAND ST
PETER STREET
WILLIAM AND MARY YARD
HEARDS COURT
SILVER STREET
UP JAMES ST
UP JOHN ST
BRIDLE STREET
GREAT PULTENEY STREET
LITTLE WINDMILL STREET
LITTLE PULTENEY STREET
PUMP
UP RUPERT ST
GOLDEN SQUARE
OLD BURLINGTON MEWS
MILL ST
NEW BURLINGTON STREET
BOYLE ST.
BEAK ST

MAR.IO



LUIGI

55 FPS (41-60)

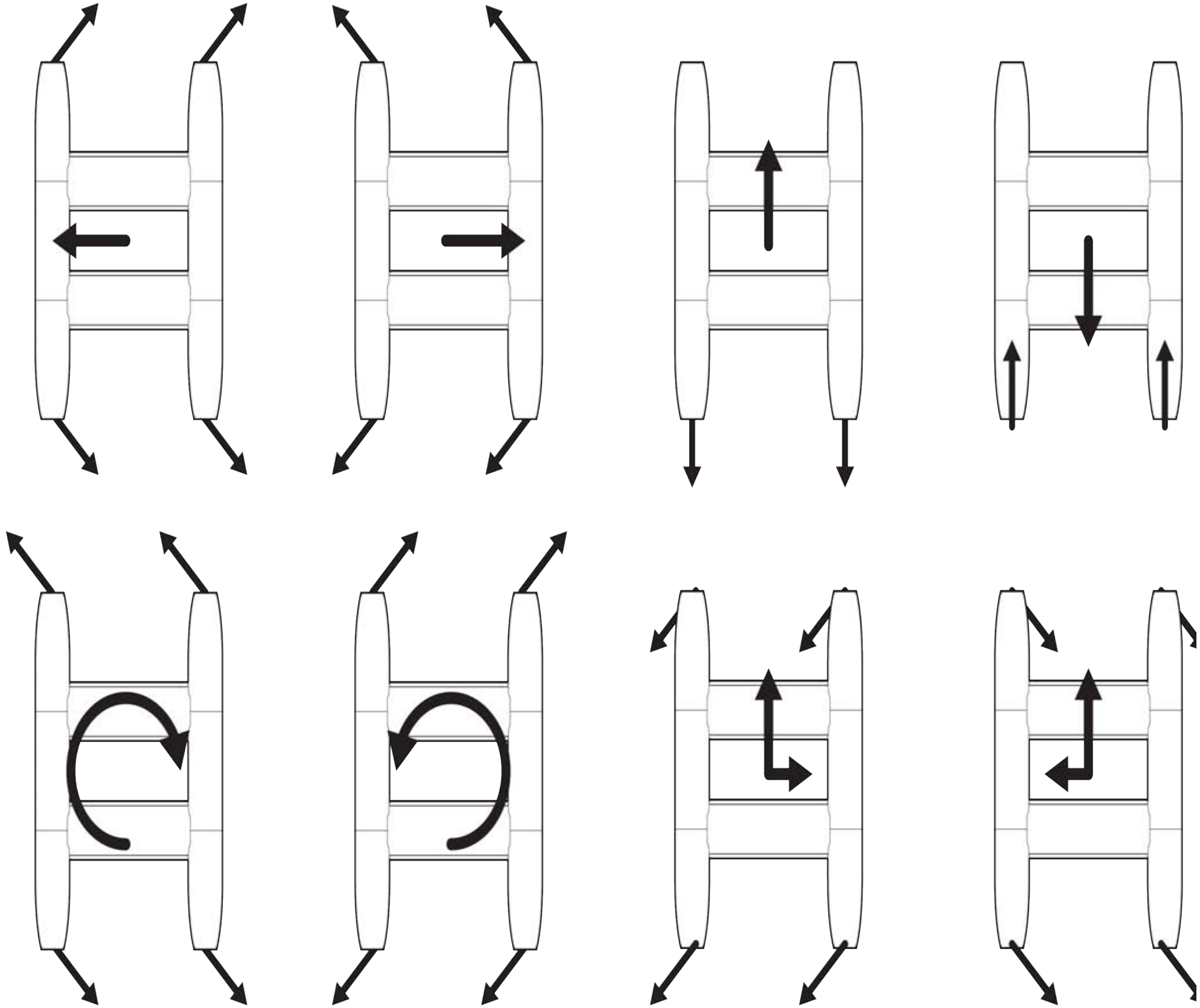
DOK
NIEUWE BRUGS BOOM
DE GROOTE KRAAN
OOSTELYK DOK
DOK
S. Ryks Magazyn
Kattenburger Brug
EYLANDS GRAGHT
Hout Tuynen
Haarlemmer Dyk
HAARL PLEIN
HAARL PORT
Vinke Straat
BROUWERS GRAGHT
Brouwers
Haring Packerye
Sparendammer Brug
Nieuwe Waels Eylandt
Binnen Kant
Ter Gragt
Rapenburg
Kadyk
S. RYKS
PARK
DAM RACK
OUDE KERCK
Anthonis Waegh
ANTHONIS MARCKT
CINGEL
HEERE
KEYSERS
PRINCE
GRAGHT
De Noorder Kerk
De Noord der Marckt
Princen Str.
Heeren Str.
Lely Gragt
De Wester Kerk
De Wester Hallen Marckt
Den Dam
'T PALAIS
(The Palace)
Hout Tuynen
Joden Bree Straat
Hout Gragt
Vlooyen Straat
Swanenb Straat
Kloveniers Burgwal
'T ROCKIN
'T GAST HUYS
(Poor House)
BINNEN AMSTEL
BOTTER MARCKT
Amstel Str.
Regulier Bree Str.
Regulier Dwars Straat
HEERE GRAGHT
KEYSERS GRAGHT
KERK STRAAT
AMSTEL KERK
VARCKEN MARCKT
OSSEN MARCKT
AMSTEL
Blom Straat
Rooze Straat
Laurier Gragt
Passers
DE NIEUWE WETERING

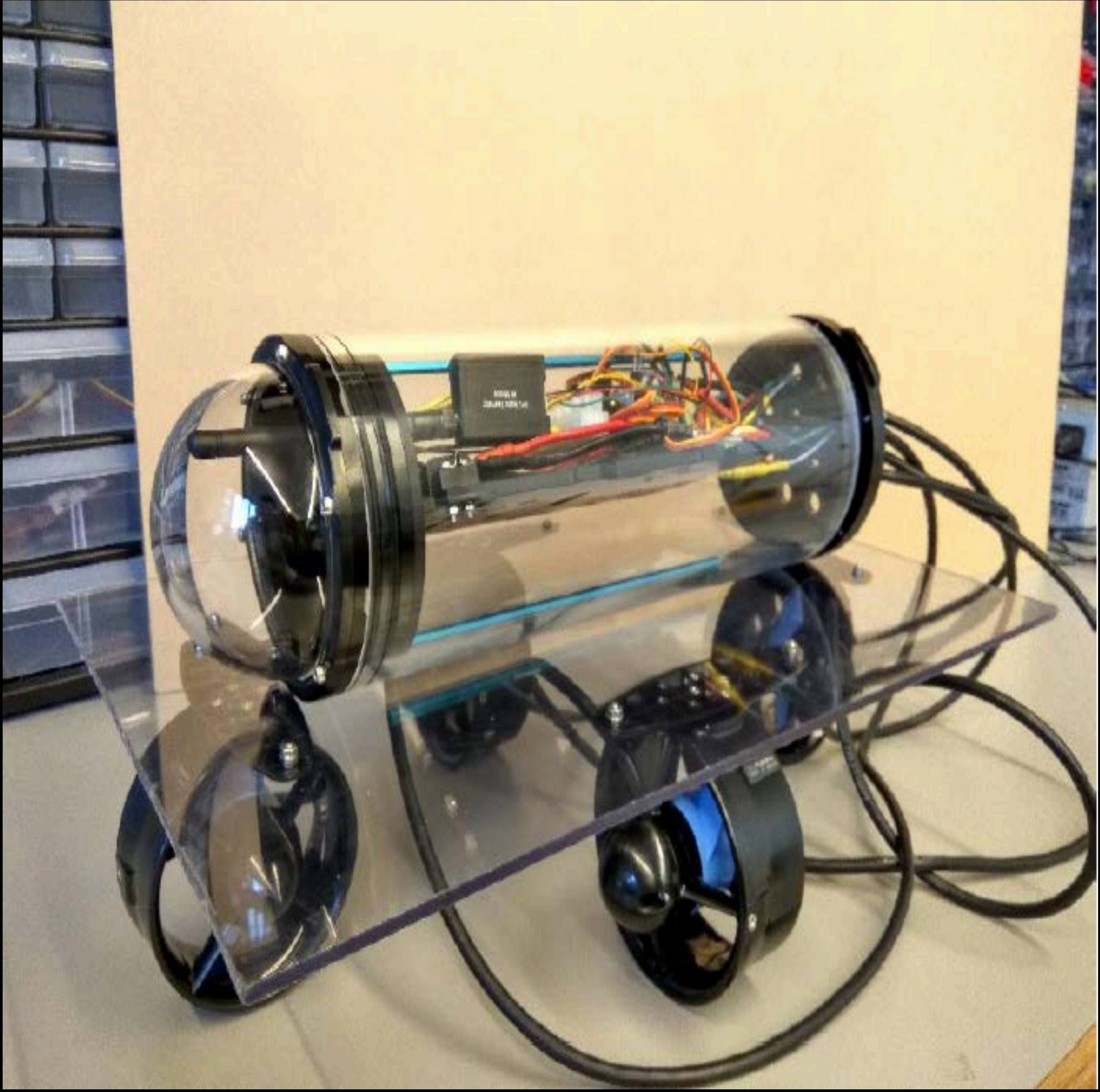

AMS
AMSTERDAM INSTITUTE FOR
ADVANCED METROPOLITAN SOLUTIONS
MIT
Massachussetts
Institute of Technology

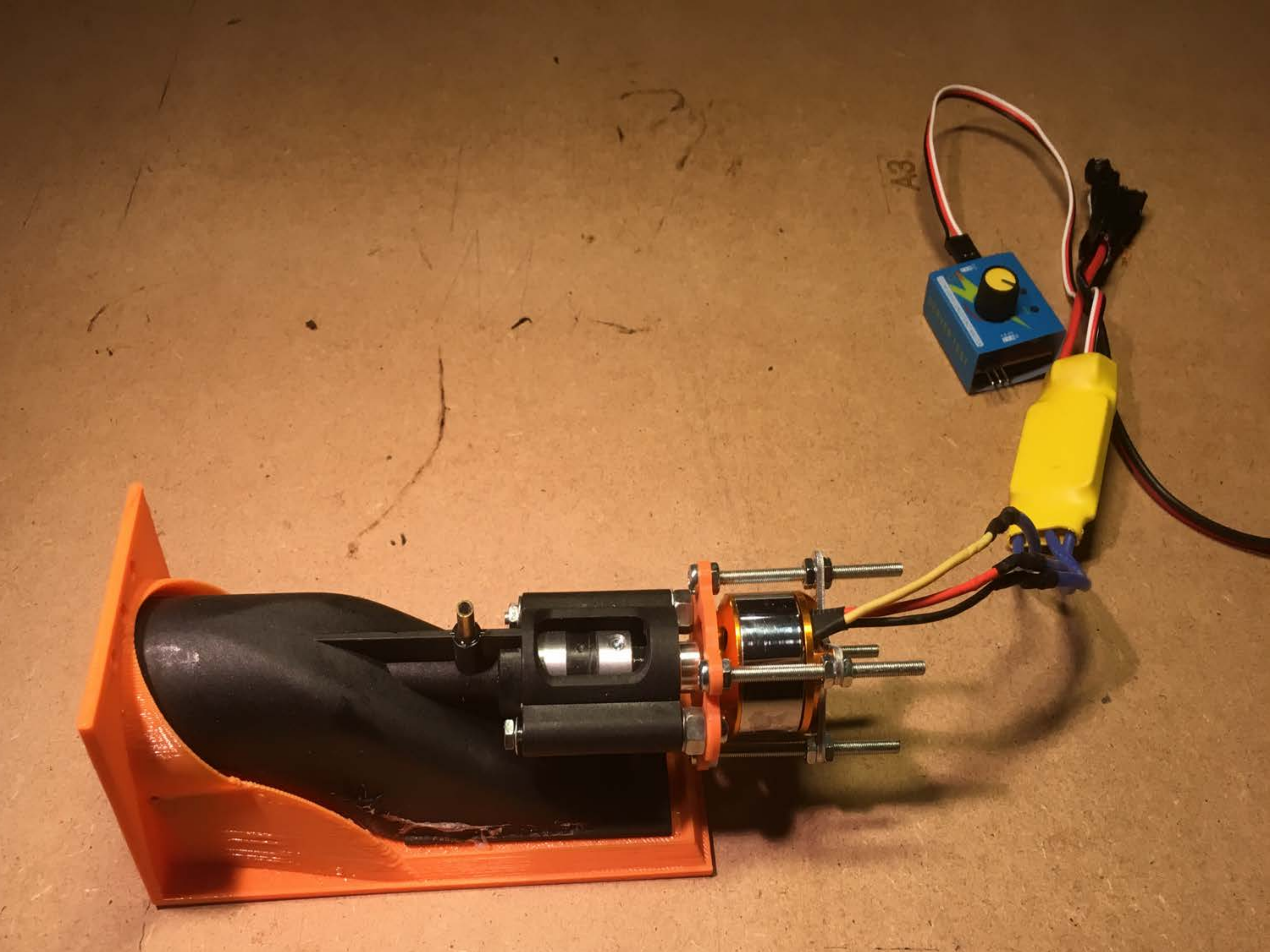
QUEENS
Hairstyle
OCCHIALI
Cartier
DHL
DHL EXPRESS AMSTERDAM

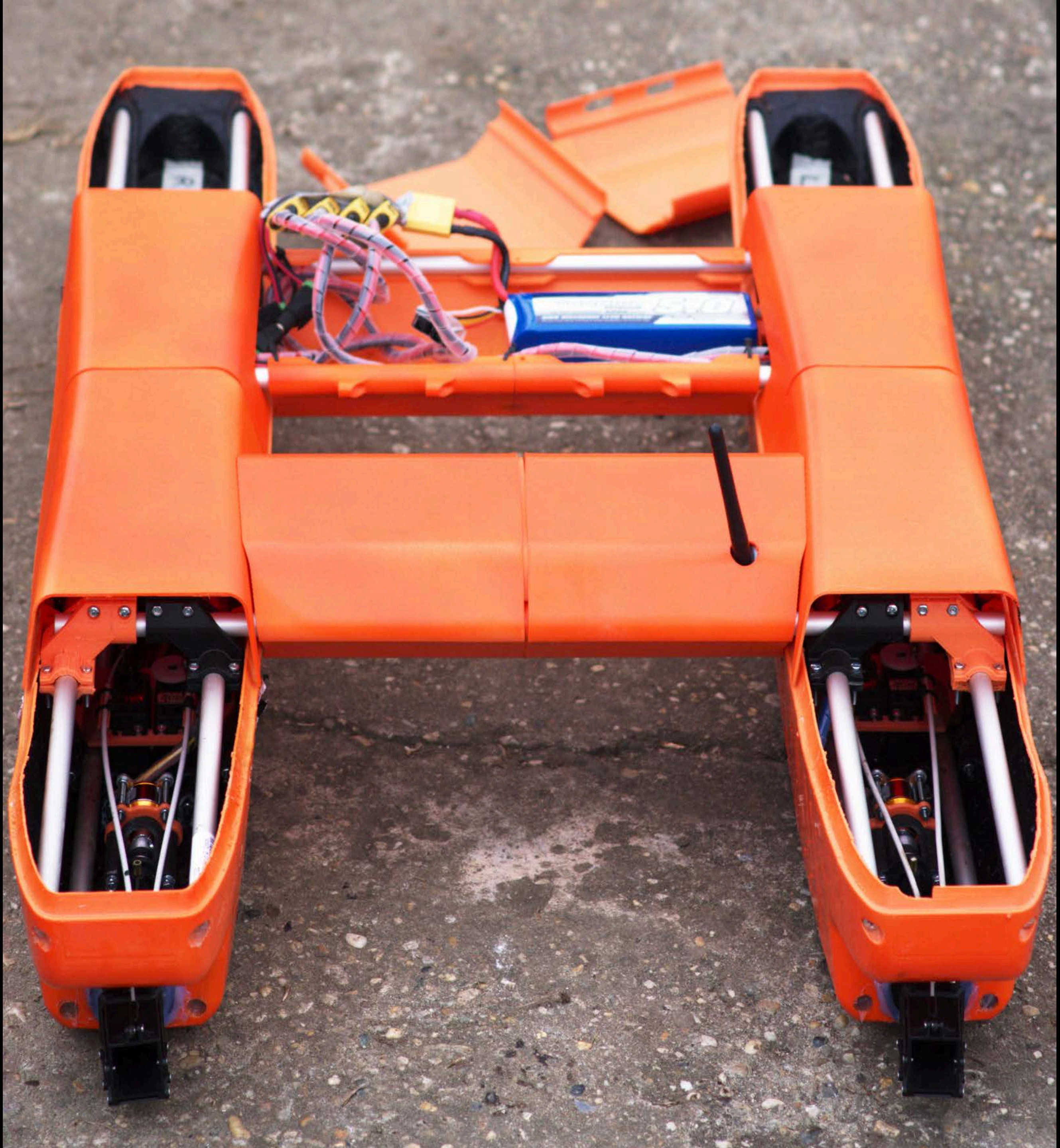

TWEE
WATER TAXI
020-535 63 6

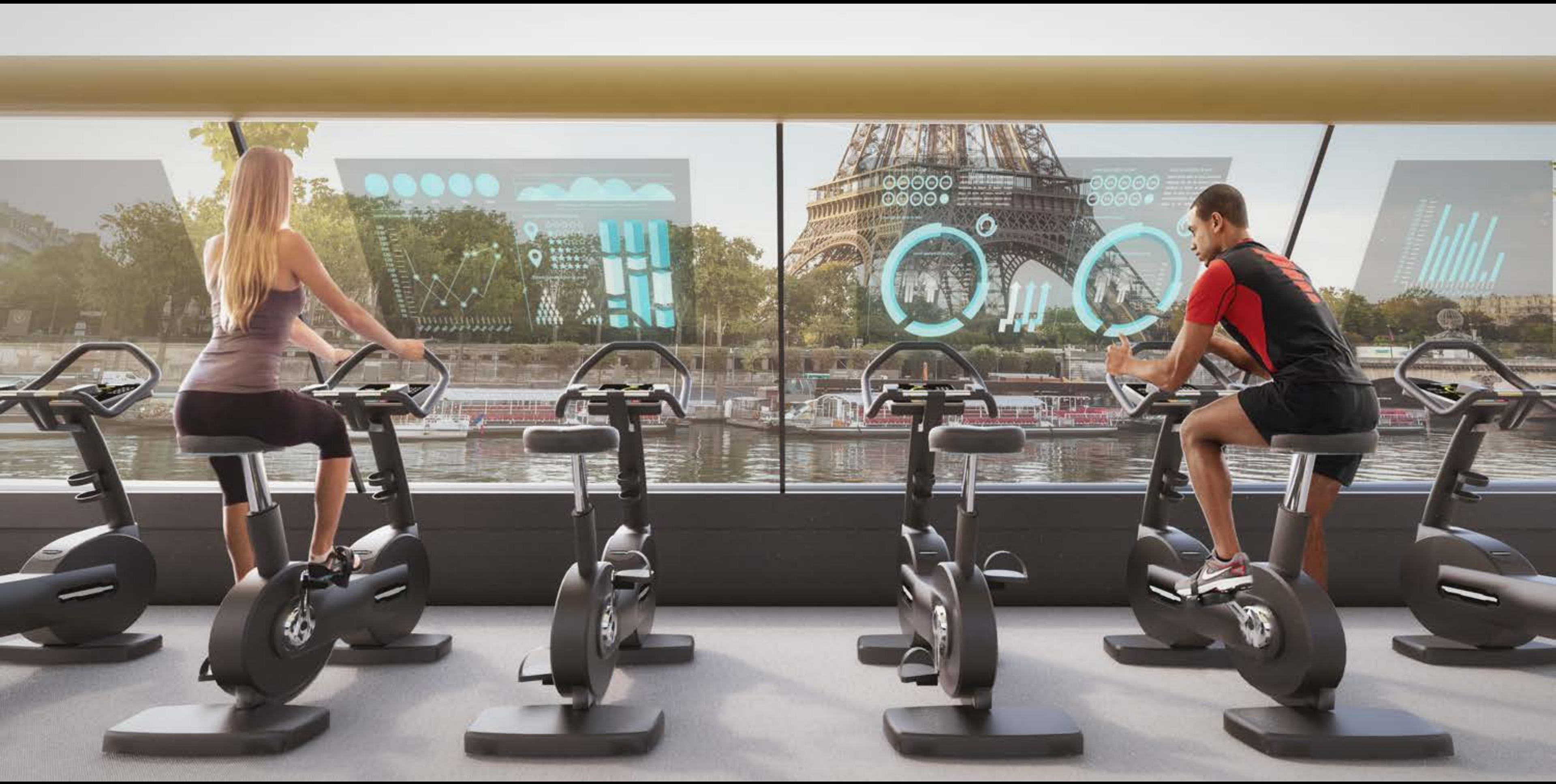

HANDLE WITH CARE
AMS






A3





Twitter
@CRASSOCIATI
@SENSEABLECITY