Changing Cities:
How to Prototype New Urban Systems
A City Science Design Workshop (MAS 552 / 4.557)

Offered by the Changing Places Research Group, Media Lab

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Course Advisor – Ramiro Almeida

Prerequisites – Permission of Instructor**,** Units (3-0-9), Fall 2014

First Class – Wednesday, 2:00 – 5:00pm, Room E15-341 (First Class Sept. 3rd)

Class Description – Today's rapidly urbanizing cities desperately need disruptive innovation that move beyond "Smart Cities" solutions that have traditionally focused on optimization of cities rather than inventing new urban systems. This course will focus on *how to* design and prototype new systems to address the problems of urban mobility, food production, and live/work spaces. This course will also develop urban analytical tools to inform the design of semi-autonomous, resilient, dense urban neighborhoods where places of living, work, culture, shopping, and play are within a 20-minute walk.

This course will focus on five "How to" modules:

- How to prototype autonomous, shared, electric mobility systems
- How to prototype hyper-efficient, transformable spaces (robotic architecture)
- How to prototype controlled environment urban food systems
- How to realize computational urbanism using augmented tangible models
- How to quantify innovation, entrepreneurship, and creative vitality in cities

Class participants will be divided into small teams (2-4 students) to focus on one "How to" module for the duration of the semester based on their interest, experience and skill sets. Each module will be lead by a mentor(s) from the City Science Initiative. Student teams are expected work together as a unit to conceptualize, design, fabricate, and assemble a series of working prototypes on throughout the term.

Enrollment – This class seeks highly motivated students with the necessary skills to prototype new urban systems (see pre-requisites for each module below). Students interested in joining the class will be required to submit a CV and/or portfolio, a short essay of interest, and sign up for a short 15-minute interview to be held on either September 4th or 5th.

How to Prototype Autonomous, Shared, Electric Mobility Systems

Students will prototype a Persuasive Electric Vehicle (PEV) – an autonomous, shared-use, electric-assist three-wheeler designed for bicycle lanes (see figure 1). Developed to function like a robotic taxi, the PEV will autonomously pick-up and drop-off passengers as well as function as a driverless package delivery service during non-peak hours. This group will also focus on developing system models for autonomous mobility-on-demand services that consider the impact on congestion, resource consumption, fleet utilization, and carbon emissions.

Figure 1: Persuasive Electric Vehicle (PEV) and a network of autonomous-shared EVs.

Prerequisites – This module seeks students with an engineering/design background with experience in mobile application programming, fabrication and rapid prototyping, and/or system modeling (e.g., system dynamics, agent based modeling).

Module Mentors – Carson Smuts, Michael Lin, Wolfgang Gruel

How to Prototype Hyper-efficient, Transformable Spaces (Robotic Architecture)

Students will create a new ecosystem of architectural robots that allow to dramatically increase the utilization and responsiveness of space, by converting traditionally static spatial objects into transformable & connected architecture. This module will build upon the CityHome project – an urban live/work space that can reconfigure and offer functionality equivalent to 3X its size by converting your bedroom into a living room, office, or dining area (see figure 2). This term we will examine how these principles and technologies can used to envision, sketch, plan, and rapidly prototype a new space in 100 days.

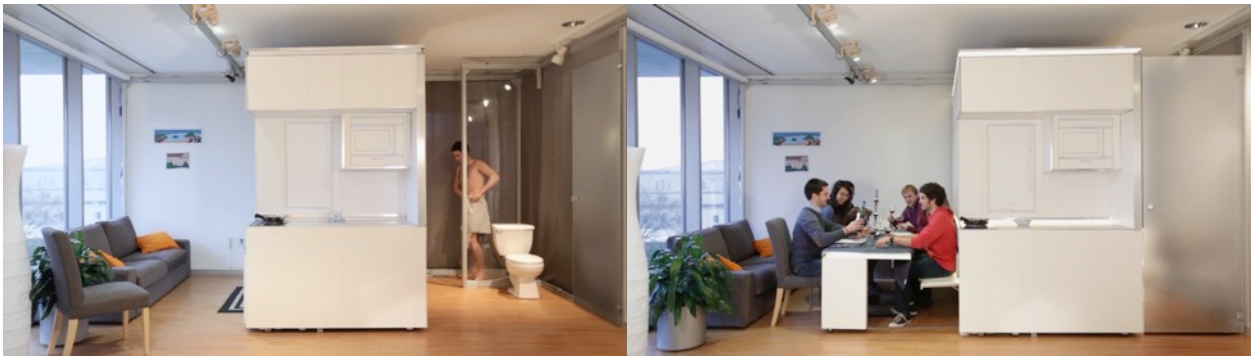

Figure 2: CityHome is a 200 square foot transformable apartment that allows for flexible and adaptable urban living (see http://cp.media.mit.edu/places-of-living-and-work/).

Prerequisites – This module seeks to create an interdisciplinary team consisting of engineers/architects with skills in one or more of the following: fabrication, electronics & sensors, embedded programming, application programming, and advanced CAD.

Module Mentor – Hasier Larrea-Tamayo

How to Prototype Controlled Environment Urban Food Systems

We are at the beginning of the maker movement for food. Growing telemetry is the data. Food is the information. In a landscape of claims, speculation and "blackbox" solutions, we are building an open source software and hardware platform to agnostically interrogate one of the oldest systems in the world – agriculture.

Students will leverage the existing control environment and modular mechanical chassis of the MIT CityFARM (see figure 3) to prototype the first open source OS for food – including macro and micro environmental sensing, multi-nodal sensor networks, agile data basing, visualization, and actuation solutions. The data collection and visualization systems will allow for optimization of the mechanical plant production systems (e.g., hydroponic shallow water raft, nutrient film technology, high-pressure aeroponic, and others) and a precise understanding of the correlation between the environmental and physical variables of plant growth.

Figure 3: The CityFARM façade integrated growth chamber (www.mitcityfarm.com, @mitcityfarm)

Prerequisites – This module seeks students with computer science, electrical engineering, mechanical engineering, and digital fabrication experience. Preference will be given to those students with programing, UI, sensor, embedded system and control design experience.

Module Mentors – Caleb Harper, Jason Nawyn and Rich Fletcher

How to Realize Computational Urbanism Using Augmented Tangible Models

Students will develop simulations that can predict and quantify the potential impact of disruptive technologies within new and existing cities. The deliverable will be an augmented reality decision support system (ARDSS) designed to facilitate non-expert stakeholder collaboration. Students will be able to use existing “CityScope” technology (see figure 4) developed in the Changing Places group at the MIT Media Lab, or they may develop their own ARDSS tools.

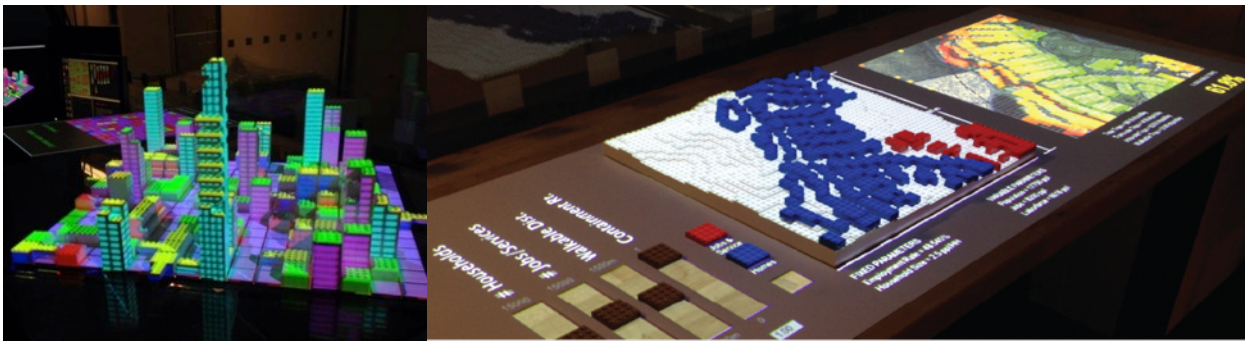

Figure 4: CityScope is a suite of simulation systems that can predict and quantify the potential impact of disruptive technologies within new and existing cities. CityScope tools typically consist of augmented reality decision support systems (ARDSS) that facilitate non-expert stakeholder collaboration within complex urban environments.

Prerequisites – This module seeks students with intro-level programming experience and prefers students with experience in 1) Java or similar, and 2) mathematical modeling and/or statistics.

Module Mentor – Ira Winder

How to Quantify Innovation, Entrepreneurship, and Creative Vitality in Cities

Students will explore analyses and visualizations of innovation, entrepreneurship and creative vitality in cities. We will review and critique existing measures, rankings, indices, and analyses of innovation and creativity in cities. Furthermore, students will examine existing – plus seek out novel – datasets revealing patterns of human action in the city at different scales of space and time (e.g. seasonal, weekly, minute-by-minute in the building, block, or neighborhood). These could include mobile telephony and messaging (e.g. Tweets), commerce (e.g. card payments), traffic flows, and more. We will explore our own Boston-metro innovation areas with an eye on the challenges of quantitatively capturing the rich essentials of what makes places great (or not) and defining what "greatness" means. Our overarching goal is to seek better indices (or rankings or scores) and analyses of vitality in the city by tapping into novel datasets and new

analytic approaches. Ultimately we aspire to compare and contrast not only cities and neighborhoods, as they exist today, but simulate how they might become as new urban systems and approaches are deployed.

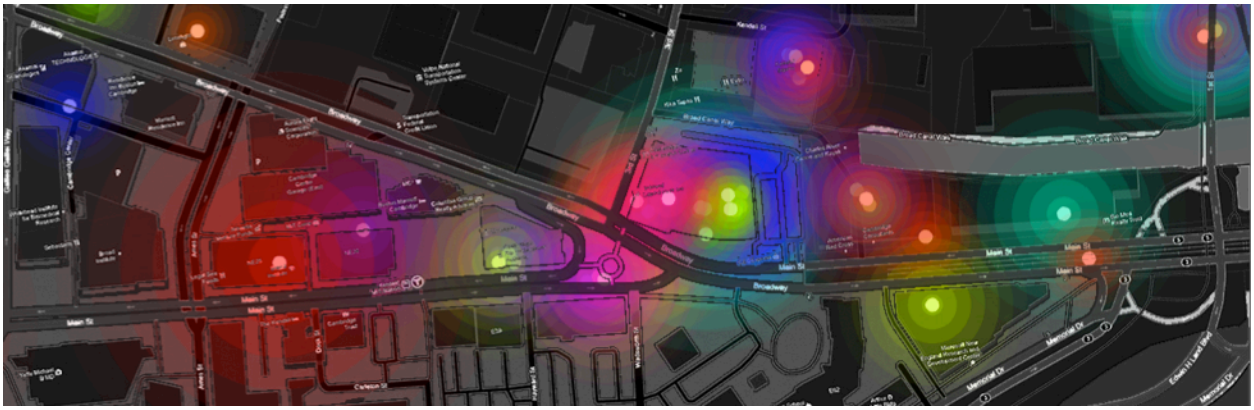

Figure 5: Urban Innovation heat map of industries in Kendall Square (Image: Context Labs)

Prerequisites – This module seeks students with engineering, design, software or social science backgrounds with experience in data analytics and visualizations, quantitative cartography and ethnography, application programming and/or system modeling.

Module Mentors – Joost Bonsen, Daan Archer, Jennifer Saura, Dan Harple.

Schedule

A typical class session will have a presentation by guest speakers, followed by student group discussions. Additional class time requirements include individual and team meetings with instructor(s) and team working meetings outside of class hours.

Week	Date	Session Overview	Lectures
1	9.3.14	**FIRST CLASS MEETING, 2pm** Introductions and presentations by Changing Places Group Students will identify their top 3 interest areas ***Course Interviews on Thursday (Sep. 4) and Friday (Sep. 5)*** ***Course admission Announcements (Sept. 8)***	Course Introduction (30 min.) Course overview (1 hour) Course logistics (30 min.)
2	9.10.14	Team assignments and introductions In-class Brainstorming and review of results. Hand out assignment # 1	Mobility (30 min.) CityScope (30 min.) (30 min.)
3	9.17.14	*Review of assignment # 1* *Start Assignment #2*	Housing (30 min.) Urban Farming (30 min.)
4	9.24.14	*Review of Assignment #2* Start Assignment #3	Urban Innovation (30 min.)
5	10.1.14	Review Assignment #3	Guest speaker (TBA)

		Formation of Research Teams Research Team Assignment #1 In-class work session	
6	10.8.14	Review Research Team progress In-class work session	Guest speaker (TBA)
7	10.15.14	*Mid-Review with invited Guests*	
8	10.22.14	**Media Lab Members Week** Poster Sessions for Industrial Members	
9	10.29.14	Introduce End-of-term project Student Work Session	
10	11.5.14	Student Work Session	
11	11.12.14	Interim Review Student Work Session	
12	11.19.14	Student Work Session	
13	11.26.14	**No Classes: Thanksgiving**	
14	12.3.14	Student Work Session	
15	12.10.14	**Last Day of Class**	
16	12.17.14	**Final REVIEW** **Invited Critics (TBC):** Joi Ito, Hiroshi Ishii, Dennis Frenchman, Mel King, Ralph Gakenheimer, Nigel Jacob, Chris Osgood, Chris Zegras	

Readings
To be announced at the first class meeting.

Reference Websites
Changing Places Research Group, MIT Media Lab: http://cp.media.mit.edu/
City Science Initiative, MIT Media Lab: http://cities.media.mit.edu/