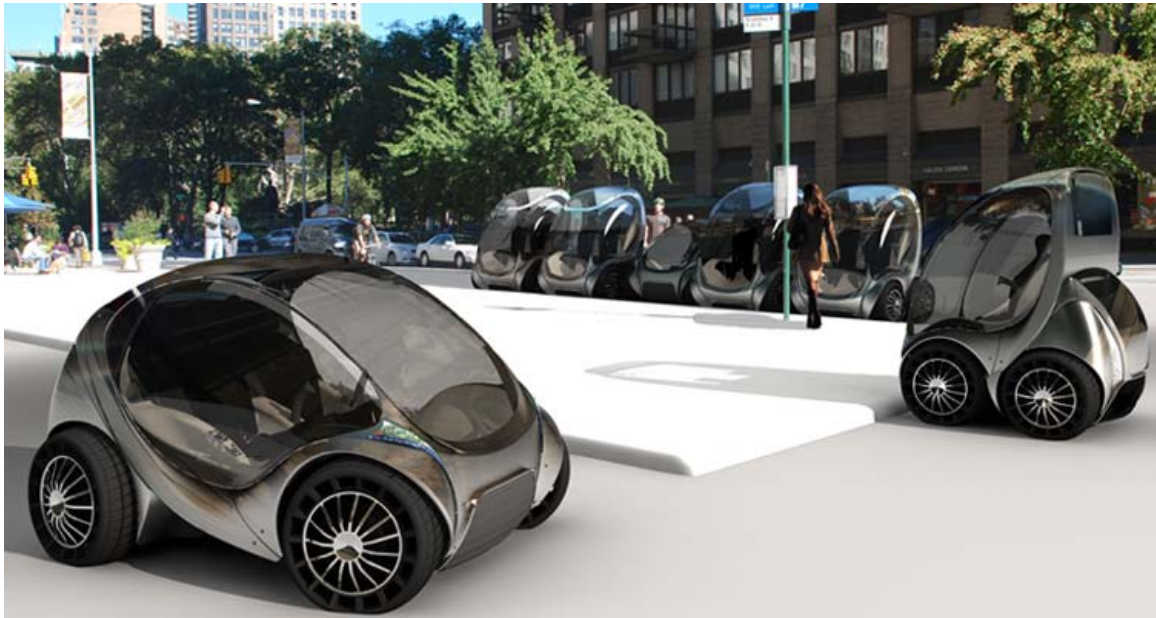


Smart Cities Group

Overview of Capabilities

Smart Cities Capabilities

The Smart Cities group of the MIT Media Lab has been focused on the problems of sustainable urban mobility since 2003. Our group has developed the concept called "Mobility on Demand" (MoD) which consists of a fleet of lightweight electric vehicles that are distributed at recharging stations strategically placed throughout a metropolitan area. Users of the MoD system are allowed the flexibility and convenience of picking-up and dropping-off of vehicles from any station (i.e., one-way rental). MoD systems solve the "first and last mile" problem of public transit systems because they enable users to link between their home and workplace via transit hubs which are often beyond walking distance. When properly implemented, MoD systems will dramatically reduce private gasoline-powered automobile use and increase use of more energy efficient transit systems, thus reducing overall carbon emissions and congestion in cities. MoD systems can also serve as supplemental energy storage or balancing capability for the electric grid by utilizing vehicle-to-grid technologies. The energy storage capability of a MoD fleet can provide peak shaving capability for local utilities and also lower the barrier for renewable but intermittent distributed power systems, such as wind and solar power.



Mobility on Demand (MoD) Charging station with lightweight electric vehicles

The Smart cities group has developed three different folding electric vehicles for MoD, including a 4-wheeler (CityCar), scooter (RoboScooter), and bicycle (GreenWheel). Each vehicle provides different carrying capacity and enclosure thus creating a mobility ecosystem that allows users to select the appropriate vehicle for each trip.

The Smart Cities group has expertise in the following areas that are crucial to implementing MoD.

1. **Urban Design and Transportation Planning** – Smart Cities’ core expertise is the in development of urban systems. The concept of MoD was developed through direct collaborations with cities of all types, including: Boston, Paris, San Francisco, Lisbon, Florence, Taipei, Singapore, Shanghai, and others. Working with government officials, city planners, transportation planners, mass transit operators, Smart Cities has created a methodology for analyzing the feasibility of MoD which includes an understanding of traffic patterns, origin-destination matrixes, commercial/residential zoning, mass-transit networks, city topography, and energy generation and transmission points. We are able to determine the critical features of an MoD system, including total fleet size, charging station location and sizing, and total number of stations for each phase of implementation. We have also closely examined existing bike- and car-sharing programs (one and two-way rentals) to glean knowledge on their urban implementation and management policies. We are currently building working relationships with a select few operators (Vélib and Zipcar). Our group has built expertise in urban and transportation planning with a particular focus on sustainable mobility, so that we are now able to develop an urban MoD implementation plan for any city or region.



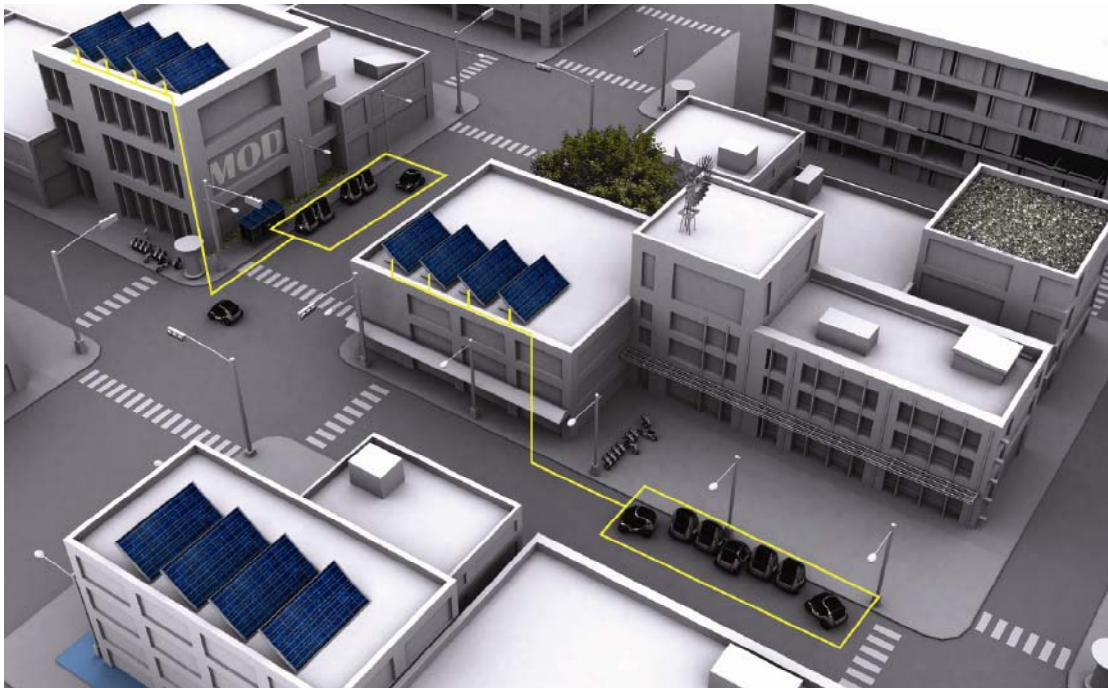
Electric Charging network for the City of Boston

2. **Vehicle Design** – Smart Cities has designed and built lightweight electric vehicles specifically tailored for MoD systems, working closely with a variety of industrial automotive partners. The vehicles are built upon a revolutionary new technology called "Wheel Robots" which incorporate the drive- and steering-motors, the suspension, and the braking inside the hub space of each wheel. This modular technology enables a high degree of maneuverability (zero turn radius and sideways parallel parking), and since there is no traditional engine, the vehicles can fold to save space for parking. All the vehicles utilize the latest in Lithium-Ion nanophosphate battery technologies, which have excellent power density and rapid recharge capability (less than 15 minutes), thus enabling a high rate of vehicle use – a crucial aspect in shared-use vehicle systems. Smart Cities has worked towards industrializing all three electric vehicles through collaborations with companies such as General Motors (USA) and Sanyang Motors (Taiwan). The RoboScooter already exists in prototype, and the GreenWheel bicycle will be commercially available in a folding version at the end of spring 2010. We are currently completing the engineering development of the CityCar and working to expedite the process towards manufacturing it. Smart Cities has built through this project expertise in automotive packaging, electrical engineering, control systems, and mechanical design.



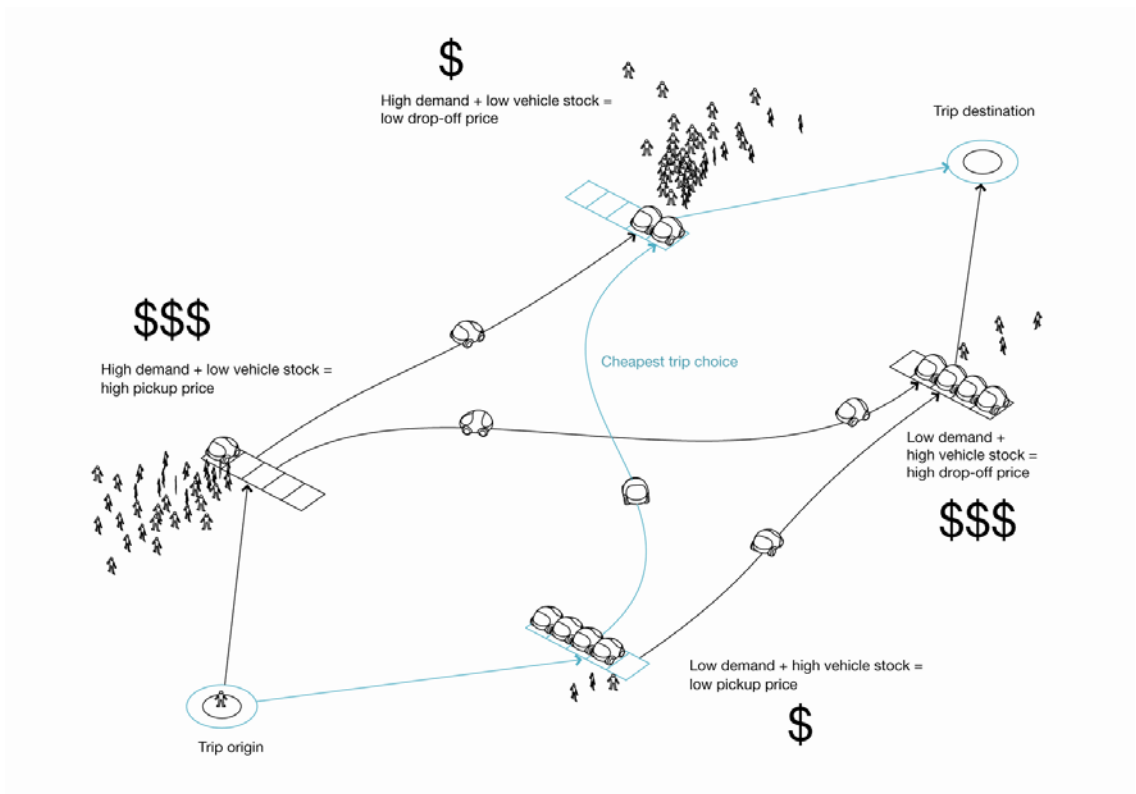
CityCars in Singapore

3. **Energy Systems** – Smart Cities has developed expertise in the design of charging infrastructure for MoD systems. Working with industrial sponsors, we are designing safe and contactless charging systems for on-street charging stations. The team is also developing systems at the vehicle fleet level that help enable Smart Grid technologies such as smart metering, peak shaving, and energy storage. The development of smart charging technologies and systems permit a charging rate that is responsive to demand levels. For example, when user demand is high, rapid charging will provide greater availability of vehicles, while a lower demand level will trigger the slower charging of vehicles. These systems will incorporate varying pricing schemes, providing a signal to users of relative demand—a system which has proved to reduce excessive energy use.



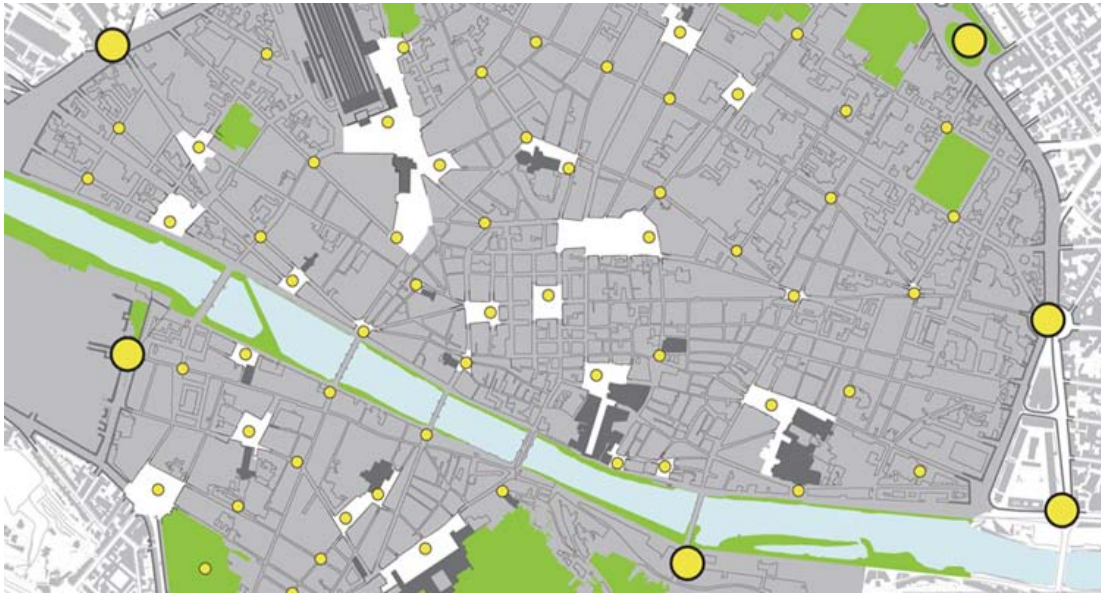
Mobility-on-Demand Network integrated with smart charging and renewable power generation

4. **Fleet Management** – The group has developed novel fleet management technologies and strategies to manage efficiently large fleets of vehicles in one-way shared use schemes. Smart Cities has been working on the problem of vehicle fleet redistribution (i.e., moving vehicles from low demand areas to high demand areas) through the study of system dynamics and agent-based modeling. Our expertise in simulating these systems had aided in the creation of a dynamic pricing policies, which creates the proper incentives for achieving system balance. The ability to shift the task of vehicle redistribution to the users through dynamic pricing minimizes the inefficiencies and costs of traditional redistribution (a large staff of employees moving vehicles from full to empty stations). The effective use of dynamic pricing will provide high levels of service (i.e., the ability to find a vehicle or parking space within a reasonable amount of time), thus allowing easy adoption of the system and maintaining the customer base. Our fleet management draws on our expertise in system dynamics, computer science, programming, and simulation testing.



Utilization of dynamic pricing for vehicle fleet redistribution

5. **Public Policy** – Working with candidate cities has allowed Smart Cities the ability to have direct dialogues with city leaders, transportation officials, and community leaders. We have been able to understand both the political and business challenges of implementing MoD, and the need to work jointly with leaders to create policies to promote the use of lightweight electric vehicles. We have continued to promote policies such as: dynamic road pricing, congesting pricing, increased mass transit funding, open standards for electric charging, and the creation of new vehicle classes which can enable more energy efficient mobility. We have set up a series workshops since 2003 to draw in participation from cities (including the New Century Cities initiative) in order to gain consensus, share knowledge, and promote MoD.



Mobility-on-Demand Network in the City of Florence Italy

For more information on Mobility-on-Demand systems and the work of the Smart Cities group please visit: <http://cities.media.mit.edu>

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