

Urban Systems Prototyping

Using LEGOs and Parametric Modeling to Design Systems for New Cities in China

A City Science 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)

First Class

The 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 Feb 6th at 2:00pm.

Class Description

The world is experiencing a period of extreme urbanization. In China alone, 300 million rural inhabitants will move to urban areas over the next 15 years. This will require building new infrastructure to accommodate the equivalent of the current population of the United States in a matter of a few decades. Cities 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 livability while dramatically reducing resource consumption. This workshop will explore new housing, mobility, energy, and food production systems for high-density cities. These systems should be resilient, scalable, adaptable, and reconfigurable.

This course will utilize, in parallel, physical (LEGOs) and virtual (3D parametric modeling) prototyping to design new urban systems in order to create 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.

The course will initially focus on the redesign of Kendall Square (and then shift to the Chinese Context) by building LEGO scale models and accompanying 3D models (Rhino) to not only represent existing environments, but also design propositions. The application of parametric modeling tools like Grasshopper will allow us to build a virtual 3D model with assigned variables that will allow us (the designer) to parametrically alter key characteristics, in order to 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.

Five Exploration Areas

This workshop will build upon the research of the Changing Places Research Group 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 Leader: Michael Lin, Sandra Richter

Students will explore the development of new, lightweight, modular, 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 as possible.

2. Resilient Energy Systems

Team Leader: Praveen Subramani, Lucy Lynn Zhao, Chen Chen

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 (CityHome)

Team Leaders: Tyrone Yang and Carlos Maria Olabarri Santos

The CityHome 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” between 225 and 450 square feet. We will explore how this strategy for creating personalized housing can accommodate advanced technologies related to energy, health, communication, et cetera.

4. Urban Food Production (Building-Integrated Aeroponics)

Team Leader: Jenny Broutin and Shaun Salzberg

By 2100, the world population is projected to grow from 7 to 10 billion. The Green Revolution that gave birth to industrial agriculture has not kept pace with the population rise: per capita production has fallen from its peak in the mid-1980's. This is largely due to the degradation of arable land through pollution or urbanization. Our current agricultural

system is not sustainable both due to yield and deleterious effects to the environment. This group will investigate technology-enabled aeroponic systems & interfaces, and their integration into urban apartments (for personal production) and rooftops (for industrial production).

5. Cityscapes for Compact Urban Cells

Team Leader: Ira Winder

This group will develop block strategies and mobility pathways for mixed-use spaces, including shared-office, housing, and facilities to support virtual companies and business incubation. The key modules that comprise this new block will include public spaces, small and large connecting streets, and variations of CityHomes including taller towers for high density living and low-rise buildings that define the streetscape. Students will consider light access, as well as vertical and horizontal circulation. This group should also seek to develop morphologies of street types and their associated vehicles and charging infrastructure.

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.

Requirements

All backgrounds are welcome to participate in the workshop. Both graduate and undergraduate students are encouraged to apply to the course. Experience in Architecture, Computer Science, Electrical Engineering, Management, Material Science, Media Arts and Sciences, Mechanical Engineering, and Urban Planning are preferred. Proficiency in LEGO building, 3D modeling in Rhino (or similar program) and Grasshopper is preferred, but not required to take the course.

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 Feb. 6th 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

<http://smarcities.media.mit.edu/download/urban-systems-prototyping.pdf>

Course Syllabus

<http://smarcities.media.mit.edu/download/mas552J-syllabus-spring2013-FINAL.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
1	2.6.13	FIRST CLASS MEETING, 1pm Introductions and presentations by Changing Places Group Students will identify their top 3 interest areas <i>Course Interviews on Friday (Feb 8) and Monday (Feb 11)</i> <i>Course admission Announcements (Sept. 12)</i>	Course Introduction (30 min.) Course overview (1 hour) Course logistics (30 min)
2	2.13.13	Team assignments and introductions In-class Brainstorming and review of results Hand out assignment # 1	Mobility (30 min.) Energy (30 min.)
3	2.20.13	<i>Review of assignment # 1</i> <i>Start Assignment #2</i>	CityHome (30 min.) Urban Farming (30 min.)

4	2.27.13	<i>Review of Assignment #2</i> Start Assignment #3	Streets (30 min.)
5	3.6.13	Review Assignment #3 Formation of Research Teams Research Team Assignment #1 In-class work session	Guest speaker (TBA)
6	3.13.13	Review Research Team progress In-class work session	Guest speaker (TBA)
7	3.20.13	<i>Mid-Review with invited Guests</i>	
8	3.27.13	Spring Break	
9	4.3.13	Introduce End-of-term project Student Work Session	
10	4.10.13	Student Work Session	
11	4.17.13	Interim Review Student Work Session	
12	4.24.13	Media Lab Members Week Poster Sessions for Industrial Members	
13	5.1.13	Student Work Session	
14	5.8.13	Student Work Session	
15	5.15.13	Last Day of Class	
16	5.22.13	Final REVIEW Invited Critics: To be confirmed Joi Ito Hiroshi Ishii Dennis Frenchman Xavier Barrera Mel King Jim Aloisi Ralph Gakenheimer Nigel Jacob Chris Osgood Stephen Connors Chris Zegras	

