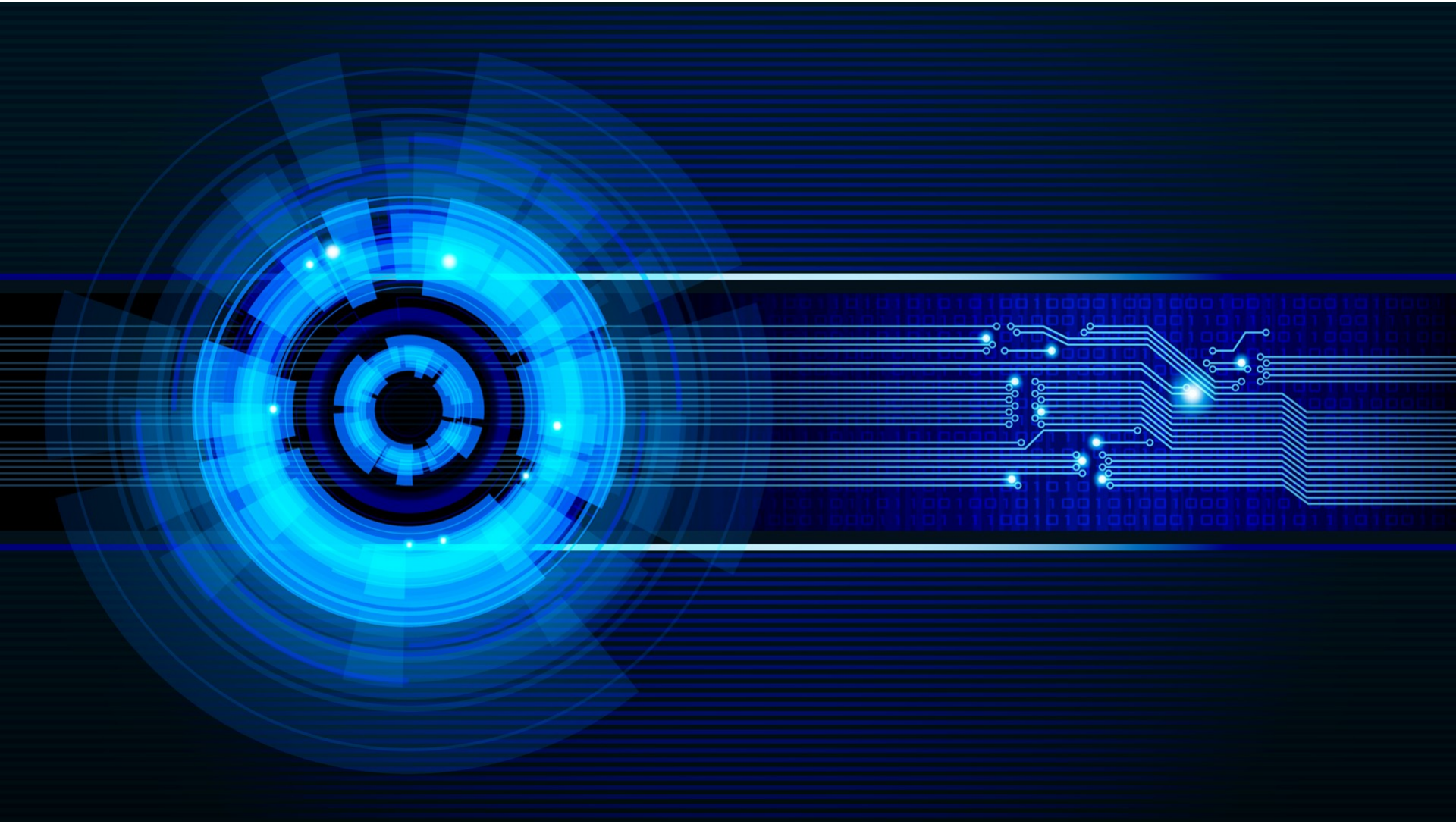
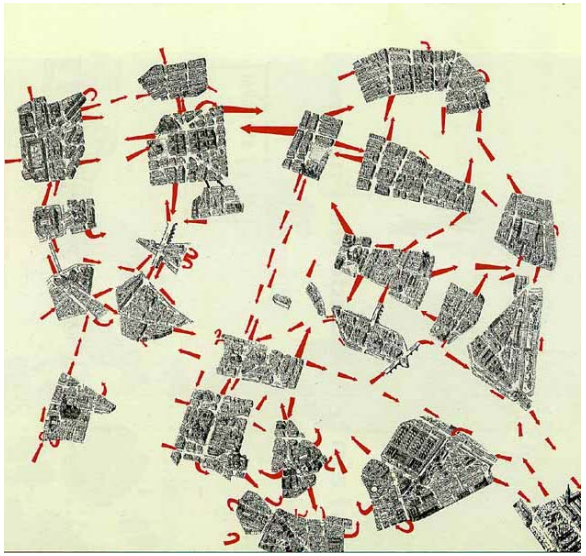
Smart City Sensor Technology | BRIDGING THE DIVIDE BETWEEN EXISTING REAL TIME URBAN USE DATA RESOURCES AND ARCHITECTURE PROFESSIONALS



Nigel M Joseph – Graduate Thesis Research Final Presentation

Bridging the Divide Between Existing Real Time Urban Use Data Resources & Architecture Professionals



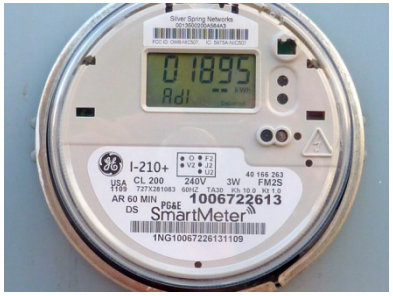
City /Region Scale

Individual/Group Scale

Cellular Participatory Sensing

Embedded Opportunistic Sensor

Environmental Sensor



Natural Resource Monitoring

Interpersonal Interactions

Pedestrian Movement

Architecture + Planning

Sensor Technology

Data

Existing Gaps In Precedent Smart City Research

- **Social – Cultural Interrelations**

  The digital, smart, or intelligent are all slippery terms used interchangeably to discuss the convergence of technology and the physical environment of urban cities. Digital Cities, Smart Phones, and Intelligent Buildings are a few of the examples of the results of semantic compounding achieved with these root terms.

  (Hollands, ***Will The Real Smart City Please Stand Up,*** 2008)

  The application of burgeoning internet communication technology has been exalted as panacea to the malaise plaguing cities and the process of city making; yet the fruits of the internet technology sector have yielded results only to the most developed and computerized economies. On the other hand, the Internet blue chips, online shopping and nanosecond email have failed to cure century old malaises, viz. illiteracy, poverty and unemployment

  (Rao, ***Bridging digital divide: Efforts in India,*** 2005)

- **Virtual – Physical Spaces**

  Architects of the twenty first century will still shape, arrange, and connect spaces (both real and virtual) to satisfy human needs; increasingly confronted by practical choices between providing for bodily presence and relying on telepresence they will find new ways to accommodate human needs in a matrix of digital telecommunication systems and reorganized circulation and transportation patterns

  (Mitchell, ***City of Bits: Space, Place, and the Infobahn***, 1995)

- **Commodity – Information Economics**

  Globally data and computing networks are replacing human capital networks at a rapid rate. New, potentially polarizing, economies ruled by informatics, and driven by emergent "spatial and informational flows" accessed via digital technologies are reshaping our conception of both physical space and time within our urban environments.

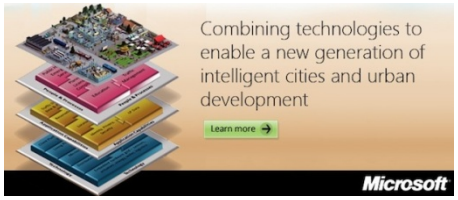
  (Castells, ***The education of city planners in the information age,*** 1997/1998)

- **Industrial - Smart Stewardship**

  Ubiquitously present telecommunications networks, smart machines, and intelligent buildings combine with water supply and waste removal, energy distribution, and transportation systems to create wherever, whenever, globally interlinked world. The old social fabric tied together by enforced commonalities of location and schedule – no longer coheres. What shall replace it

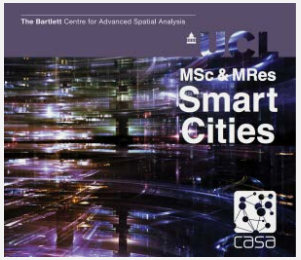
  (Mitchell, ***E-Topia: Urban Life, Jim - But Not As We Know It,*** 1999)

Precedent Backgrounds Engaged in Smart City Research



GE

Institute for Data Sciences and Engineering
COLUMBIA UNIVERSITY



IBM
Smarter Cities

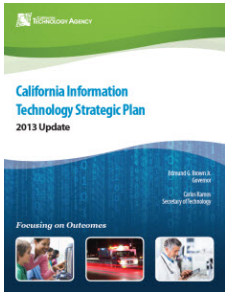
MIT
senseable city lab:.::

CUSP
CENTER FOR URBAN SCIENCE + PROGRESS

Buro Happold
Consulting Engineers

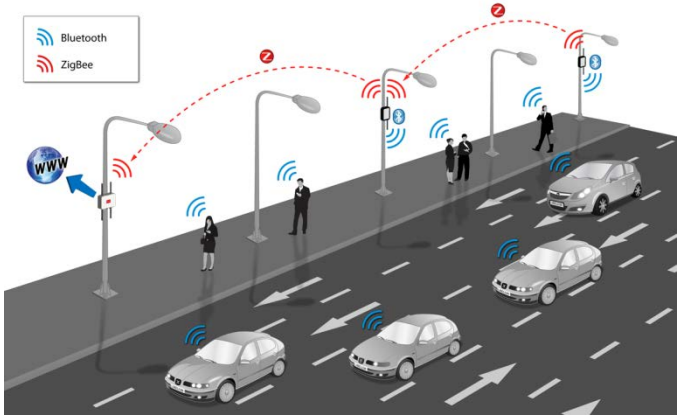
ARUP

SmartCity
SAN DIEGO

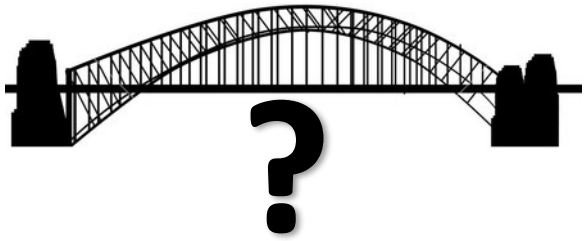


Research Question

Can the real time data produced, in perpetuity, by emerging environmental sensor technologies be harnessed to increase the quantity of topical urban data resources available to practicing architectural professionals engaged in the stewardship of contemporary cities and developing urban regions?

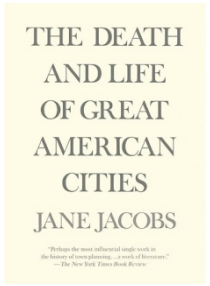


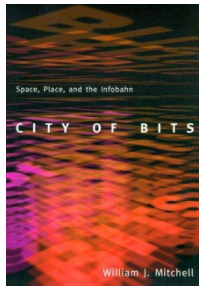
Real Time Urban Use Data



Architectural Practice & Research

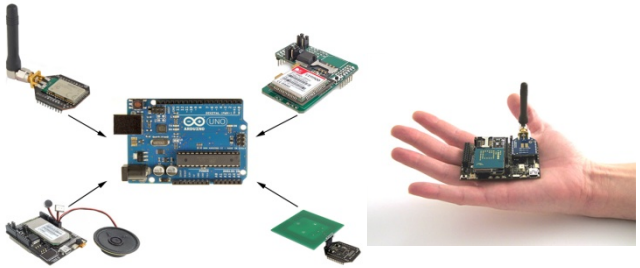
Triangulated Research Approach





❖ **Critical Evaluation of Peer Reviewed Literature**
- Immediacy of Smart City development + Exploitable gaps in precedent research
- Precedent links between architecture and Smart City development
- Case study examples engaged in urban data acquisition via environmental sensing

❖ **Analysis of Contemporary Environmental Sensor Technology**
- Sensor Typology
- Accessibility
- Adaptability
- Applicability
- Etc.



❖ **Survey of Engaged Professionals**
- Current extent of practical engagement between architectural professionals and Smart City initiatives.
- Data sharing protocols in current Smart City initiatives
- Typology of current Smart City initiatives
- Goals and Outcomes of current Smart City initiatives
- Etc.

Critical Literature Review

Common Linkages

Issue:	*Smart City*	*Architecture*
Social Justice	Digital Divide	Agency
Tectonics	Smart Materials	Craft
Ecology	Smart Growth	Sustainability
Urban Data	Real Time Sensing	Cartography/Archeology

> How we distribute our activities along these new technology enabled space and time dimensions will provide a powerful guide for digital places; where we choose to go for face to face activities, how much work can be done remotely mediated by computer access, and how does this impact the design of place?
>
> (Horan, ***Digital Places: Building Our City of Bits***, 2000)

Case Study Precedents

Selection Criteria: Smart City – Opportunistic Sensing – Environmental Sensors – Open Data – Internet Access

Global Snapshot of Smart City penetration:

New York	Verona Smart City
Chicago	Yokohama Smart City
Detroit	Songdo International Business District
San Diego	Smart Santander
Miami	Malta SmartCity business park
Boston	India
Autstin	Australia
Smart City Vienna	Smart City Málaga
Aarhus Smart City	Lyon Smart City
Amsterdam Smart City	Kochi Smart City business park
Cairo Smart Village	Edinborough
Dubai Smart City	Dubai Internet City
Seoul	Hong Kong
London	Tel Aviv

Smart City Regions Selected For Critical Examination

Santander Spain	Lubeck Germany
Belgrade Serbia	Guilford United Kingdom
Chicago Illinois	Masdar Abu Dhabi

Screen Capture of Environmental Sensing Device Locations In Santander Spain

Analysis of Sensor Technologies

Available Sensor Typologies

Atmospherics

- Temperature
- LPG
- Humidity
- Nitrogen dioxide - NO2
- Oxygen - O2
- Alcohol derivates
- Carbon monoxide – CO
- Air pollutants
- Atmospheric pressure
- Ozone - O3
- Carbon dioxide - CO2
- Hydrocarbons - VOC

Acoustics /Optics

- Noise sensor
- Sonograph
- Luminescence

Hydrology

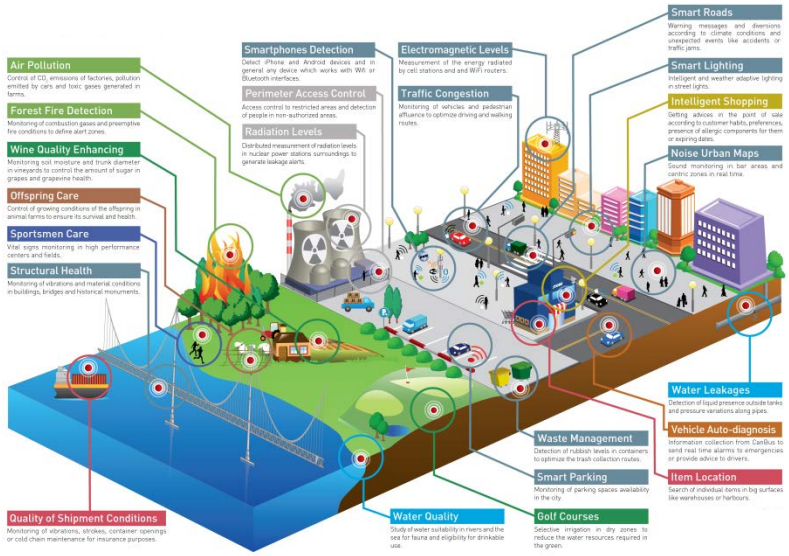
- Moisture
- Liquid Level
- Liquid Flow

Energy

- Radiation
- Current
- Linear Displacement

Presence

- Motion
- Dendrometer
- Pressure



Accessibility

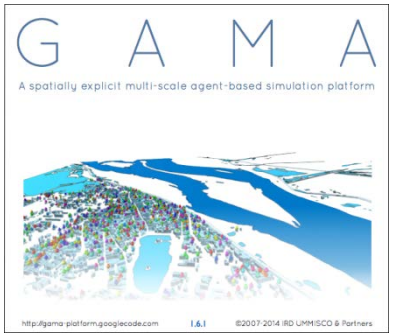
Hardware

libelium
wireless distributed communications

Environmental Technology, Inc.

APC
American Power Conversion

Software



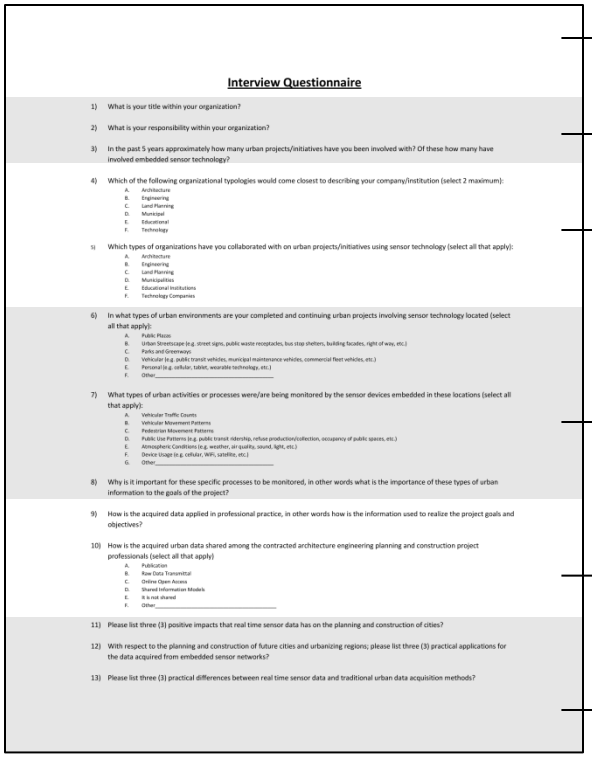
esri

INTERGRAPH | erdas
an Intergraph brand

Google

Rhinoceros®
NURBS Modeling for Windows

Survey of Engaged Professionals



Interview Questionnaire

1) What is your title within your organization?

2) What is your responsibility within your organization?

3) In the past 5 years approximately how many urban projects/initiatives have you been involved with? Of these how many have involved embedded sensor technology?

4) Which of the following organizational typologies would come closest to describing your company/institution (select 2 maximum):
   A. Architecture
   B. Engineering
   C. Land Planning
   D. Municipal
   E. Educational
   F. Technology

5) Which types of organizations have you collaborated with on urban projects/initiatives using sensor technology (select all that apply):
   A. Architecture
   B. Engineering
   C. Land Planning
   D. Municipalities
   E. Educational Institutions
   F. Technology Companies

6) In what types of urban environments are your completed and continuing urban projects involving sensor technology located (select all that apply):
   A. Public Places
   B. Urban Streetscape (e.g. street signs, public waste receptacles, bus stop shelters, building facades, right of way, etc.)
   C. Parks and Greenways
   D. Vehicular (e.g. public transit vehicles, municipal maintenance vehicles, commercial fleet vehicles, etc.)
   E. Personal (e.g. cellular, tablet, wearable technology, etc.)
   F. Other_____

7) What types of urban activities or processes were/are being monitored by the sensor devices embedded in these locations (select all that apply):
   A. Vehicular Traffic Counts
   B. Vehicular Movement Patterns
   C. Pedestrian Movement Patterns
   D. Public Use Patterns (e.g. public transit ridership, refuse production/collection, occupancy of public spaces, etc.)
   E. Atmospheric Conditions (e.g. weather, air quality, sound, light, etc.)
   F. Device Usage (e.g. cellular, WiFi, satellite, etc.)
   G. Other_____

8) Why is it important for these specific processes to be monitored, in other words what is the importance of these types of urban information to the goals of the project?

9) How is the acquired data applied in professional practice, in other words how is the information used to realize the project goals and objectives?

10) How is the acquired urban data shared among the contracted architecture engineering planning and construction project professionals (select all that apply)
   A. Publication
   B. Raw Data Transmittal
   C. Online Open Access
   D. Shared Information Models
   E. It is not shared
   F. Other_____

11) Please list three (3) positive impacts that real time sensor data has on the planning and construction of cities?

12) With respect to the planning and construction of future cities and urbanizing regions; please list three (3) practical applications for the data acquired from embedded sensor networks?

13) Please list three (3) practical differences between real time sensor data and traditional urban data acquisition methods?

Interview Questionnaire

Thirteen Questions Total Delivered Via Email

Personal : Validation of Professional Background and Subject Expertise.

Entity: Validation of Entity Typology and Engagement with Architecture + Planning Entities.

Sensors: Validation of Sensor Deployments, Typology, Initiative Goals, and Outcomes.

Urban Data: Validation of Sharing and Application of Acquired Data.

Alternatives: Illumination of Alternative Sensor and Data Applications, and Typologies.

Interview Sources (snapshot)

Selection Criteria: Individuals and entities currently or recently engaged in Smart City initiatives involving Environmental Sensing deployments.

Architectural Entity:	*Commercial Entity*	*Academic Entity*	*Civic Entity*
Foster+Partners	IBM	NYU	City of Chicago
Arup	Siemens	MIT	City of New York
Burro Happhold	Cisco	Columbia	City of Detroit
HOK	Arduino	University of Chicago	City of San Diego
Kohn Pedersen Fox	General Electric	Rice	City of Baltimore

Research Outcomes

❖ **Hypothesis #01: Architecture professionals are not currently engaging with emerging real time urban use data resources**

Literature Review

Survey Of Engaged Professionals

❖ **Hypothesis #02: Real time urban use data is available to architectural and planning professionals**

SmartSantander

Case Study: Environmental Sensors

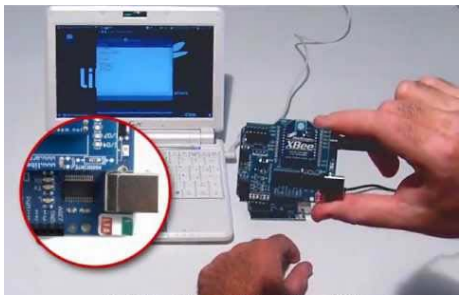
CALIFORNIA OPEN DATA HANDBOOK

OPEN NEW YORK

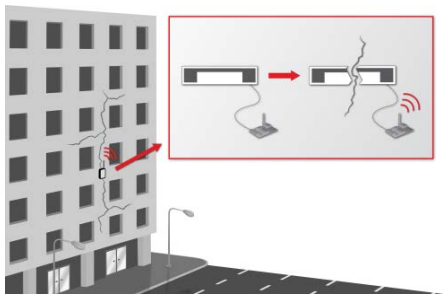
Case Study: Open Data Movement

Case Study: Smart City Policy

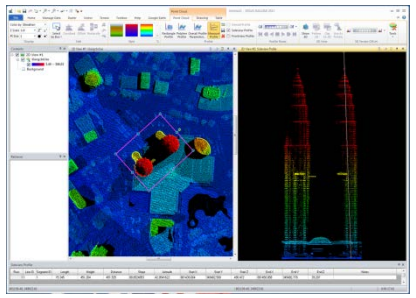
❖ **Hypothesis #03: Real time urban use data is accessible and applicable to architectural and planning professionals**



Sensor Technology Analysis: Accessibility /Flexibility



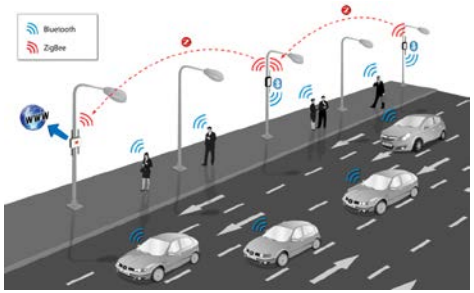
Sensor Technology Analysis: Applicability/Utility



Sensor Technology Analysis: Accessibility/Applicability

Research Conclusions

The real time data produced, in perpetuity, by emerging environmental sensor technologies can be harnessed to increase the quantity of topical urban data resources available to practicing architectural professionals engaged in the stewardship of contemporary cities and developing urban regions.



Real Time Urban Use Data

+

Architectural Practice & Research

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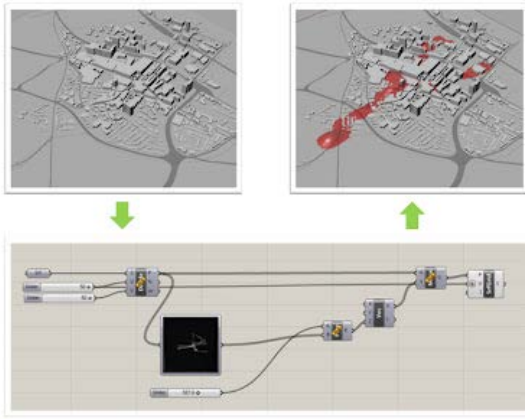
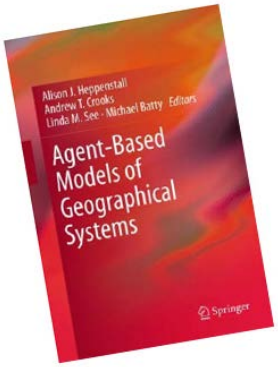
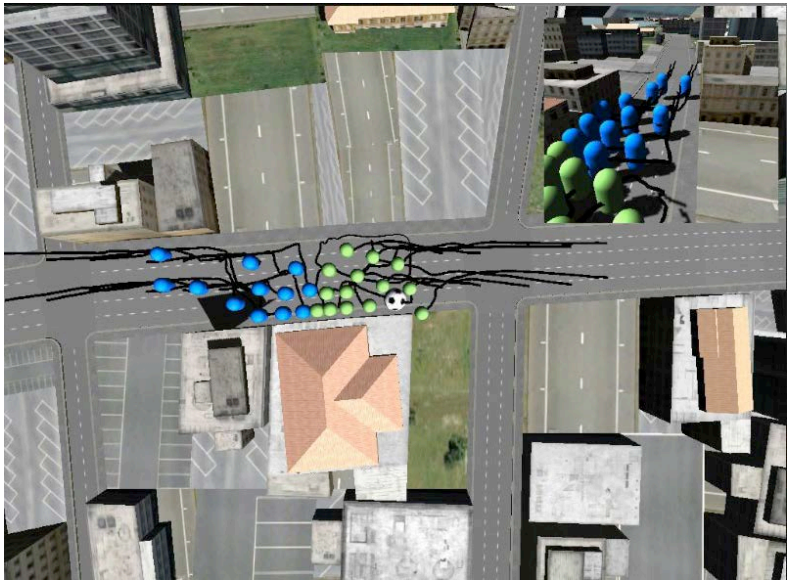
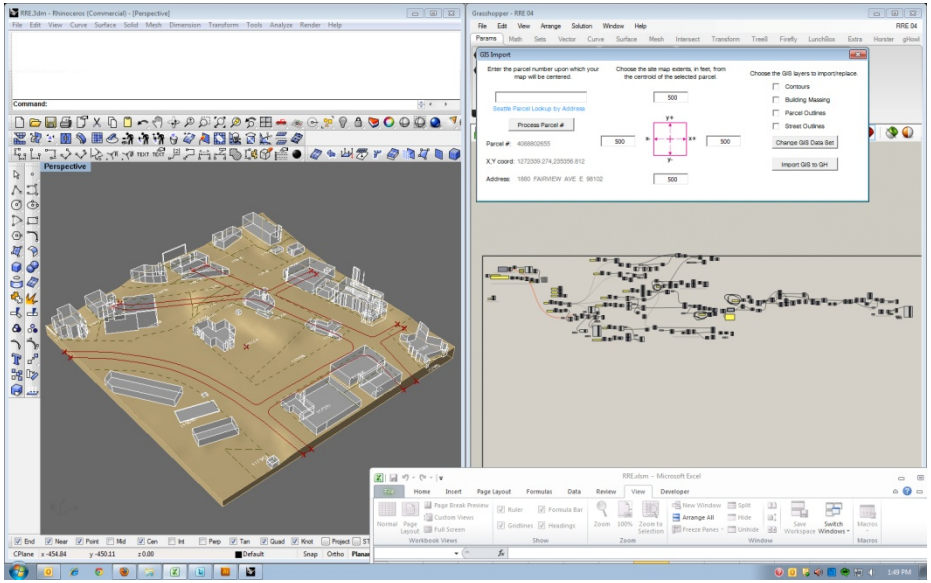






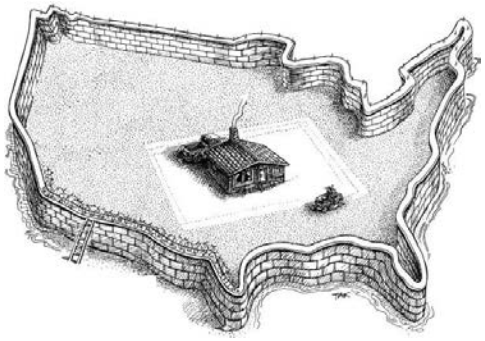
Urban Data Agent Based Modeling Simulations



Urban Data Geospatialization Model

Research Conclusions

(Limitations)

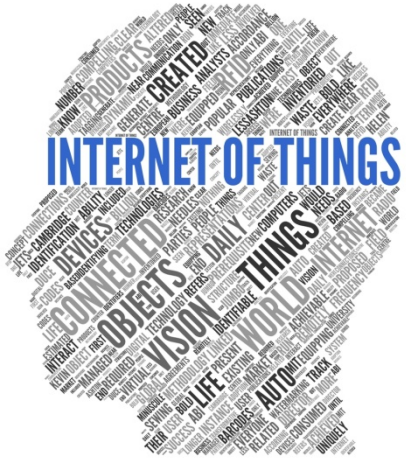


Opportunistic Sensing U.S. Penetration

Engineering vs. Architectural Professionals

Cellular Automata & Participatory Sensing

Computer Programming Language

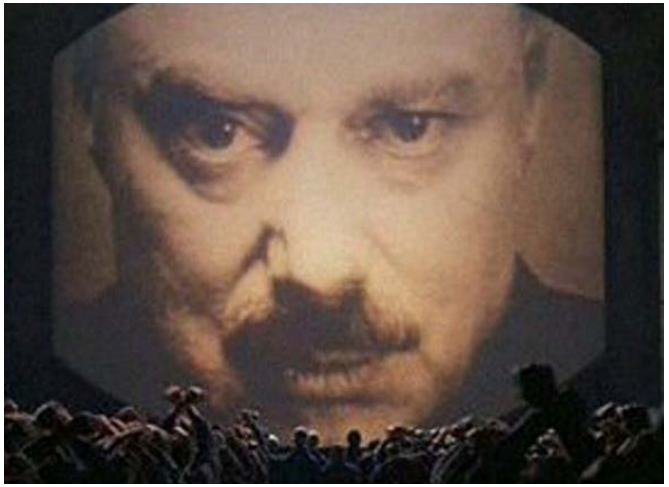


The Internet of Things (IoT)

Research Conclusions

(Areas For Further Investigation)

Usage Data For Interior & Private Space

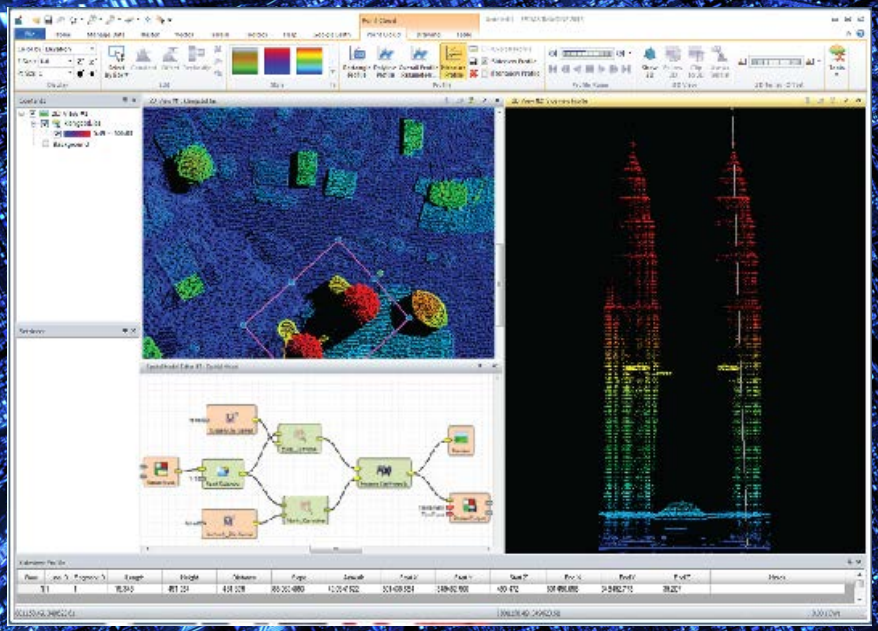


Urban Data Management & Transparency

Personal Privacy

Personal Security

THANK YOU



QUESTIONS?