

Innovation Hubs

Kendall Square as Laboratory for High-Density Urban Living

A City Science Design Workshop (MAS 552 / 4.557)

Offered by the Changing Places Research Group, Media Lab

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Prerequisites

Permission of Instructor

Units (3-0-9), Spring 2013

First Class – This workshop will meet each Wednesday from 2:00pm – 5:00pm in Room E14-525, (5th Floor, New Media Lab Building). The first session is on September 4th at 2:00pm. In addition to class, each week will start off with a lunchtime guest speaker from 12:30-2pm (details below).

Class Description – The world is experiencing a period of extreme urbanization. In China alone, 250+ million rural inhabitants will move to urban areas over the next 15 years. This will require building new infrastructure to accommodate nearly the equivalent of the current population of the United States in a matter of a few decades. Cities in the 21st century will account for nearly 90% of global population growth, 80% of wealth creation, and 60% of total energy consumption. It is a global imperative to develop systems that improve the livability of cities while dramatically reducing resource consumption. This workshop will explore *new urban systems* for high-density cities including systems for mobility, energy, food production, and live/work. The workshop will focus on the design of resilient, scalable, adaptable, and reconfigurable systems.

This course will utilize CityScope, an urban simulation tool, which consists of physical scale models (built of LEGO bricks) and 3D projection mapping (based on 3D parametric modeling) to prototype the design of Compact Urban Cells – a neighborhood area of approximately one square kilometer in diameter that contains most of what citizens need for everyday life. Compact Urban Cells are walkable neighborhoods with a diverse mix of live/work areas that utilize shared mobility systems, distributed renewable power generation, shared spaces, and integrated vertical urban farming.

As a test case, the course will focus on the redesign of Kendall Square as a new sustainable model for developing hyper-dense urban environments in the U.S. and abroad. Students will initially study precedents for innovation hubs in other cities, and then they will build LEGO scale models and accompanying 3D models (in Rhino) that can be visualized in the CityScope platform to represent their design interventions and illustrate system-level affects. The application of parametric modeling tools like Grasshopper will allow students to build a virtual 3D model that can simulate major design changes in population density, resource consumption, street design/patterns, volume/size of buildings, etc. By using LEGOs and Grasshopper, we can quickly prototype "sketch" models at various scales, document, critique/learn from each design, suggest improvements, and make further iterations.

Requirements – This course is particularly relevant to graduate students with backgrounds in engineering systems design, computer science, data visualization, user interface, mechanical engineering, architecture, and urban design. Proficiency in LEGO building, 3D modeling in Rhino (or similar CAD program) and Grasshopper is preferred, but not required to take the course. Students of all academic backgrounds are welcome to participate in the workshop. Both graduate and undergraduate students are encouraged to apply to the course.

Five Exploration Areas – This workshop will build upon the research of the Changing Places Research Group, at the MIT Media Lab, to explore five distinct research areas, each led by research assistants. Students in the class may identify where their own interests overlap with the research group and select an exploration area as a starting point.

1. Electric Mobility Ecosystems

Team Leaders: Michael Lin, Daniel Goodman, Kamal Farrah, Sandra Richter

Students will explore the development of new, lightweight, autonomous, electric vehicles and mobility-on-demand systems tailored for high-density cities in China. Mobility on Demand (MoD) Systems provide a sustainable, efficient, and economically viable fleet of electric vehicles in a one-way shared use system. Several mobility-on-demand vehicles have been designed at the Media Lab, including the CityCar (commercialized as Hiriko), RoboScooter, and the Persuasive Electric Vehicle (PEV). Combining MoD with well-planned public mass transit creates an entire mobility ecosystem that can service a population with as few vehicles and parking spaces as possible.

2. Resilient Energy Systems

Team Leader: Praveen Subramani

The energy team will explore technologies for renewable energy, applying relevant technologies to high-density neighborhoods, or “compact urban cells,” in new cities in China. Distributed systems of partially self-sufficient, local microgrids will help maintain energy autonomy for each urban cell. Students will learn about existing energy generation and distribution technologies as well as nascent areas such as Smart Grids, Vehicle-to-Grid (V2G) technologies, and grid energy storage. One key focus area that will be grid storage systems or second-life automotive battery buffers to store energy from intermittent renewable sources and provide backup power during emergencies.

3. Transformable Live-Work Spaces

Team Leaders: Hasier Larrea-Tamayo and Oier Arano

The Live-Work team will focus on small, high-performance, hyper-efficient, transformable urban apartments for young professionals. Urban housing solutions that respond to the changing live/work patterns in today's cities and to serve the needs of different demographics will be explored. Apartments will have the ability to be dynamically reconfigured to accommodate a wide range of activities from sleeping to working to entertainment to exercise, with a focus on “micro-units” called CityHomes between 225 and 450 square feet. This team will explore urban strategies for creating live/work systems that integrate housing, mobility, energy, and food production.

4. Urban Food Production (Building-Integrated Aeroponics)

Team Leader: Caleb Harper

In 2008, enough food was produced to feed 11 billion people. With a world population of 7 billion people, why were nearly 1 billion people classified as “hungry” or nutrient deprived, and another 1 billion people declared obese? One considerable driver is that approximately 1/3 of our food is lost due to supply chain inefficiencies and waste. We are producing too much food to compensate for deficiencies in getting the food from the farm to the consumers. This leads to over processing and damaging of our land on multiple levels – from pesticides to fertilizers to gross over use of water – over 60% of worldwide freshwater is currently used for agriculture. As the population continues to grow dramatically in cities, we must consider new technologies to enable more efficient and responsible means of producing and distributing food to people in urban areas. This group will investigate technology-enabled systems & interfaces, and their integration into the urban environment (facades, rooftops, open areas) for industrial production.

5. Innovation Hub Task Force

Team Leader: Ira Winder, Mohammad Hadhrawi

The Zoning Board of the City of Cambridge has established a new Kendall Square Special Entrepreneurship District, with the goal of turning the area into a high-profile, high-density, hyper-efficient model for "creative cities" and a living laboratory for urban innovation. This team will be tasked with creating new zoning requirements that will dramatically increase the urban density of the area while simultaneously addressing fundamental urban needs for food, water, waste, mobility, living and working spaces. Some sample zoning requirements may include the tripling of Floor-Area-Ratio (FAR), the banning of all privately owned internal combustion engine vehicles, increased use of shared-vehicle programs (like Hubway) mandates for integrating urban farming on surfaces of buildings, ability to rezone (including the shifting of air rights), setting of max building heights, elimination of private parking, etc. The result of the zoning studies will be a set of massing models (in LEGOs and in 3D) of the maximum build out for Kendall Square by identifying key areas of urban growth. This team will also set guidelines for the quality-of-life commission that will oversee the Kendall Square development.

Course General Consultants

Topper Carew and Ramiro Almeida will bring their real-world experience in technology, design, art, music, mobility, and entrepreneurship to the course by providing advice and mentorship throughout the course.

Class Structure

Students will work in small teams throughout the semester led by project team leaders from the Changing Places research group at the MIT Media Lab. Projects will run throughout the term with reviews with invited academic and industry guests. With previous high-demand for the class, students will be required to apply and interview for placement into the course. The instructors will formulate teams based on student interest, background diversity, and skill sets.

Expected Student Deliverables

Students will work within existing problem spaces in the urban environment, and propose well-crafted design solutions that creatively address the problems. Students will be expected to propose design solutions through LEGO models, 3D parametric models (Rhino/Grasshopper), illustrations, building scale prototypes (working and non-working), back-of-the-envelope calculations, videos, and other types of media.

City Science Lunch Series

The City Science Initiative (cities.media.mit.edu) will host a guest speaker each week from 1230-200pm. Invited guests will speak about design, technology, and policy issues related to making cities smarter and more sustainable. Attendance is required. Lunch will be served.

Enrollment

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. More information on this process will be discussed on the first class session on September 4th at 2pm in E14-525.

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/>

Course Flyer and Syllabus

<http://smartcities.media.mit.edu/download/kendall-livinglab.pdf>

Course Text

Reinventing the Automobile: Personal Urban Mobility for the 21st Century by William J. Mitchell, Christopher Borroni-Bird, and Lawrence Burns.

Excerpts from the Proceedings from the Urban Age Conference: The Electric City

“After the Car,” John Urry

“The Benefits of Density,” Edward Glaeser

“The Electric City,” Ricky Burdett and Philipp Rode

DATA Section – Residential/Employment Density

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	City Science Lunch Lectures (12-130pm, room TBD)
1	9.4.13	FIRST CLASS MEETING, 2pm Introductions and presentations by	Course Introduction (30)	Kevin Slavin

		<p>Changing Places Group</p> <p>Students will identify their top 3 interest areas</p> <p>Course Interviews on Thursday (Sep. 5) and Friday (Sep. 6)</p> <p>Course admission Announcements (Sept. 9)</p>	<p>min.)</p> <p>Course overview (1 hour)</p> <p>Course logistics (30 min)</p>	
2	9.11.13	<p>Team assignments and introductions</p> <p>In-class Brainstorming and review of results</p> <p>Hand out assignment # 1</p>	<p>Mobility (30 min.)</p> <p>Energy (30 min.)</p>	Nigel Jacob, Chris Osgood
3	9.18.13	<p><i>Review of assignment # 1</i></p> <p><i>Start Assignment #2</i></p>	<p>CityHome (30 min.)</p> <p>Urban Farming (30 min.)</p>	John Fernandez
4	9.25.13	<p><i>Review of Assignment #2</i></p> <p><i>Start Assignment #3</i></p>	Zoning (30 min.)	Nigel Wilson
5	10.2.13	<p>Review Assignment #3</p> <p>Formation of Research Teams</p> <p>Research Team Assignment #1</p> <p>In-class work session</p>	Guest speaker (TBA)	Olivier de Weck
6	10.9.13	<p>Review Research Team progress</p> <p>In-class work session</p>	Guest speaker (TBA)	Marta Gonzalez
7	10.16.13	<i>Mid-Review with invited Guests</i>		Sertac Karaman
8	10.23.13	<p>Media Lab Members Week</p> <p>Poster Sessions for Industrial Members</p>		Joe Coughlin
9	10.30.13	<p>Introduce End-of-term project</p> <p>Student Work Session</p>		John Macomber
10	11.6.13	Student Work Session		Katja Schechtner
11	11.13.13	<p>Interim Review</p> <p>Student Work Session</p>		
12	11.20.13	Student Work Session		
13	11.27.13	No Classes: Thanksgiving		
14	12.4.13	Student Work Session		
15	12.11.13	Last Day of Class		
16	12.18.13	<p>Final REVIEW</p> <p>Invited Critics: To be confirmed</p> <p>Joi Ito, Hiroshi Ishii, Dennis Frenchman Mel King, Jim Aloisi, Ralph Gakenheimer Nigel Jacob, Chris Osgood, Chris Zegras</p>		