## MIT and Manufacturing Industries

Manufacturing, while undergoing tremendous change over the past decade, continues to be vitally important to both the developing and the developed world. The challenges and opportunities for the manufacturing sector continue to drive transformation and innovation toward a data-driven factory of the future. Emerging technologies in areas such as data analytics, 3D printing, sensors and the Internet of Things, and robotics will be necessary to drive global manufacturing competitiveness.

The Massachusetts Institute of Technology is perfectly poised to address the spectrum of these challenges, as it plays a leading role in education, research, and public service in many fields, fostering a problem-solving approach that encourages researchers to work together across departments, fields, and institutional boundaries. The resulting collaborations have included thousands of fruitful partnerships with industry and other leading research institutions.

In addition, entrepreneurship and innovation are at the heart of MIT’s *mens et manus* (mind and hand) practical education and have had significant impact in the world: A 2015 report suggested that 30,000 companies founded by MIT alumni were active as of 2014, employing 4.6 million people and producing annual revenues of $1.9 trillion.

Many MIT engagements in advanced manufacturing with industry and government are coordinated under the Office of the Provost and in partnership with the MIT Innovation Initiative. Examples of the deep expertise of MIT’s faculty and multidisciplinary education and research, which address current challenges in manufacturing include:

- **Dr. Neil Gershenfeld**, Director of the MIT Center for Bits & Atoms, is the originator of the growing global network of field fab labs that provide widespread access to prototype tools for personal fabrication, and directs the Fab Academy, the associated program for distributed research and education in the principles and practices of digital fabrication.
- **Julie Shah**, Professor of Aeronautics and Astronautics, has developed innovative methods for enabling fluid human-robot teamwork in time-critical, safety-critical domains, ranging from manufacturing to surgery to space exploration. Her work on industrial human-robot collaboration was recognized by MIT Technology Review as one of the 10 Breakthrough Technologies of 2013.
- **MIT’s Center for Bits and Atoms (CBA)** is a unique digital fabrication facility that gathers tools across disciplines and length scales for making and measuring things, including electron microscopes and focused ion beam probes for nanostructures, laser micromachining, and multi-axis machining and 3D printing for macrostructures.
• MIT, Carnegie Mellon, Georgia Tech, and the University of Pennsylvania are competing in 2016 for a $70M federal award for an Advanced Robotics Manufacturing (ARM) Institute, with the overall goal to lower the barriers for organizations to accelerate the deployment and integration of advanced robotics technologies in manufacturing.

• On the basis of the U.S. President’s Council of Advisors on Science and Technology (PCAST) “Report to the President on Ensuring American Leadership in Advanced Manufacturing” (2011), the Advanced Manufacturing Partnership (AMP) Steering Committee was established and co-chaired by MIT President Susan Hockfield and Dow Chemical CEO & President Andrew Liveris. MIT hosted the 2011 New England Regional AMP Meeting and produced analyses that established the AMP Office and the National Network for Manufacturing Innovation (NNMI). Following the success of this effort, AMP2.0, co-chaired by MIT President Rafael Reif and Dow CEO Andrew Liveris, was established (2013), providing deeper analysis into manufacturing technology areas of shared public-private priority, scale-up of new technologies and companies, education and workforce development, the function of the NNMI, and the image of manufacturing careers.

• Production in the Innovation Economy (PIE) was an MIT-led multiyear study, culminating in a 2013 conference, two books (Making in America: From Innovation to Market; Production in the Innovation Economy), and was the basis for the content and pace of the AMP1.0 and 2.0.

• MIT education and workforce training programs with industry partners include Masters of Engineering in Manufacturing; Leaders for Global Operations Dual Degree (MS/MBA); Consortium for Integrated Photonic Systems Manufacturing (CIPSM), led by MIT; Nanoengineered Composite Aerospace Structures Consortium (NCST), led by MIT.

• Vibrant student resources such as the ProtoWorks at the Martin Trust Center for MIT Entrepreneurship; MIT MakerWorks; Project Manus; and MakerLodge.

In the following pages, a selection of MIT centers, departments, groups, and labs are presented. These entities are actively involved with research and education related to manufacturing-relevant topics bulleted below.

- Additive manufacturing / digital fabrication / 3D printing
- Advanced manufacturing
- AI & machine learning
- Big data & analytics
- Control systems
- Data security
- Design / product design & development
- Digital economy
- Engineering and complex systems
- Innovation
- Internet of things
- Management
- Pharma
- Robotics
- Sensors / sensing
- Supply chains/logistics
- Sustainability

For close to 70 years, the Industrial Liaison Program (ILP) has provided expert navigation of MIT’s vast resources. MIT’s ILP can bring the intellectual power of MIT to you by connecting your organization to the expertise, talent, and technologies that can make a difference in your company. 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.mit.edu/.
ADDITIVE MANUFACTURING / DIGITAL FABRICATION / 3D PRINTING

The Center for Bits and Atoms (CBA) is an interdisciplinary initiative exploring the boundary between computer science and physical science. CBA studies how to turn data into things, and things into data. CBA’s projects involve collaborations with researchers from across MIT’s campus and around the world. CBA personnel have participated in advances at the boundary between bits and atoms, such as what were among the first complete quantum computations, using nuclear spins in molecules; physical one-way cryptographic functions, implemented by mesoscopic light scattering; intelligent infrastructure, for energy efficiency; coded folding, for programming matter; and the additive assembly of functional digital materials.

The Computational Fabrication Group at the MIT Computer Science and Artificial Intelligence Laboratory investigates problems in digital manufacturing and computer graphics. Areas of research include computational materials and digital fabrication, virtual humans and robotics, computational photography and displays.

The Design Fabrication Group explores the application of digital fabrication for building delivery. The group aims to discover effective methods to apply computation to the design and production of buildings directly from 3D CAD models and its systems make possible immediate manufacturing of structures as a kit of parts from a 3D model. The dfab group uses a variety manufacturing methods from additive to subtractive.

The Mediated Matter group creates biologically inspired and engineered design fabrication tools and technologies and structures. Its material ecology research area integrates computational form-finding strategies with biologically inspired fabrication, with the goal of enhancing the relation between natural and man-made environments by achieving high degrees of design customization and versatility, environmental performance integration and material efficiency. The group works to establish new forms of design and novel processes of material practice at the intersection of computer science, material engineering, design and ecology, with broad applications across multiple scales.

The Self-Assembly Lab’s cross-disciplinary research invents self-assembly and programmable material technologies aimed at reimagining construction, manufacturing, product assembly and performance. The group has demonstrated that this phenomenon is scale-independent and can be utilized for self-constructing and manufacturing systems at nearly every scale. They have also identified the key ingredients for self-assembly as a simple set of responsive building blocks, energy, and interactions that can be designed within nearly every material and machining process available.

ADVANCED MANUFACTURING

The Mechosynthesis Group aims to create new materials, machines, and design principles for advanced manufacturing. Much of our work seeks to discover and exploit micro- and nanoscale phenomena toward new and improved energy storage materials, electronic devices, composite structures, engineered surfaces, medical diagnostics, and consumer products. The group’s work is multidisciplinary, yet generally at a nexus of manufacturing, materials, and mechanical design.
National Network for Manufacturing Innovation (NNMI) Institutes at MIT: Designed to foster innovation and accelerate advanced manufacturing in the US, new public-private consortiums are working to create a sustainable manufacturing. The newest (2016) of these MIIs is the Advanced Functional Fibers of America (AFFOA) Institute, which includes a new vision for a distributed foundry for functional fabric production and for training the workforce of the future. MIT leads and coordinates the education and workforce training program of AIM Photonics, called the AIM Photonics Academy, developing online/hands-on tools for photonic device manufacturing integrated with industry partners. And in NextFlex, MIT is proposing “education factories” that integrate manufacturing training for flexible hybrid electronics with development of training skills and kits that inspire today’s young “makers” to make more.

AI & MACHINE LEARNING

The Computer Science and Artificial Intelligence Laboratory (CSAIL) researchers have been key movers in developments like time-sharing, massively parallel computers, public key encryption, the mass commercialization of robots, and much of the technology underlying the ARPANet, Internet and the World Wide Web. CSAIL’s many research groups are organized into three focus areas: artificial intelligence, systems, and theory. Research is conducted in almost all aspects of computer science, as well as exploring revolutionary new computational methods for advancing healthcare, manufacturing, energy and human productivity.

The Learning and Intelligent Systems Group’s interdisciplinary research is aimed at discovering the principles underlying the design of artificially intelligent robots, with the goal of creating robots that can perform the kinds of everyday tasks that come naturally to humans. The group’s research brings together ideas from motion and task planning, machine learning, reinforcement learning, and computer vision to synthesize robot systems that are capable of behaving intelligently across a wide range of problem domains.

The Multimodal Understanding Group’s objective is to build techniques, software and hardware that enable natural interaction with information. The group’s research focuses on building and testing systems that understand body- and hand-based gestures; improving, generalizing and applying sketch recognition algorithms to real-world problems; and building systems that integrate speech with the gesture and sketch modalities, by leveraging speech understanding and natural language processing research.

BIG DATA & ANALYTICS

BigData @ CSAIL researchers are investigating how to transform big data into big insights. The initiative’s approach brings together world leaders in parallel architecture, massive-scale data processing, algorithms, machine learning, visualization, and interfaces to collectively identify and address the fundamental technology challenges faced with Big Data. The approach is focused on the themes of computational platforms; scalable algorithms; machine learning and understanding; and privacy and security.

The Database Group (DBg) at MIT conducts research on all areas of database systems and information management. Projects range from the design of new user interfaces and query languages to low-level query execution issues, ranging from design of new systems for database analytics and main memory databases to query processing in next generation pervasive and
ubiquitous environments, such as sensor networks, wide area information systems, personal databases, and the Web.

The mission of the MIT Institute for Data, Systems, and Society (IDSS) is to advance education and research in state-of-the-art, analytical methods in information and decision systems; statistics and data science; and the social sciences, and to apply these methods to address complex societal challenges in a diverse set of areas such as finance, energy systems, urbanization, social networks, and health. IDSS research is rooted in three core disciplines: statistics and data science, information and decision theory, and human and institutional behavior.

The Macro Connections group focuses on the development of analytical tools that can help improve our understanding of the world’s macro structures in all of their complexity. Macro Connections research combines data, visualization techniques, statistical methods, and theoretical insights by developing methods to analyze and represent networks—such as the networks connecting countries to the products they export, or historical characters to their peers—which helps improve our understanding of the world.

**CONTROL SYSTEMS**

The Active Adaptive Control Laboratory investigates complex intelligent systems that require adaptation, learning, and control. Projects include energy distribution in smart grid, co-design of control and implementation platform for cyber-physical systems, adaptive flight control systems, and adaptive technology for automotive platforms.

The Laboratory for Information and Decision Systems (LIDS) is an interdepartmental research center committed to advancing research and education in the analytical information and decision sciences, specifically: Systems and control, communications and networks, and inference and statistical data processing. Throughout its history, LIDS has been at the forefront of major methodological developments in a wide range of fields, including: energy, defense, telecommunications, information technology, the automotive industry, and human health.

The Mechatronics Research Laboratory (MRL) conducts research and development in the areas of system dynamics, modeling, instrumentation, control systems, and design with applications to nanotechnology, biotechnology, robotics and automation.

**DATA SECURITY, PRIVACY, TRUST**

The Computer Systems Security Group researches and builds secure, practical, and flexible systems. The group’s work spans operating systems, computer architecture, distributed systems, programming languages, and web browsers.

The goal of CyberSecurity@CSAIL is to identify and develop technologies to address the most significant security issues confronting organizations in the next decade. CyberSecurity@CSAIL aims to provide an integrated and formal approach to the security of systems, combining design and analysis methods from cryptography, software and hardware.

The Cryptography and Information Security Group (CIS Group) develops techniques for securing tomorrow’s global information infrastructure by exploring theoretical foundations,
near-term practical applications, and long-range speculative research. The group aims to understand the theoretical power of cryptography and the practical engineering of secure information systems, from appropriate definitions and proofs of security, through cryptographic algorithm and protocol design, to implementations of real applications with easy-to-use security features. Research examples include: Micropayments; digital signatures; electronic voting; private information retrieval.

The MIT Internet Trust Consortium uses its expertise and knowledgebase to develop new technological building blocks that underlie the emerging personal data ecosystem. These blocks can be combined to address issues like identity management & authentication, authorization & consent management, data security, data mining & privacy-preservation, and digital death & meaningful archiving.

**DESIGN, PRODUCT DESIGN & DEVELOPMENT**

The Ideation Laboratory at MIT aims to deepen the theoretical foundations of early stage design process across product design, engineering design, system design, and beyond in order to develop transformational strategies for creating compelling new products and systems that address challenges of global competitiveness, sustainability, and emerging markets.

The Integrated Design & Management (IDM) is an MS degree in engineering and management track with a curriculum that combines the inspired, intuitive methods taught in the world’s best design schools, with the systematic, analytical methods of the world’s best engineering and business schools. IDM’s student and faculty backgrounds are composed of equal parts engineering, business, and design. Its core curriculum is taught in the Integrated Design Lab, where interdisciplinary teams have dedicated team space to practice the human-centered design process, complete with state-of-the-art tools from 3D printers to robotic arms.

The Department of Mechanical Engineering (MechE) conducts research in a range of areas, such as mechanics, product design, manufacturing, energy, nanoengineering, ocean engineering, controls, instrumentation, robotics, and bioengineering, that are diverse and allow for rich collaboration both within the department and with other engineering and science disciplines at MIT and beyond. These broad areas of focus and the department’s commitment to multidisciplinary research results in an exciting variety of innovative projects.

The MIT Mobile Experience Lab seeks to reinvent and creatively design connections between people, information and places. Using cutting-edge information and mobile technology, the lab seeks to improve people’s lives through the careful design of meaningful experiences. The multidisciplinary team designs new technologies, carefully considering their impact on societies, spaces and communities. Project area examples: Digital fabrication; product design; urban spaces; responsive environments.

**DIGITAL ECONOMY**

The Center for Information Systems Research (CISR) conducts field-based research related to how companies design themselves and manage for success in the digital economy. CISR aims to develop concepts and frameworks that address the challenges of leading increasingly dynamic, global, and information-intensive organizations. The relevance of CISR’s research is ensured by the active participation of corporate sponsors from a range of industries. Research results are
shared with CISR Patron/Sponsor community through working papers, research briefings, an annual conference, and sponsor forums.

The Initiative on the Digital Economy (IDE) researchers examine how people and businesses work, interact, and will ultimately prosper in a time of rapid digital transformation. The initiative helps organizations understand how the digital transformation is affecting society and everyday life. IDE conducts research in four key areas: Productivity, employment, and inequality; big data and information privacy; new digital business models; social analytics and digital experimentation.

ENGINEERING AND COMPLEX SYSTEMS

MIT’s Center for Computational Engineering (CCE) focus is on computational approaches for engineering problems—the formulation and implementation of new approaches that are more efficient and capable; and the informed application of existing approaches to important engineering questions. Areas of applications include materials & manufacturing; nano/micro systems; biological & biomedical processes/systems; and infrastructure systems & services; energy; environment; and transportation.

The Partnership for a Systems Approach to Safety and Security (PSAS) research group works to create new tools and processes to implement a systems thinking approach to safety. PSAS encourages participation from multiple MIT schools (engineering, management, social sciences, and sciences) as well as collaborators at other universities and in other countries. PSAS affiliates are working on safety in aviation (aircraft and air transportation systems), spacecraft, medical devices and healthcare, automobiles, railroads, nuclear power, defense systems, energy, and large manufacturing/process facilities.

The MIT Strategic Engineering Research Group works toward architecting and designing complex systems and products in a way that deliberately accounts for future uncertainty and context in order to maximize their lifecycle value. The goal of the group’s research is to make the engineering of complex systems more strategic in the areas of Systems Architecture and Engineering; Multidisciplinary Design Optimization; Integrated Modeling and Simulation; System Lifecycle Properties; Product Platforms and Commonality; and Space Systems Logistics.

MIT Systems Engineering Advancement Research Initiative (SEArI) performs collaborative research to address advanced systems engineering challenges. SEArI has a strong foundation in the space system and defense design and architecture domain, with more recent work branching into the transportation and infrastructure systems domain. The methods and practices developed by SEArI aim for truly cross-domain applicability.

INNOVATION

The Industrial Performance Center (IPC) studies innovation, productivity and competitiveness. The IPC specializes in bringing together teams of researchers in engineering, science, management and the social sciences to carry out innovative, applied research on industrial growth and transformation, national and regional economic growth and competitiveness, and innovation performance. Its research is organized around the following broad themes of energy; globalization; innovation; and production.
The **MIT Innovation Initiative (MITii)** is committed to strengthening MIT’s innovation and entrepreneurship landscape by: Serving as a connector across the wide range of student groups, programs, and campus centers; supporting MIT’s most successful innovation and entrepreneurship programs to reach more students and external partners; raising the profile of MIT’s entire landscape through convening events, publications, and programmatic efforts that include representation from across all five schools; and filling in gaps in the landscape through the creation of new educational programs, research efforts, and physical infrastructure.

The **MIT Innovation Initiative Lab for Innovation Science and Policy** aims to develop the area of ‘innovation science’—an emerging field that can be thought of as applying the scientific method to the practice of innovation. Using a diversity of methods, the lab empirically investigates how innovation occurs, and pioneers more systematic assessments of possible interventions (such as policies, programs or incentives) to achieve desired innovation outcomes (such as the creation of innovation-driven enterprises, job creation, economic and social impact, vibrant innovation economy). Areas of focus: metrics, policies, programs, boundaries, scale-up.

The **MIT Startup Exchange (STEX)** is a web community for the MIT innovation ecosystem, particularly MIT ILP’s members, MIT-connected startups and all MIT employees or alumni who have active startup engagements.

**INTERNET OF THINGS**

The **Auto-ID Labs** are an independent network of currently seven academic research labs (including MIT) that research and develop new technologies for revolutionizing global commerce and providing previously un-realizable consumer benefits. The Labs research is divided into the following: business processes and applications (fundamentally new business processes and industries); software and network (future architecture of the Internet of Things); and hardware (next-class tags which include memory, battery, sensors and actuators).

**MANAGEMENT**

The **MIT Sloan School of Management** is devoted to its mission of developing principled, innovative leaders who improve the world and to generate ideas that advance management practice. MIT Sloan faculty members are leading economists, public policy experts, entrepreneurs, and executives of companies large and small. Their research in such critical areas as finance and policy, innovation and entrepreneurship, technology, healthcare, and sustainability is conducted alongside private sector leaders and practitioners with the support and partnership of MIT Sloan students.

MIT **Leaders for Global Operations (LGO)** partners with the School of Engineering and the Sloan School of Management to deliver a unique, interdisciplinary Engineering-MBA dual degree program. The two-year program features internships at elite partner companies that are all leaders in their industries. LGO students develop leadership skills for the pharmaceutical, manufacturing, geosciences, energy, high-tech, and global supply chain industries. The combination of advanced engineering and Sloan MBA knowledge makes LGO graduates among the most sought after on the job market. LGO alums lead a variety of product development, global operations, and manufacturing development initiatives at leading companies and entrepreneurial ventures throughout the world.
The mission of the Center for Biomedical Innovation (CBI) is to improve global health by overcoming obstacles to the development and implementation of biomedical innovation. CBI is addressing profound challenges in the global biomedical industry by developing, testing, and disseminating new knowledge and tools designed for real world application through the following programs: the Biomanufacturing Research Program, the Consortium on Adventitious Agents in Biomanufacturing, and New Drug Development Paradigms.

The Novartis-MIT Center for Continuous Manufacturing is a research collaboration combining the industrial expertise of Novartis with MIT’s scientific and technological leadership toward developing new technologies to replace the pharmaceutical industry’s conventional batch-based system with a continuous manufacturing process. Continuous manufacturing benefits include: Accelerating the introduction of new drugs through efficient production processes; requiring the use of smaller production facilities; minimizing waste, energy consumption, and raw material use; monitoring drug quality on a continuous basis; and enhancing process reliability and flexibility to respond to market needs.

ROBOTICS

The d’Arbeloff Laboratory for Information Systems and Technology’s focus is the science and technology of robotic systems motivated by both practical applications and scientific interests. The d’Arbeloff Laboratory extends traditional bio-mimetic robotics to new frontiers of robotics for seeking effective solutions to socially and economically challenging problems, developing key enabling technologies, such as novel actuators, sensors, and communication technology, and exploring the possibility of using live cells and organelles as components of robots. Project example: Autonomous mobile robot systems triple scissor extender—6-DOF lifting and positioning robot for autonomous aircraft manufacturing.

The Distributed Robotics Laboratory (DRL) work spans areas including modular and self-reconfiguring robots, soft robotics, rapid design of customizable personal robots, distributed algorithms and systems of self-organizing robots, networks of robots and sensors for first-responders, mobile sensor networks, animals and robots, cooperative underwater robotics, desktop robotics, and forming, moving, and navigating sparse 2D and 3D structures.

The Interactive Robotics Group is developing innovative methods for enabling fluid human-robot collaboration. The group’s vision is to harness relative strengths of humans and robots to accomplish what neither can do alone. The focus is on developing robots that work in teams with people in high-intensity and safety-critical applications, including industrial manufacturing, disaster response, and space exploration.

The overarching goal of the Model-based Embedded and Robotic Systems lab (MERS) is to develop “cognitive robots,” robots that are able to think and act much like humans do. Research is in the areas of goal-driven planning; natural human/robot teaming; and reasoning about the robot and the environment.

The Robot Locomotion Group’s goal is to build machines that exploit their natural dynamics to achieve extraordinary agility and efficiency. The group’s projects include dynamics and control for humanoid robots, robotic manipulation, and dynamic walking over rough terrain, flight
control for aggressive maneuvers in unmanned aerial vehicles, feedback control for fluid
dynamics and soft robotics, and connections between perception and control.

The **Robust Robotics Group** aims to build unmanned vehicles that can fly without GPS
through unmapped indoor environments, robots that can drive through unmapped cities, and
expanding the scope of state of the art models for understanding abstract spatial concepts
necessary to carry out manipulation, navigation and planning tasks. The group focuses on
problems of planning and control in domains with uncertain models, using optimization,
statistical estimation and machine learning to learn good plans and policies from experience.

### SENSORS / SENSING

The **Fluid Interfaces** group radically rethinks human-computer interaction with the aim of
designing novel form factors that leverage the full range of user sensory capabilities and control
modalities while exploring the following themes: Interfaces that perceive the user, her current
context and actions and offer relevant services and information; interfaces that offer a more
natural interaction experience, allowing use of the functionality without diverting attention or
disrupting user actions; wearable interfaces that augment the human senses and capabilities;
interfaces designed for more specific or limited applications making innovative use of their
physical shape, size and materials.

The **Responsive Environments** group explores how sensor networks augment and mediate
human experience, interaction and perception, while developing new sensing modalities and
enabling technologies that create new forms of interactive experience and expression. The
group’s work encompasses the development and application of various types of sensor
networks, energy harvesting and power management, and the technical foundation of
ubiquitous computing, and has been highlighted in diverse application areas, such as
automotive systems, smart highways, RFID, wearable computing, and interactive media.

The **Tangible Media** group’s focus is on the design of seamless interfaces between humans,
digital information, and the physical environment. The Tangible Media group is designing a
variety of “tangible interfaces” by giving physical form to digital information, seamlessly
coupling the dual worlds of bits and atoms. The goal is to change the “painted bits” of GUIs to
“tangible bits,” taking advantage of the richness of multimodal human senses and skills
developed through our lifetime of interaction with the physical world.

### SUPPLY CHAINS / LOGISTICS

The **Center for Transportation & Logistics** (CTL) is widely recognized as an international
leader in supply chain management education and research. 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; and to management, planning and operations for
trucking, railroad, air and ocean carriers.

The **MIT Forum for Supply Chain Innovation (the Forum)** is composed of academics and
industry members whose support allows Forum researchers to provide customer-focused
solutions to design and manage the new supply chain. The rigorous approach used guides
businesses through the latest innovations in supply chain management, technology, and
implementation techniques. Members have the opportunity to participate in both industry-wide research into the supply chain as well as initiating their own specific research project.

**Operations Research Center (ORC)** research has led to significant contributions in such areas as health care, education, transportation, manufacturing, and finance. Whether helping a health care company predict future costs and improve medical outcomes or affecting systemic change in how a city assigns students to its public schools, ORC research streamlines business operations and shapes meaningful policies. Research topic examples include health care analytics; machine learning and its interface with optimization; online algorithms; personalized medicine; pricing and revenue management; social networks; supply chain management.

**Sustainability**

The **Center for Clean Water and Clean Energy** at MIT and KFUPM focuses on research in desalination, low carbon energy, related areas of design and manufacturing as well as curriculum development in mechanical engineering. Projects are in the areas of clean energy, clean water, and design.

The **Environmentally Benign Manufacturing** research group is focused on examining the environmental effects associated with manufacturing and products. Research areas include: the thermodynamic, economic, and life cycle assessment of manufacturing processes and systems, products and recycling systems. Additional work looks at the environmental effects from the consumption side of the issue.

The **MIT Joint Program on the Science & Policy of Global Change**’s integrated team of natural and social scientists studies the interactions between human and Earth systems to provide a sound foundation of scientific knowledge that will aid decision-makers in confronting the challenges of future food, energy, water, climate and air pollution, among others.

**Metals and Minerals for the Environment (MME)** is a forum for industry and academia to shape a more sustainable future for the metals and minerals industry. MME brings together world-renowned leaders to approach the issues relevant to the metal and mineral life cycle from a multi-disciplinary perspective. Research addresses mine operations, extraction and manufacturing, metals and minerals life cycle, etc.

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.