

MAS 552.J / 4.557J

MIT Living Labs

Our campus as a testbed for mobility, energy, and housing innovations

Changing Places Group, Media Lab

Instructors – Kent Larson, Ryan Chin

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Prerequisites – Permission of Instructor

Logistics – Wednesday 2pm-5pm ~ Fall 2011 ~ Room E14-525

Units (3-0-9)

First Class – Wednesday, September 7

<http://cp.media.mit.edu/education/classes>

Course Collaborators – Joost Bonsen, Jenny Broutin, Topper Carew, Viroth Chiraphadhanakul, Karthik Dinakar, William Lark, Jr., Brandon Martin-Anderson, Nicholas Pennycooke, Daniel Smithwick, Shaun Salzberg, and Praveen Subramani.

Class Description

MIT has made a major commitment to long-term breakthrough research on energy. However, we propose that the MIT campus should be a living laboratory to explore how dramatic reductions in energy use can be achieved today. Students will be challenged to develop mobility, energy, and housing innovations that including new lightweight electric vehicles, electric charging and smart grid technologies, transformable high performance housing, persuasive interfaces for energy conversation, and incentives to encourage the use of more energy efficient mobility systems. The potential benefits of an integrated ecosystem approach may include, for example, the freeing up of land for new housing by reducing parking through transportation modal shifts or the introduction of bike sharing programs.

The Living Labs course this term will focus on two major innovations in urban systems: 1) Mobility-on-Demand (MoD) Systems and 2) the CityHome. MoD systems consist of a fleet of Lightweight Electric Vehicles (LEVs) distributed at charging stations in an urban service area. Users can simply walk up to the closest charging station, swipe a credit card, and drive to any other station. MoD systems are essentially one-way rental schemes that tackle the “First and Last Mile” problem of public transit systems. The CityCar designed by the Changing Places group at the MIT Media lab is a LEV designed specifically for MoD systems. The CityCar is a two-passenger LEV that utilizes robotic wheels that enable high maneuverability in tight spaces. It also can transform and fold to minimize parking footprint – an extremely valuable asset in cities. This term we will focus on developing a number of key components of MoD: 1) Designing a new “Persuasive” LEV that encourages exercise and mobility simultaneously, 2) New Energy Systems for MoD systems that incorporate rapid charging, grid storage, and distributed renewable power generation, and 3) Dynamic incentives that address the issues of fleet management.

As work becomes more distributed, mobile, and service-based, and companies become increasingly virtual, the workplace is rapidly evolving. Simultaneously, homes are becoming

centers of production, entertainment, health care, commerce, energy production, and learning. The buildings that support these activities and the transportation systems that link them currently operate at unsustainable levels. The CityHome project focuses on developing live/work spaces for these changes. Like the CityCar, the CityHome transforms (by movable walls and furniture) in order to reconfigure itself into different live/work arrangements. Designed with highly optimized and reconfigurable housing modules, the CityHome incorporates urban farming, electric vehicle charging and parking, and new energy systems (like robotic facades and energy storage systems). The combination of MoD systems and the CityHome concept provides synergistic opportunities to build resilient and redundant urban systems for cities. This term we will focus on developing the following focus areas on the CityHome: 1) Designing the transformable live/work module, 2) CityHome building design that incorporates urban farming, robotic facades, and CityCar parking “dispensers”, and 3) rethinking today’s urban streetscape for new live/work spaces and MoD systems.

The Living Labs workshop will focus on building upon these concepts in six distinct research areas and applying them onto MIT’s campus and Boston’s Innovation district (described below).

Current Changing Places Research: Six Exploration Areas in the Urban Environment

Six explorations areas in the urban environment have been identified and are under investigation by our researchers. Students in the class can find where their own interests overlap with the research group and select an exploration area as a starting point.

1. Lightweight Electric Vehicles (LEVs)

Team Leaders: Nicholas Pennycooke, Marcus Martinez, Will Lark

The Changing Places Group has developed 3 LEVs for MoD systems: The CityCar, RoboScooter, and the GreenWheel Electric bicycle. This term we will focus on a new LEV called the “Persuasive” Electric Vehicle (PEV) – an LEV that simultaneously addresses the problem of congestion, pollution, obesity, and aging. The vehicle incorporates the latest in-wheel motor technologies so that the rider has the option of providing their own propulsion through exercise (i.e., pedaling), power solely from electric motors, or combination of human effort and electric-assistance. In order to attract a broad audience, the vehicle should be capable of being driven in bicycle lanes, should be stable (i.e., 3 wheels or more), and provide shelter and minimal climate control, as well as easy ingress/egress. In addition to the physical design of the vehicle, we will explore incentive based systems to encourage the minimal use of electric power and maximize exercise. We will design and build prototype designs for the PEV and its interface this term.

2. New Energy Systems for Electric Mobility

Team Leader: Praveen Subramani

Taking the MIT campus as a site for deployment, this group will develop strategies for deploying electric charging systems for a campus fleet of shared-use electric vehicles. Students will learn about existing electric charging technologies and standards as well as nascent technologies such as rapid charging, inductive contactless charging (or wireless power transfer), Smart Grids, Vehicle-to-Grid (V2G) technologies, and innovative energy storage. We will focus primarily on design strategies that consider the entire energy ecosystem from energy generation (MIT’s cogeneration plant, urban electric grids, and potential renewables) to energy distribution and transmission at the system and local levels, such as between building energy systems and vehicles. We will also examine the feasibility of harnessing energy stored in EVs that can be transmitted back to the grid for peak

shaving or load balancing purposes. This group will compute the system requirements for a small fleet of EVs and their respective charging infrastructure and design a charging network for the campus. One key focus area that will be incorporated into this design is the application of second life of EV batteries as part of this new energy storage ecosystem.

3. CityHome: Transformable Module

Team Leader: Dan Smithwick

The CityHome project focuses on developing customizable urban housing that addresses the changing live/work patterns in today's cities. Changing Places has developed a chassis/infill system that allows for the standardization of key modular components (HVAC, structure, electrical wiring, plumbing, etc.) for the chassis and the personalization of infill components (walls, cabinetry, furniture, windows, etc.) to create a highly customizable kit-of-parts module for urban housing. This term we will focus on the design of one housing module that can be integrated into a larger overall building design. This "transformable" module will have the square footage of a single bedroom apartment, but can be reconfigured into dozens of designs including: one-bedroom with a guest suite, a workout area and studio, home office for a start-up, dining for a party of 20, etc. The CityHome should be designed so that users can easily and quickly transform the unit by simply manipulating and actuating walls and furniture. Online configuration tools can be created for potential new occupants of the CityHome so that they can design and personalize their units electronically.

4. CityHome: CityCar Dispenser, Urban Farming, and Robotic Facades

Team Leaders: Jenny Broutin, Shaun Salzberg

A complete CityHome on an urban site will require the integration of transformable housing modules into a building configuration that considers light access, vertical and horizontal circulation, heating/cooling, and urban integration into a selected site. In addition to live/work modules, it will be vital integrate urban mobility systems (like MoD) and their requirements for parking and electric charging into the CityHome. The integration of electric charging systems also open up the opportunity to examine the benefits of energy storage (perhaps from the second life use of EV batteries) which can lower the cost of renewable power in buildings. This team will focus on the design of the CityHome on a specific site on MIT's campus that will integrate a CityCar "Dispenser" that can storage, service, electrically recharge, and "dispense" vehicles to waiting users and visitors. This term we will develop additional features for the building including Urban Farming modules and Robotic facades that provide intelligent lighting as well as passive/heating and cooling systems.

5. Dynamic Incentives and Persuasive Interfaces for Sustainable Mode Shifts

Team Leaders: Virod Chiraphadhanakul, Karthik Dinakar, Brandon Martin-Anderson

Encouraging positive transportation mode shifts from gasoline powered private automobiles to electric vehicles, public transport, bicycling, or walking is a key area for achieving sustainable urban mobility. Government subsidies, policies, and taxes have traditionally been the mechanism for promoting these shifts. This term we will focus on how incentives can influence user behavior in order to make environmentally sound mode choices. We are particularly interested in how dynamic incentives (i.e., incentives that vary in value, time,

and location) can create modal shifts. We will also examine how dynamic incentives can be incorporated into the design of “Persuasive” user interfaces.

The case study this term for this group will be to develop meaningful dynamic incentives for one-way shared-use fleets – otherwise known as Mobility-on-Demand (MoD) systems. MoD systems allow users to travel point-to-point, by picking up vehicles at charging stations and allowing users to drop-off at any other charging station. Similar to bike sharing programs, MoD systems suffer from massive redistribution problems. Vehicles tend to accumulate at some stations and will be lacking at others (for example: Bicycles tend to cluster at the bottom of hills rather than at the top), thus necessitating expensive and environmentally unfriendly redistribution through trucks and/or employees simply moving vehicles back to empty stations. Currently all bike share operators spend over 40% of total operational costs towards redistribution. Solving this problem will break new ground in MoD systems that use more complex and costly vehicles like electric cars. This term we will focus on creating dynamic incentives and persuasive interfaces for MoD systems.

6. Redesigning the Streetscape Experience

Team Leader: Ryan Chin

The introduction of LEVs and electric charging infrastructure will undoubtedly change the urban streetscape. Cities are currently installing charging stations on city streets, parking lots and garages, but face many issues in integrating this new urban furniture including charging post placement, introduction of local transformers, etc. In response to the emergence of bike sharing programs, cities have introduced new bike lanes to encourage modal shifts. These new requirements also require cities to make hard decisions on resources; for example, new bike lanes require space that must be taken away from either parked cars or vehicle lanes. Charging posts also require space on the street and often require additional power equipment nearby. The increased use of charging points in the city will proliferate the number of dangling power cords. We will explore the potential benefits of inductive charging (wireless power transmission) for street charging which can eliminate this street clutter.

This team will focus on rethinking the urban streetscape by developing design propositions for small (S), medium (M), large (L), and extra large (XL) streets that integrate LEVs and their accompanying infrastructure. The team will design standards for S, M, L, XL streets that will determine vehicular and pedestrian access, vehicle station placement (bus stops, MoD charging points), lane markings, signaling, landscape integration, street dimensions, etc. This team will also develop design propositions for transforming a traditional street into an electrified street with urban vibrancy and amenities including outdoor cafes, front frontage for local businesses, and street vending.

Project Site

The entire MIT campus will be our site to begin the semester. We will select a number of specific sites, public space, streets, and intersections for each team (determined by the needs of each project problem). Each team will develop generalizable solutions using the MIT campus until the mid-review. We will then shift our focus to Boston's Innovation district (South Boston waterfront) for the remainder of the term and we will schedule an all-day charrette with the City of Boston (transportation and Redevelopment Authority). The all-day charrette will be scheduled outside of class time to allow for more interaction with the city officials, tour of the innovation district,

and brainstorming sessions. We will carefully coordinate with each team to avoid conflicts with other classes.

Boston Innovation District:
<http://www.innovationdistrict.org/>

Urban Ventures Course (MAS S63)

Parallel to the Living Labs course, the MIT Media Lab will be offering an complementary course called Urban Ventures taught by Joost Bensen and Kent Larson that will focus on founding, financing, and building entrepreneurial ventures with a mission of improving vital future cities. We encourage registration in both courses as there will be many shared resources including access to current Media Lab research, industry leaders and innovators, shared guest lectures (2-3pm on most class sessions), and field visits to implementation sites across Boston.

Class Structure

Students will work in small teams throughout the semester led by project liaisons from the Changing Places research group at the MIT Media Lab. In addition, each team will have one student leader who will be responsible for coordinating his/her team's design work with a team from the Urban Ventures course that is working on a parallel project.

Projects will run throughout the term with several joint Living Labs and Urban Ventures 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 Living Labs course. The course instructors will formulate teams based on student interest, background diversity, and skill sets.

Expected Student Deliverables

Students will collaborate in teams, 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 illustrations, building scale prototypes (working and non-working), back-of-the-envelope calculations, videos, and other types of media.

Requirements

All backgrounds are welcome to participate in the workshop. Both graduate and undergraduate students are encouraged to apply to the course. Backgrounds in Architecture, Computer Science, Electrical Engineering, Management, Material Science, Media Arts and Sciences, Mechanical Engineering, and Urban Planning are preferred.

Schedule

Mobility-on-Demand meets from 2-5:00pm, Room E14-525. (5th floor conf. room)
Urban Ventures meets from 1pm-3:00pm, Room E14-525 (5th floor lecture hall)
Joint Lectures: 2-3pm in the E14-525

A typical class session will have a presentation by current entrepreneurs, 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
1	9.07.11	<p>FIRST CLASS MEETING, 2PM Introductions and presentations by Changing Places Group Students will identify their top 3 interest areas</p> <p>Course Interviews on Thursday and Friday (September 8 & 9)</p>
2	9.14.11	<p>Teams are introduced and meet with team liaisons Assignment #1 in class assignment Review Assignment #1 Assignment #2 (distributed)</p>
3	9.21.11	<p>No Classes – Student Holiday</p> <p><i>Team leaders to meet with their groups on Assignment #2</i> <i>“Behind the Scenes” MIT Campus Tour (Joost Bonsen)</i> <i>MIT Cogen Plant Tour</i></p>
4	9.28.11	<p>Guest Lecture: Shared Vehicles in the City (Speakers TBC) Moshe Safdie Xavier Barrera (Vehicle Sharing) Robert Hampshire Robin Chase Nicole Freedman, Boston Bike Czar Zipcar representative</p> <p>Progress update on Assignment #2 Distribute Sponsor Week Poster specifications</p>
5	10.05.11	<p>Guest Lecture: Responsive Housing in New Cities (Speakers TBC) Ling Yi, AbodeZ Larry Sass, MIT Bill Haney, Blu Homes Air B&B Dennis Frenchman, MIT Guest from Bensonwood Jarmo Suominen Flatpak</p>
6	10.12.11	<p>Media Lab Sponsor Week Class Poster Session Invite Sponsor to speak as a guest (TBD) Sponsor Interaction (1-hour) Work time</p>
7	10.19.11	<p>Guest Lecture: Persuasive Interfaces and Apps (Speakers TBC) Stephen Intille iCarTel Nike Plus Sandy Pentland Ginger.io or Get daily Data</p>

		<p>Nexercise Everyfit.com Piano Stairs Ben Resner Copenhagen bike policy (contact) City of Boston rep. (mode shifts) – Incentives mechanisms</p>
8	10.26.11	<p>Guest Lecture: New Energy Systems in the City (Speakers TBC) Stephen Connors, MIT (Smart Grid) Witricity representative Schneider Electric Craig Carlson, Boston Power Don Sadoway, MIT</p> <p>Nigel Jacob, City of Boston, New Urban Mechanics</p> <p>Review Assignment #2</p>
9	11.02.11	<p>MIDTERM REVIEW (Critics TBC) Introduce City of Boston Charrette (Innovation District)</p> <p>Guest Critics: City of Boston (DOT, BRA, others) Dennis Frenchman Xavier Barrera, Mel King & Topper Carew Tim Rowe, Kendall Sq. Association Leland Cheung Bob Simha, MIT John DiFava, MIT</p> <p><i>All day site visit and Charrette in South Boston (Friday, Nov 4th)</i></p>
10	11.09.11	<p>William Lark, Jr. (From Pencil to Product: CityCar to Hiriko)</p> <p>Bill Mitchell Symposium on Thursday and Friday (Nov 10,11) by special invitation</p>
11	11.16.11	<p>Student Work Session Joint session with Urban Ventures Students</p>
12	11.23.11	<p>No official Class – Office Hours Available by Appointment (Thanksgiving Week)</p>
13	11.30.11	<p>Student Work Session</p>

14	12.07.11	Student Work Session
15	12.14.11	Last Day of Class Joint session with Urban Ventures Students
16	12.21.11	Final REVIEW Invited Critics: TBD