MIT Industry Brief

MIT and the Building/Construction Industries

MIT's Industrial Liaison Program (ILP) can bring the intellectual power of MIT to your organization by providing a direct connection to the knowledge, experience and resources at MIT in these fields – giving you the ideas to stay ahead. For more information about how the ILP can put the resources of MIT to work for you, call us at 1-617-253-2691, e-mail us at liaison@ilp.mit.edu, or visit http://ilp-www.mit.edu.

The Massachusetts Institute of Technology (MIT) is a leading center of research and education on topics important to the building/construction and related industries such as:

- *Building, infrastructure*
- *Materials, energy*
- *Architecture, design*
- *Smart technologies, sensor systems*
- *Housing, urban development/planning, real estate*

Following are brief descriptions of a selection of MIT centers, departments, groups, and labs conducting research and education in these areas. Please note that this is not a comprehensive summary of research being conducted at MIT in the topic areas listed above.

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BUILDING, INFRASTRUCTURE

The ***Building Technology Program*** is an interdepartmental program that brings together the faculty and students from the Departments of Architecture, Civil and Environmental Engineering, and Mechanical Engineering. The program is research based and provides a focus for graduate students interested in the development and application of advanced technology for buildings of all types. Areas of focus include building structures, materials, industrialized building systems, energy and lighting in buildings, air quality control, and building simulation. Subjects include fundamentals of technology, applications to buildings, design studios, laboratories, and independent research projects. Research projects fall under these broad topics: Building ventilation and diagnostics; building energy studies; building materials and construction; daylighting; structures; and international studies.

The ***Infrastructure Science and Technology Group*** (IST Group) aims to contribute to the science and engineering knowledgebase for the advancement of understanding, assessment, and effective renewal of civil infrastructure systems. Through fundamental and applied research, and education, the IST Group works to develop new scientific and engineering knowledge in the following key areas: Deterioration science, examining the conditions and processes by which materials and structures breakdown overtime; Assessment technologies, allowing assessment of the existing mechanical condition of materials and structures; and Renewal engineering which aims at the extension of the life of physical infrastructure systems and components, and at the enhancement of load capacities of these systems to meet the increased demands imposed on them.

The ***MIT Mass Customization Interest Group*** is an MIT-Industry collaboration devoted to improving the ability of companies to efficiently customize products and services in various industries and for diverse customer groups. This industry interest group aggregates the key players in the

area of mass customization and strives to become a vital community of practice in this field. The group is hosted by the MIT Design Lab, an interdisciplinary center at MIT bridging design, architecture, engineering, and management research.

The ***Department of Civil & Environmental Engineering*** (CEE) endeavors to provide human services in a sustainable way, balancing society's need for long-term infrastructure with environmental health. In research, the department seeks to understand natural systems, to foster the intelligent use of resources and to design sustainable infrastructures. CEE is focused on technological innovations, seeking advances in basic knowledge and taking a systems perspective. Efforts are concentrated on quantitative and analytical approaches, novel experiment-based modeling, and the development and/or use of appropriate tools and technology. CEE's research and graduate education programs coalesce around three fields of inquiry: environmental science and engineering; mechanics, materials and structures; and transportation.

MATERIALS, ENERGY

The ***MIT Daylighting Lab*** focuses on increasing how much natural light can be used in buildings, so as to decrease energy consumption for lighting, heating and cooling, improve comfort and well-being, generate aesthetical value, and provide a connection to the outside. Current projects aim at providing more support for design, open up technological innovations, refine daylighting metrics, and overall, bring more daylighting inside in a better way.

The ***Materials Processing Center*** (MPC) researchers cover the full range of advanced materials, processes, and technologies including: electronic materials; batteries and fuel cells; polymers; advanced ceramics; materials joining; composites of all types; photonics; electrochemical processing; traditional metallurgy; environmental degradation; materials modeling; materials systems analysis; nanostructured materials; magnetic materials and processes; biomaterials; and materials economics. The center recently added new research thrusts in materials for infrastructure and materials for energy applications.

Civil and Environmental Engineering Dept.: Mechanics of Materials and Structures research centers on the development of new materials; the nondestructive evaluation of structures; the repair and retrofit of structures using advanced plastic composites; and the synthesis and evaluation of innovative designs. Projects dealing with the mechanics of materials focus on high-performance concrete (fiber-reinforced and silica fume composites), advanced plastic composites, intelligent construction materials, manipulation of materials at the nanoscale and the atomistic modeling of proteins and other natural materials. Structures research includes projects on computer-aided structural engineering, intelligent structural engineering system and innovative concepts in high performance structures. Research in nondestructive evaluation focuses on infrastructural systems, including concrete and steel structures and soils.

Mechanical Engineering Department Research in Energy Science and Engineering focuses on technologies for efficient energy conversion and utilization, which aim to meet the urgent challenge of a safe, sustainable energy supply. Energy research activities are focused on new and existing technologies at the systems and scientific levels. Research spans the following technical areas: automotive power plants and ocean propulsion systems; fossil fuel combustion; wind power; solar energy; electrochemical energy storage; thermoelectric technologies; fuel cells; hydrogen production and storage; refrigeration; thermohydraulics of power systems; energy efficiency in a wide range of systems; ocean energy; certain aspects of nuclear energy; hybrid engines; thermal management of electronics; and energy efficient buildings.

ARCHITECTURE, DESIGN

MIT House_n is a Department of Architecture research group that explores how new technologies, materials, and strategies for design can make possible dynamic, evolving places that respond to the complexities of life. Major House_n initiatives include The PlaceLab and the Open Source Building Alliance. House_n research is focused on how the design of the home and its related technologies, products, and services should evolve to better meet the opportunities and challenges of the future. MIT researchers are investigating methods for merging new technologies with person-centered design and are generating new ideas, technologies, and methodologies that support the creation of innovative products and services. This broad research approach is leading to innovative product ideas that are unlikely to be uncovered in more narrowly-focused industries or research endeavors. To facilitate these studies, a unique "living laboratory" residential home research facility called the PlaceLab has been constructed near MIT.

The ***OPEN Prototype Initiative*** has been formed to develop a series of prototypical homes that test a new model for the design and fabrication of highly responsive places of living. It brings together advanced academic research and prototyping with sophisticated commercial design and production processes. This initiative will allow industrial partners to collaborate in the prototyping and deployment of new home-related materials, systems, and devices.

The goal of the ***Open Source Building Alliance*** (OSBA) is to develop key components of a more responsive model for creating places of living where: (1) Developers become integrators and alliance builders to offer tailored solutions to individuals, (2) Architects design design-engines to efficiently create thousands of unique environments, (3) Manufacturers agree on interface standards and become tier-one suppliers of components, (4) Builders become installers and assemblers, and (5) Customers (home buyers) become "designers" at the center of the process by receiving personalized information about design, products, and services at the point of decision.

The ***MIT Design Laboratory,*** a multidisciplinary laboratory within the School of Architecture and Planning, focuses on the theories, techniques, and practices of innovative design. It pursues research, executes practical design and art projects, and engages in scholarship and criticism. It is organized as a collection of multidisciplinary research and project teams, and it is not constrained by the traditional boundaries among design, planning and engineering professions and disciplines. The Laboratory is particularly interested in the emerging possibilities of new information technologies, new material, fabrication, and construction technologies, new ways of providing functionality at micro- and nano-scales, new techniques for engineering biological materials and structures, and new planning and management strategies. It is concerned not only with the design of individual products, buildings, and urban areas, but also with the roles that these elements play in larger urban, regional, and global systems and their long-term sustainability. It is committed to the highest standards of design quality, and it pursues its projects within a context of vigorous debate about related issues of values, ethics, and social justice.

The ***Digital Design and Fabrication Group*** is a center for education and research in areas of rapid prototyping and CAD/CAM operations for architects and designers. The group engages faculty and students in research focused on the relationship between design computing and the physical output of information using rapid prototyping and CAD/CAM machines for design representation and reflection.

The ***Department of Architecture*** is composed of the following five interacting discipline groups: Architectural Design; Building Technology; Computation; History, Theory and Criticism of Architecture and Art (HTC); and Visual Arts. Depth is provided in technical areas such as computation, new modes of design and production, materials, structure and energy, as well as in the arts, humanities and social studies.

The ***Aga Khan Program for Islamic Architecture*** (AKPIA) at MIT is dedicated to the study of Islamic architecture, urbanism, visual culture and conservation, in an effort to respond to the cultural and educational needs of a diverse constituency drawn from all over the world. The aim of the program is to concentrate its teaching and research activities in the following directions: To enhance the understanding of Islamic architecture and urbanism in light of critical, theoretical and developmental issues; to support research at the forefront of the field in areas of history, theory and criticism of architecture and urbanism; to explore approaches to architecture that respond critically and thoughtfully to contemporary conditions, aspirations, and beliefs in the Islamic world; to provide an extensive base of information about architecture in the Islamic world and to share it with scholars, teachers, and practitioners from everywhere.

SMART TECHNOLOGIES, SENSOR SYSTEMS

The ***PlaceLab*** is a joint MIT and TIAX, LLC initiative. It is a residential condominium in Cambridge, Massachusetts, designed to be a highly flexible and multi-disciplinary observational research facility for the scientific study of people and their interaction patterns with new technologies and home environments. Hundreds of sensing components are installed in nearly every part of the home (one-bedroom condominium). These sensors are being used to develop innovative user interface applications that help people easily control their environment, save resources, remain mentally and physically active, and stay healthy. The sensors are also being used to monitor activity in the environment so that researchers can carefully study how people react to new devices, systems, and architectural design strategies in the complex context of the home.

The research of the ***Smart Cities*** group in the MIT Media Lab focuses on intelligent, sustainable buildings, mobility systems, and cities. It explores the application of new technologies to enabling urban energy efficiency and sustainability, enhanced opportunity and equity, and cultural creativity. The group is particularly concerned with the emerging roles of networked intelligence in fabrication and construction, urban mobility, building design and intelligently responsive operation, and public space. Examples of the Smart Cities' concept car research include the city car, zero car, and athlete car projects.

The ***SENSEable City Laboratory*** research focuses on studying and predicting how digital technology is changing the way we describe, design, and occupy cities. Interconnected computational elements are increasingly saturating the built

environment (whether small-scale mobile devices, or larger-scale infrastructural microprocessors). This new condition allows us to design technology that could function as an interface between people and the city. Projects carried out at the lab are intended to help us learn how the cities are used and thus make better use of their resources and improve their design. The Lab's researchers come from various disciplines such as physics, architecture, urban planning, the arts, electrical engineering, and computer science. This allows performing technological development with an emphasis on behavior as well as functionality and form, and evaluating design in terms of both emotion and use.

The ***Center for Environmental Sensing and Modeling*** (CENSAM) strives to provide proof of concepts in the paradigm of pervasive monitoring, modeling and control within the highly developed and carefully managed urban environment of Singapore. The long-term goal is to develop a representation of the natural and built environment that will seamlessly transition from micro-scale processes (level of individual constructed facilities, 1-10km), to the meso-scale of the city-state of Singapore (10-100km) and the macrosystem of the coupled biosphere-atmosphere-ocean (regional scale, 100-1000km). Multiple resolution environmental models will assimilate remote sensing data from satellite and airborne platforms with ground observations from diverse sensor networks and mobile sub-marine AUV sensor platforms. Research areas include the built and natural environment; urban hydrology and water resources; coastal environment; marine and underwater sensing; and integrated environmental models.

Research in the ***MIT AgeLab*** is conducted by a multi-disciplinary and global team of researchers, business partners, universities, and the aging community working to design, develop, and deploy innovations to improve quality of life. The AgeLab's work is "use-inspired basic research." It aims to be profoundly practical in everyday living -- transportation, health, communications, business, work and retirement, planning and decision making, play and recreation, and caregiving, while seeking to advance basic understanding of how aging impacts and is impacted by social, economic and technological systems. Field research, theoretical models, and laboratory experiments focus on project areas such as: driving and personal mobility; National Older Driver Safety Advisory Council; wellness and self-empowered health; independent living and caregiving; business strategy and policy innovation; and retirement and longevity planning.

HOUSING, URBAN DEVELOPMENT/PLANNING, REAL ESTATE

The ***Department of Urban Studies and Planning*** (DUSP), within the School of Architecture and Planning, is comprised of four specialization areas (also referred to as Program Groups): City Design and Development; Environmental Policy and Planning; Housing, Community and Economic Development; and the International Development Group. There are also three cross-cutting areas of study: Transportation Planning and Policy, Urban Information Systems (UIS), and Regional Planning. Now totaling close to 60 teaching faculty members, it has the largest planning faculty in the United States. The department is organized around the following core questions of engagement and progressive change: "Can we make a difference in the world? Can we design better cities? Can we help places grow more sustainably? Can we help communities thrive? Can we help advance equitable world development?"

Urban Information Systems is a cross-cutting group in MIT's Department of Urban Studies and Planning (DUSP). Research and reaching focuses on the use of information technologies to understand the relationships underlying urban spatial structure and on the use of technology to facilitate broader and deeper participation in the planning of urban futures. Participating faculty come from DUSP's four program groups with particular interests in applying computing technology. Faculty and student interests go beyond specific computing technologies or techniques in order to understand the ripple effects of computing, communications, and digital spatial information on urban and regional planning processes and on the methods for shaping and nurturing metropolitan areas.

The ***Center for Real Estate*** (CRE) aims to improve the quality of the built environment through education programs that increase the skills, knowledge, and creativity of those in the real estate industry; through research which creates useful knowledge about real estate and leads to more informed professional practice; and through facilitating communication among members of the real estate community worldwide. CRE's education programs include a one-year Master's degree in real estate development, investment, and management; a summer institute of short professional development courses; and special seminars for industry and academic participants. Research covers a broad range of topics including real estate performance and financial returns, real estate capital markets, and globalization; issues in the management of corporate real estate; and property markets. The center also serves as a forum for the real estate industry.

The ***MIT Urbanization Laboratory*** (UrbLab) provides a structure for exploring design and development issues posed by the kind of rapid urbanization now being seen in China and India and for inventing new models of city form and function to accommodate such breakneck growth without sacrificing livability. The Lab works to apply new tools of technology for revealing patterns of growth, for simulating other options and for designing more rapidly, and to encourage high standards of urban livability through policy, finance and design mechanisms. The UrbLab also seeks to expand the range of real estate products offered in the marketplace – including, for example, housing that is affordable to a broader range of the population – and to develop models for a more sustainable architecture and lower-impact development less dependent on the car.

The ***Project for Reclamation Excellence*** (P-REX) is a project undertaken at the Department of Urban Studies and Planning. P-REX partners with like-minded groups to implement its interdisciplinary research and consultation. Partner institutions include, municipalities, state and federal agencies, universities, foundations, and corporations involved in the planning and design of the natural and built environment. The project focuses on the concept of "Systemic Design," which implies that there are larger scale forces in the built and natural environment that, if properly understood, will lead to more intelligent project scenarios as opposed to superficial cosmetics. Systemic Design merges the existing stresses on a landscape with multi-layered, time-based strategies that work to reclaim value and increase sustainability in the built environment. Systemic Design seeks to interact with the environmental, economical, and programmatic stresses across regional territories.

MIT @ Lawrence is an example of sustained civic engagement between faculty, students, and staff of MIT and civic leaders, residents, and community-based organizations in Lawrence, Massachusetts. MIT@Lawrence advances the idea of equity by supporting locally-led collective asset-building projects and research in three functional domains: Affordable Rental and Homeownership Housing Production; Asset-Building as an Economic and Community Development Strategy; and Youth Pathways to Education, Careers, and Community. Projects have included: Strategic Plan for the Development of Affordable Housing, and Holistic Revitalization in Small Industrial Cities: Ideas and Tools for Urban Housing Development.

The ***Special Interest Group in Urban Settlement*** (SIGUS) links housing and community interests in the Department of Architecture and Department of Urban Studies, focusing on developing areas worldwide. SIGUS explores the new professionalism emerging for architects and planners, and concentrates on service, participation and non-traditional client groups. SIGUS offers workshops and short courses, and carry out research and outreach programs stressing participatory methods in promoting affordable and equitable housing. Research is focused in four areas: Design and planning; dissemination of information; sustainability; and the role of the professional.

The ***Center for Transportation & Logistics*** (CTL) is part of the Engineering Systems Division in the School of Engineering. The center is widely recognized as an international leader in the field of transportation and logistics. Along with basic contributions to the understanding of transportation system planning, operations and management, its efforts include significant contributions to logistics modeling and supply chain management for shippers; to technology and policy analysis for government; and to management, planning and operations for trucking, railroad, air and ocean carriers.

The mission of the Massachusetts Institute of Technology is to advance knowledge and educate students and others in science, technology, and additional areas of scholarship. MIT is committed to generating, disseminating and preserving knowledge and to working to bring this knowledge to bear on the world's great challenges. As part of its mission, MIT maintains relationships with industrial organizations that enable the exchange of ideas in the context of real-world problems and demonstrate how principles studied at MIT are applied to generate practical benefits for industry and society. MIT's Industrial Liaison Program helps develop these relationships by facilitating industry's access to MIT and its vast resources.