MIT Industry Brief

MIT and the Supply Chain Logistics/Transportation 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 companies and organizations interested in supply chain and logistics issues, as well as the transportation industries such as:

- *Transportation systems and Logistics*
- *Supply Chain Management and Logistics*
- *Computing, Communications, and Networking*
- *Management and Information Technology*
- *Computation, Analysis, Modeling*
- *Environmental Impact, Sustainability*

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 conducted at MIT in the topic areas listed above.

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TRANSPORTATION SYSTEMS AND LOGISTICS

Transportation @ MIT is a coordinated effort to address one of civilization's most pressing challenges: the environmental impact of the world's ever-increasing demand for transportation. Building on MIT's rich tradition of engineering research and interdisciplinary collaboration, the initiative knits together the wide-ranging, robust research already under way at the Institute and creates new opportunities for education and innovation. The initiative will start as a two-year pilot program with initial support from its three participating schools. Plans are under way for the development of two labs, one in Cambridge and one outside the United States, where researchers can apply and test new processes, technologies and policies.

Research in the ***MIT AgeLab*** is conducted by a multi-disciplinary and global team of researchers, business partners, universities, and the aging community toward designing, developing, and deploying innovations that 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.

The ***Center for Ocean Engineering*** has significant research efforts in fluid mechanics and hydrodynamics, acoustics, offshore mechanics, marine robotics and sensors, and ocean sensing and forecasting. In addition, the Naval Construction program provides advanced graduate education on the design of naval ships and vehicles. The faculty, staff, and affiliates of the Center for Ocean Engineering do cutting-edge research in nine laboratories. Center faculty and staff address a number of ocean-related activities, including: observation and exploration of the ocean; naval construction and engineering; ocean resource development; shipping and transportation; ocean energy; ocean acoustics; the role of the ocean in the global environment and in climate change; oceanographic engineering; marine robotics; and biomimetics. There is also a teaching lab where students get hands-on experience in ocean engineering research and design.

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 ***Cooperative Mobility Program*** (CMP) brings together transportation scholars from MIT and other universities with transportation specialists and sponsors to explore current and future issues of worldwide mobility. CMP supports a vision of a sustainable, multi-modal transportation system that will provide the mobility necessary to foster global economic development while remaining compatible with social needs and environmental protection. CMP is grounded in empirical research on travel behavior, technological approaches, and public policies that affect mobility in both developed and developing countries, and compiles an annual Mobility Observatory that tracks innovative developments in transportation policy, management, and technology. Research projects include forecasts of worldwide demand for mobility; implications of transportation trends for controlling greenhouse gas emissions; trajectories of motorization in developing countries; public policies to control transportation-related regional air quality; impacts of intelligent transportation systems on mobility; land use policies to control and shape transportation demand; and innovative public transit policies.

The ***Global Airline Industry Program*** is a multidisciplinary team of faculty, staff and graduate students drawn from the Schools of Engineering, Management, and Humanities and Social Sciences to study the global airline industry. The goal of the program is to develop a body of knowledge for understanding development, growth and competitive advantage in this industry, which is one of the most diverse, dynamic and perplexing of the world. The Program includes work addressing aspects of the economics, management and operations of air carriers. The scope also includes interactions with airline companies, aircraft and engine manufacturers, airports, air traffic control and regulatory or supervisory agencies such as the Federal Aviation Administration (FAA) and the International Civil Aviation Organization (ICAO).

The ***Intelligent Transportation Research Center*** (ITRC) focuses on the key Intelligent Transportation Systems (ITS) technologies, including an integrated network of transportation information, automatic crash & incident detection, notification and response, advanced crash avoidance technology, advanced transportation monitoring and management, etc., in order to improve the safety, security, efficiency, mobile access, and environment. There are two areas of emphasis for research conducted in the center: the integration of component technology research and system design research, and the integration of technical possibilities and social needs.

The ***Intelligent Transportation Systems*** (ITS) Program unites researchers from a variety of departments, centers, and laboratories -- including the Center for Transportation and Logistics, the departments of Civil and Environmental Engineering, Mechanical Engineering, Electrical Engineering & Computer Science, and the Sloan School of Management -- in conducting multi-disciplinary research on the applications of modern information technologies to transportation systems. Initial efforts have focused on the conceptual design of intelligent transportation systems and on the development of computer tools for design and evaluation of ITS services.

The ***International Center for Air Transportation*** (ICAT) is to improve the safety, efficiency and capacity of domestic and international air transportation and its infrastructure, utilizing information technology and human centered systems analysis. Global information systems are central to the future operation of international air transportation. Modern information technology systems of interest to ICAT include: global communication and positioning; international air traffic management; scheduling, dispatch and maintenance support; vehicle management; passenger information and communication; and real-time vehicle diagnostics. Areas of research include: Air Traffic Management; Air Transportation Infrastructure and Economics; Aviation Safety and Weather;

Airline Management and Operations; Human Factors; Flight Instrumentation; and Environmental Impact of Aviation. ICAT, and its predecessors, the Aeronautical Systems Laboratory and Flight Transportation Laboratory, pioneered concepts in air traffic management and flight deck automation and displays that are now in common use.

The ***International Motor Vehicle Program*** (IMVP) is the oldest and largest international research consortium aimed at understanding the challenges facing the global automotive industry. IMVP research focuses on management issues including production systems, technology, and sustainability issues. Sponsors, researchers, and IMVP management determine the research agenda collaboratively. Some of the main IMVP research topics include managing the extended enterprise; the web-enabled automotive; and visions of a sustainable future. Meanwhile, the program's core Assembly and Vehicle Engineering benchmarking surveys continue, joined by a third one focused on Innovation and Advanced Engineering.

The ***Operations Research Center*** (ORC) provides educational and research opportunities for students and faculty interested in this interdisciplinary field, which draws upon ideas from engineering, management, mathematics, and psychology to apply scientific methods to decision-making. The MIT ORC draws faculty from 8 different departments at MIT, including members from each school. ORC faculty contribute to a wide range of application domains such as flexible manufacturing systems; financial engineering services; air traffic control; transportation systems; public services, such as urban emergency systems; safety and risk analysis in air transportation; and more.

The ***Department of Civil & Environmental Engineering*** (CEE) Transportation group has provided leadership in the field of transportation research for many years by emphasizing an interdisciplinary systems approach incorporating engineering, urban planning, transport system management and public policy. This interdisciplinary approach is being applied to the concept of sustainable transportation to address the critical issues confronting the world. The scope of the group's research has broadened from a focus on the operation of existing systems to include consideration of the interactions of transportation infrastructure and operation, urban spatial structure and land use, economic growth, resource and energy use, and environmental impacts at various spatial and temporal scales. The group's goal is to contribute to the conceptualization and realization of a system in which people can readily move and effectively transport goods while facilitating economic growth and reducing environmental impacts to sustainable levels. Research encompasses the following areas: Emission standards; new technologies; transportation modes and regional planning; equity; and infrastructure renewal.

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?"

SUPPLY CHAIN MANAGEMENT AND LOGISTICS

The ***MIT Forum for Supply Chain Innovation*** (the Forum) provides a unique collaborative environment as the center of an expert community, harnessing the world-leading capabilities of MIT. Through its research, the Forum affects supply chain management and shapes its effect on business strategy. It is dedicated to delivering innovative solutions to supply chain issues and is able to provide each member with unique research, driving new ideas for excellence in supply chain design and implementation, together with technology-based solutions that make a difference. The Forum is a partner by helping its partners to understand, manage and implement innovation into their own supply chain. Research topics include: multi-agent systems for supply chain innovation; supply contracts; electronics supply chain; dynamic supply chain evolution; supply chain integration; optimizing buy/make decisions; inventory management and dynamic pricing; service supply chains; supply chain strategies; RFID and real-time data in adaptable supply chain management; and distributed interactive simulation.

The aim of the ***MIT Efficient Healthcare Delivery Group***--MEHD Group is to drive innovation in healthcare supply chain management. The mission of the MEHD Group is to envision the future of the healthcare system and create new knowledge, new technologies, and new business practices that will help improve healthcare delivery everywhere. The MEHD Group will drive research to: Identify the Dynamics of the Current Healthcare Supply Chain; Apply Scenario-Based Planning Methodologies to the Healthcare Supply Chain; and

Recommend and develop game-changing strategies, policies, and technologies.

The MIT ***Global SCALE Network*** is an international alliance of leading research centers dedicated to the development of supply chain and logistics excellence through innovation. The ***SCALE (Supply Chain and Logistics Excellence) Network*** spans North America, Latin America, and Europe, with plans to expand into Asia and Africa. The Network includes: MIT Center for Transportation & Logistics (MIT-CTL) in Cambridge, MA; the Zaragoza Logistics Center (ZLC) in Zaragoza, Spain; and the Center for Latin-American Logistics Innovation (CLI) in Bogota, Colombia. This unique Network will allow faculty, researchers, students and affiliated companies from all three centers to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

The MIT ***Space Logistics Project*** / Interplanetary Supply Chain Management & Logistics Architecture: Sustainable space exploration will require appropriate interplanetary supply-chain management. Unlike Apollo, where everything was carried along, future exploration will have to rely on a complex supply-chain network on the ground and in space. The primary goal of the Interplanetary Supply Chain Management and Logistics Architectures (IPSCM&LA) project is to develop a comprehensive SCM framework and planning tool for space logistics. The overall objective of this project is to develop an integrated capability for guiding the development of the interplanetary supply chain that will be required to enable sustainable space exploration of the Earth-Moon-Mars system and beyond.

Supply Chain Response to Disruption: After September 11, 2001, researchers at the MIT Center for Transportation and Logistics (CTL) conducted studies to understand how supply chains are impacted by disruptions such as terrorist attacks, natural disasters and logistics failures. The project resulted in rich content that has been published in a number of articles and books. The research group is working on various aspects of applying resilience to supply chains, to the maritime transportation system, and developing secure supply chains.

The ***Supply Chain 2020*** (SC2020) Project is a multiyear research effort to identify and analyze the factors that are critical to the success of future supply chains. This pioneering project will map out the process innovations that will underpin successful supply chains as far into the future as the year 2020. Initiated by the MIT-Zaragoza International Logistics Program, the global research project involves dozens of faculty, research staff, and students at MIT and institutions around the world. Two advisory councils, the Industry Advisory Council (IAC) and the European Advisory Council (EAC), made up of supply chain executives from leading companies, are playing a crucial role in helping to shape the work and generate new ideas. SC2020 research is broad and far-reaching, and aims to develop scenarios of the future that will help supply chain community explore different strategies and operating models to support the overall business strategy.

The ***MIT-Zaragoza International Logistics Program*** is a unique research and education partnership that brings together the supply chain interests of academia, industry and government -- all linked to the development of the largest and most up-to-date logistics park in Europe. The program was established in 2003 by the MIT Center for Transportation and Logistics (CTL), the University of Zaragoza, the government of Aragón, industry partners, and the PLAZA logistics park in Zaragoza, Spain. The partnership allows researchers from MIT and the Zaragoza Logistics Center (ZLC) to experiment with new logistics processes, concepts and technologies and to move research findings quickly into practice. To develop business leaders, MIT-Zaragoza offers graduate and executive education, in English, to students from around the world.

COMPUTING, COMMUNICATIONS AND NETWORKING

The ***Auto-ID Labs*** at MIT is dedicated to creating the "Internet of Things" using RFID and wireless sensor networks. The aim of the Auto-ID Labs from the start was to create a global system for tracking goods using a single numbering system called the Electronic Product Code. The Auto-ID Labs are the leading global network of academic research laboratories in the field of networked RFID. The labs comprise seven of the world's most renowned research universities located on four different continents.

The ***RFID Systems Integration Laboratory*** (part of the MIT Forum for Supply Chain Innovation) invites vendors, users and supporters of the Forum to contribute, participate and guide the set–up, experimentation and innovation at the RFID Lab. Users can suggest specific testing requirements for either software, hardware or assembled systems and can directly request that the Lab research and/or create innovative solutions and sponsor them accordingly. Vendors are able to work with the Lab and can refer clients to the Lab to experiment with new technology and are able to use the lab as a demo facility with accompanied visits with their customers. Individuals from vendor companies or users may take advantage of the fellow–in–residence option available through the MIT Forum for Supply Chain Innovation and send personnel to MIT to work on their specific project.

MIT's ***Center for Wireless Networking*** brings together and fosters interaction among an extraordinarily diverse collection of faculty, staff, and students on campus with interests and expertise in one or more aspects of wireless technology. Its members, who are affiliated with many different laboratories, departments, and schools at MIT, are focused on developing the radical algorithms, protocols, architectures, devices, circuits, and systems that will enable seamless, transparent, robust, ubiquitous, secure mobile connectivity and exciting new generations of applications.

The ***Laboratory for Information and Decision Systems*** (LIDS) is an interdepartmental research laboratory with a fundamental research goal of advancing the field of systems, communications and control. In doing this, it recognizes the interdependence of these fields and the fundamental role that computation plays in this research. LIDS conducts basic theoretical studies in communication and control and is committed to advancing the state of knowledge of technologically important areas such as atmospheric optical communications and multivariable robust control. The research activities of LIDS cover a wide range of theoretical and applied areas in learning, adaptation, and layered intelligent systems, communication science and systems, control theory, estimation and signal processing, algorithms, and perceptual systems and machine learning.

MANAGEMENT AND INFORMATION TECHNOLOGY

The MIT ***Center for Digital Business*** is focused on being the leading source of innovation, knowledge creation, dissemination and utilization, in management theory and practice for digital business. The Center has established a large-scale research program to investigate the latest trends and techniques in digital business and has worked with more than 50 corporate sponsors, funded more than 60 faculty and performed more than 75 research projects. The core of this program is the custom matching of sponsor companies with MIT faculty to form research teams that address issues that are relevant to both industry and academia. Four broad areas of focus are digital marketing, digital productivity, digital services, and digital health.

The ***Center for Information Systems Research*** (CISR) conducts field-based research on issues related to the management and use of information technology (IT) in complex organizations. Established at the MIT Sloan School of Management in 1974, CISR's mission is to develop concepts and frameworks to help executives address the IT-related challenges of leading increasingly dynamic, global, and information-intensive organizations. Research results are disseminated primarily through working papers, research briefings, an annual conference, and sponsor forums.

The MIT ***Center for Collective Intelligence*** (CCI) conducts research on how new communications technologies are changing they way people work together. This research effort draws on the strengths of many diverse organizations across the Institute including: the Sloan School of Management, Computer Science and Artificial Intelligence Laboratory, Media Laboratory, Brain and Cognitive Sciences Department, McGovern Institute for Brain Research, and Leadership Center. CCI's mission is to understand collective intelligence at a deep level in order to create and take advantage of the new possibilities it enables. Projects range from collective prediction (combining human and machine intelligence in new ways to make accurate predictions about future events) to collective intelligence in healthcare (harnessing the collective intelligence of medical professionals and researchers to provide better healthcare) to sensible organizations (using new sensors embedded in wearable "social badges" as a kind of "information microscope" to systematically analyze organizations).

The ***Industrial Performance Center*** (IPC) concentrates on field-based, often large-scale studies designed to help leaders in business, labor, government, and universities better understand global industrial developments and to work with them to develop practical new approaches for strengthening public policies, business strategies, technical practices, and educational programs. The center's interdisciplinary teams observe, analyze and report on strategic, technological, and organizational developments in a broad range of industries and examine the implications for society and the global economy. The IPC research program is organized around the following themes: energy innovation; globalization, jobs and skills; interpretive innovation; and global value chains.

The ***Leaders for Global Operations*** (LGO) program is a collaboration among MIT Sloan School of Management, MIT School of Engineering, and more than 20 industry partners. LGO program students receive two degrees in two years: either an MBA or a MS in Management degree from MIT Sloan School of Management, and a MS degree from one of eight participating departments in the School of Engineering. The program provides a solid background in critical areas of manufacturing, including manufacturing processes, design and development, operations management, information technology, teamwork, leadership, change management, and systems thinking. The LGO community develops, designs, implements, and participates in a forward-looking, integrative engineering and management program that gives its partners

the knowledge, tools, and support they need to strengthen, lead, and transform industry. (Until mid-2009, the LGO was known as the Leaders for Manufacturing (LFM) program.)

The ***Sloan School of Management*** is one of the world's leading business schools — conducting cutting-edge research and providing management education to top students from more than 60 countries. The mission of the MIT Sloan School of Management is to develop principled, innovative leaders who improve the world and to generate ideas that advance management practice. MIT Sloan offers undergraduate, master's, PhD, executive education and non-degree programs together with special seminars, conferences, and programs for alumni. The MIT Sloan faculty includes 93 full-time professors and 16 adjunct or visiting faculty; the student body consists of more than 1,100 graduates and undergraduates. MIT Sloan has 20,000 alumni, residing in 90 countries. More than 650 companies have been founded by MIT Sloan alumni.

COMPUTATION, ANALYSIS, MODELING

The ***Center for Computational Research in Economics and Management Science*** (CREMS) advances knowledge about modeling in economics, finance, statistics, and management, bringing together researchers from disciplines such as econometrics, statistics, computer science, and operations research to focus on the algorithmic research and related software development that provide a basis for today's advanced modeling techniques. Current research is focused on nonparametric modeling; robust statistics and data-mining; statistical learning; variable and feature selection; risk measurement and portfolio optimization in finance, data visualization, bioinformatics; and the analysis of health and drug surveillance data.

The ***Complex Systems Research Laboratory*** (CSRL) designs system modeling, analysis, and visualization theory and tools to assist in the design and operation of safer systems with greater capability. The lab applies a system's approach to engineering that includes building technical foundations and knowledge and integrating these with the organizational, political, and cultural aspects of system construction and operation. While CSRL's emphasis is aerospace systems and applications, its research results are applicable to complex systems in such domains as transportation, energy, and health. Research projects include design for safety; model-based system engineering; reusable, component-based system architectures; interactive visualization; human-centered system design; system diagnosis and fault tolerance; system sustainment; system engineering of software-intensive systems; and organizational factors in engineering and project management.

The ***Computation for Design and Optimization*** (CDO) is an interdepartmental Master of Science degree program that educates students in the formulation, analysis, implementation, and application of computational approaches to designing and operating engineered systems, emphasizing: breadth through introductory courses in numerical analysis and simulation, optimization, and applied probability; depth in optimization methods and numerical methods for partial differential equations; multidisciplinary aspects of computation; hands-on experience through projects, assignments, and a master's thesis.

ENVIRONMENTAL IMPACT, SUSTAINABILITY

The ***Carbon-Efficient Supply Chains*** initiative in the Center for Transportation and Logistics (CTL) address three challenges in developing carbon-efficient strategies for supply chains: 1) Measurement - How do you calculate the carbon footprint of a supply chain? Where do you start and stop? What do you include? 2) Strategy & Decision Making - What are the right strategies to reduce the energy and carbon emissions through out the supply chain? How do you prioritize technology investments based on your current footprint and supply chain strategy? 3) Labeling & Reporting - How do you communicate the carbon footprint to consumers and stakeholders? How do you communicate carbon information within the supply chain?

The ***Materials Systems Laboratory*** (MSL) studies the strategic implications of materials and materials processing choices. MSL research seeks to understand the competitive position of materials in specific applications, such as assessment of different candidate materials, assessment of process technologies, and evaluation of both the economic and non-economic consequences of each alternative. The lab also evaluates the promise and limits of materials, processes and designs; identifies specific areas of improvement for each alternative that will improve its competitiveness; and determines the "best case" scenario for each option. The MSL develops quantitative tools whenever possible to address direct manufacturing costs of each alternative and total lifecycle costs, and sustainability factors. The focus of the lab is on developing tools useful at an early stage of product design. MSL methodologies include technical cost modeling, lifecycle cost and emissions tracking, decision analysis techniques, systems dynamics modeling, and system cost modeling.

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.

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.