



The landscape of retail and consumer products industries continues to shift and provide a spectrum of challenges. Forces driving change in the global marketplace include such things as the changing consumer (i.e., aging population, millennials, middle class growth) and consumer behaviors (i.e., mobile phones as means to shop, social media, subscription/membership services), technologies that inform and support some of those dynamics and behaviors (i.e., big data/analytics and secure platforms, IoT, 3D printing). In addition, rising labor/commodity costs, integrating online and store offerings, climate change, and other factors are having an impact.

What makes MIT unique in its ability to generate advances in the aforementioned fields?

- MIT is a world class research university: The 2017 QS World University Rankings identified MIT as the #1 university in the world in engineering and technology as well as the natural sciences.
- MIT is solutions-focused, entrepreneurial, and impact driven: as of 2014 MIT faculty and alumni had founded more than 30,000 companies and continues to spin-out 80-100 new companies each year.
- MIT is at the center of the Boston innovation ecosystem: its ability to engage and leverage this ecosystem is unmatched.
- MIT is a convener of global thought leadership: through this network MIT helps address strategic and technical solutions to the major challenges facing society.
- MIT's interdisciplinary culture: allowing thought leaders from multiple disciplines and fields to collaborate freely and reach for the previously unimaginable.

MIT Corporate Relations provides access to MIT through two integrated programs, the MIT Industrial Liaison Program (ILP) <http://ilp.mit.edu/> and MIT Startup Exchange <http://startupexchange.mit.edu>

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 topics of relevance to the consumer products and retail industries bulleted below.

- AI, Machine Learning
- Big data/Analytics
- Consumer Behavior
- Data Security, Privacy, Trust
- Demographics
- Design
- Digital
- Digital Interfaces, Internet of Things, Sensing
- Fabrication & Manufacturing
- Human resources
- Innovation
- Marketing
- Robotics / Unmanned Vehicles
- Social Networks/Media, Collective Intelligence
- Supply chains/Logistics

AI, MACHINE LEARNING

The **ALFA group: Anyscale Learning For All** studies scalable machine learning technology, evolutionary algorithms, and data science frameworks for large-scale knowledge mining, prediction, analytics and optimization with projects in clinical medicine knowledge discovery, cybersecurity, and MOOC technology.

The **Computational Perception & Cognition group** research area is computational neuroscience, cognitive computing and computer vision, ranges from theory to experiments to applications, accelerating the rate at which discoveries are made by solving problems through a multi-disciplinary way of thinking. An example project is, armed with knowledge about how humans perceive visualizations, building computational tools to reason about posters, graphs, and visualizations, with applications to design, advertising, and user interfaces.

The **Data to AI group** in the MIT Institute for Data Systems and Society (IDSS) is interested in big data science and machine learning, and is focused on how to solve foundational issues preventing artificial intelligence and machine learning solutions to reach their full potential for societal applications.

The **Probabilistic Computing Project** is building a new generation of computing systems that integrate probability and randomness into the basic building blocks of software and hardware. The group has discovered that this approach leads to surprising new AI capabilities and are exploring them via a combination of academic research and entrepreneurship. The researchers also carry out basic research on the mathematical foundations of probabilistic computation. The group's work is made as freely available as possible via open-source software, public workshops, and online educational materials, and they collaborate with industry and non-profit partners on applications in the public interest.

The goal of **SystemsThatLearn@CSAIL** is to promote in-depth interactions between industry and academia. Member companies will have the opportunity to be exposed to multiple research projects that span the full spectrum of machine learning/artificial intelligence and analytics. The initiative will collaborate closely with industry to provide real-world applications and drive impact. The group's team of world-class researchers covers the full spectrum of research in systems and machine learning.

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 explore all the challenges and opportunities presented by big data, from cloud computing, data management, massive scale data analysis, algorithms, data mining, machine learning, security, privacy and visualization to all of big data's applications.

The **Billion Prices Project** at the MIT School of Management is an academic initiative that uses prices collected from hundreds of online retailers around the world on a daily basis to conduct research in macro and international economics. It is "Big Data" for macro- and international economics.

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 **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 **MIT Institute for Data, Systems, and Society (IDSS)** is committed to addressing complex societal challenges by advancing education and research at the intersection of statistics, data science, information and decision systems, and social sciences. IDSS applies state-of-the-art, analytical methods in information and decision systems, statistics and data science, and the social sciences to address complex societal challenges in a diverse set of areas such as finance, energy systems, urbanization, social networks, and health.



INDUSTRY BRIEF

MIT AND CONSUMER PRODUCTS / RETAIL INDUSTRIES

The **Mathematics Department at MIT** is one of the top-ranked mathematics departments in the US— a world center in Pure and Applied Mathematics. In pure mathematics, the department explores exciting current research directions in most of the major fields. The pure math group studies many aspects of algebra, analysis, geometry, mathematical logic and foundations, number theory, probability and statistics, and representation theory. The applied math group focuses on combinatorics, computational biology, computational science & numerical analysis, physical applied mathematics, theoretical computer science, theoretical physics.

The **Statistics and Data Science Center** is an MIT-wide focal point for advancing research and education programs related to statistics and data science. The Center was created in 2015 with the goal of formalizing and consolidating efforts in statistics at MIT. The Center's academic mission is to host and develop new academic programs, from a minor to a PhD in statistics and data science. The Center is also a window on the cutting-edge research in statistics and data science that is performed at MIT, characterized by a unique integration of computation and domain knowledge to statistical questions.

CONSUMER BEHAVIOR

The **Affective Computing Group** aims to bridge the gap between human emotions and computational technology. Research addresses machine recognition and modeling of human emotional expression, including the invention of new software tools to help people gather, communicate, and express emotional information and to better manage and understand the ways emotion impacts health, social interaction, learning, memory, and behavior. The group advances the latest affective technology and machine learning analytics with applications that improve lives.

The **MIT Sloan Neuroeconomics Lab** is a multidisciplinary research center studying problems at the intersection of economics, management, and cognitive neuroscience. The lab's projects are stimulated by economic theory and decision analysis, which provide an ideal standard, as beautiful conceptually as it is flawed empirically. The group studies behavior that appears anomalous in light of the rational model, focusing especially on financial, medical and consumption choices. Methods include functional MRI, lab experiments, game theory, Bayesian modeling and machine learning.

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 **CyberSecurity@CSAIL** approaches security from all sides (programming languages, software verification, computer architecture, crypto, systems, policy) with the goal of creating security "by default" and removing program error as a source of vulnerability. The researchers are designing new theoretical and practical foundations of secure computing that integrate security in the design process. By bringing together world-renowned leaders in the security specialties of cryptography, hardware, and software, they will leverage the existing research portfolio and work collaboratively with industry partners to address the most pressing cybersecurity challenges.

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.

The **Trust::Data Consortium** addresses the growing tension between societal data proliferation and data security by developing specifications, software, tools and documentation that help organizations adopt a holistic approach to cyber protection. Trust::Data is building new models for digital identity, data provenance, universal access, and secure privacy-preserving transactions to harness the future potential of global data sharing. The consortium brings together MIT researchers and business vanguards to collaborate on the development of open-source software that enables better data security and privacy, while also allowing for easier data sharing, and more robust digital identity.



DEMOGRAPHICS

The **MIT AgeLab**'s multidisciplinary research works with business, government, and NGOs to improve the quality of life of older people and those who care for them. The AgeLab applies consumer-centered systems thinking to understand the challenges and opportunities of longevity and emerging generational lifestyles to catalyze innovation across business markets. Work is focused on the impact of disruptive demographics on society, business strategy and innovation. For instance, what are the implications of disruptive demographics on how businesses engage the consumer, develop products and services, deliver value and see aging as a source of economic opportunity?

DESIGN

The **Computational Making Group** works to articulate and circumscribe an emerging area of interdisciplinary research called 'computational making.' The group is expanding the study of making beyond its current bounds, and examining the potentials of computational theories and techniques in making activities across contexts and scales. The focus is not on the end results of making activities, but on the processes and practices of their formation. Viewed as a material and perceptual enterprise, the group proposes making as a counterpoint to designing, often viewed as an immaterial and cognitive enterprise with a concomitant foregrounding of design "thinking" and "reasoning."

The **Design Lab** is particularly interested in the emerging possibilities afforded by: 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. The group is concerned not only with the design of individual products, systems, buildings, and urban areas, but also with the roles these elements play in larger urban, regional, and global systems and their long-term sustainability.

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)** researches and teaches at the interfaces of ideas, where several disciplines such as physics, math, electronics, and computer science, and engineering intersect in the nimble hands of broadly trained MIT mechanical engineers. Faculty and students conduct research in a range of areas, such as mechanics; design & manufacturing; energy; micro- & nanoengineering; ocean science & engineering; controls, instrumentation & robotics; and bioengineering.

DIGITAL

The **Center for Information Systems Research (CISR)** helps executives meet the challenge of leading dynamic, global, and information-intensive organizations. CISR provides the CIO and other digital leaders with insights on topics such as business complexity, data monetization, and the digital workplace. Through research, teaching, and events, the center stimulates interaction among scholars, students and practitioners. More than ninety firms sponsor the center's work and participate in the consortium.

The **Initiative on the Digital Economy (IDE)** is a team of visionary, internationally recognized thought leaders and researchers examining how people and businesses work, interact, and will ultimately prosper in a time of rapid digital transformation. Drawing on MIT Sloan School of Management's faculty and strengths in technology and innovation, the IDE is analyzing the broad sociological changes brought about by the advance and spread of digital technology. Research is focused on: Productivity, employment, and inequality; big data and information privacy; new digital business models; and social analytics and digital experimentation.

DIGITAL INTERFACES, INTERNET OF THINGS, SENSING

The **Auto-ID Labs** are the leading global research network of academic laboratories in the field of Internet of Things (IoT). The labs comprise seven of the world's most renowned research universities located on four different continents, including MIT). The labs believe that the next generation of the IoT can revolutionize global commerce and provide previously unrealizable consumer benefits. The labs aim to add the consumer to the currently B2B-oriented business model of GS1 and explore opportunities for new hardware, software, business processes and applications including Linked Open Data for Products and Services.

The **Fluid Interfaces group** radically rethinks the relationship between people and their personal digital devices. The group aims to design systems that serve users' true needs better than today's smartphones. The systems the group builds are always on, highly personalized, and integrate more closely with the user's mind and body. They continuously mediate and enhance a user's interactions with the world around them, thereby supporting memory and learning processes, as well as decision-making and behavior change.

The **Object-based Media group** explores the future of electronic visual communication and expression, and how the distribution of computational intelligence throughout video and audio communication systems can make a richer connection between the people at the ends of the systems, whether a broadcast system or a peer-to-peer environment. The group develops hardware and software technologies to support the requirements of such a scenario, with particular focus on new input and output technologies, advanced interfaces for consumer electronics, and self-organization among smart devices.

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. Group research encompasses the development and application of various types of sensor networks, energy harvesting and power management, and the technical foundation of ubiquitous computing. Work is highlighted in diverse application areas, which have included automotive systems, smart highways, RFID, wearable computing, and interactive media.

The **Tangible Media group** explores Tangible Bits & Radical Atoms visions to seamlessly couple the dual world of bits and atoms by giving dynamic physical form to digital information and computation. The goal is to go beyond the current mainstream of Painted Bits (pixels) to enrich human interactions and to take advantage of the multimodal human senses and dextrous skills developed through a lifetime of interaction with the physical world.

FABRICATION & MANUFACTURING

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 **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 **HCI Engineering Group (HCIE)** at the MIT Computer Science and Artificial Intelligence Laboratory works at the intersection of human-computer interaction and personal fabrication tools. The group's long-term vision is that in the future anybody will be able to create anything anywhere anytime. Working towards this goal, the group builds novel hardware and software systems that advance personal fabrication technologies.

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 **Mechanosynthesis Group** aims to create new materials, machines, and design principles for advanced manufacturing. Much of the group's work seeks to discover and exploit micro- and nanoscale phenomena



INDUSTRY BRIEF

MIT AND CONSUMER PRODUCTS / RETAIL INDUSTRIES

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.

The **Self-Assembly Lab's** cross-disciplinary research invents self-assembly and programmable material technologies aimed at re-imagining 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.

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 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.

HUMAN RESOURCES

The **Institute for Work and Employment Research (IWER)** is comprised of faculty from the MIT Sloan School of Management and other departments across the Institute to educate a new generation of researchers to reinvent the ways we work. The mission: address the needs and realities of 21st-century workers and the organizations that employ them.

The **MIT Leadership Center (MLC)** is dedicated to the study and practice of leadership where people who change our world aren't defined by titles — they discern big problems, spot opportunities, and rally others to collectively solve them in creative ways. By offering access to cutting-edge research, education, and dynamic conversations, the MLC strengthens the capacity of individuals, teams and organizations to develop innovative solutions to complex problems and develop the next generation of leaders worldwide.

INNOVATION

The **Industrial Performance Center (IPC)** is focused on firms, industries and technological change in the global economy and how their emergence and transformation impact society at large. With a particular interest in Innovation, Productivity and Competitiveness, the IPC brings together teams of researchers in engineering, science, management and the social sciences at MIT and beyond to carry out innovative, applied research in broad areas of innovation ecosystems, advanced manufacturing, energy, and globalization.

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** was established to help 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 (policies, programs or incentives) to achieve desired innovation outcomes (creation of innovation-driven enterprises, job creation, economic and social impact, vibrant innovation economy).

The **MIT Startup Exchange** 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. The Exchange lists 1500+ MIT-connected start-



INDUSTRY BRIEF

MIT AND CONSUMER PRODUCTS / RETAIL INDUSTRIES

ups in various stages of development and since 2009, has arranged 200+ one-to-one meetings between MIT ILP member companies and MIT-connected startups.

MARKETING

The **Operations Research Center (ORC)** education and research draws upon ideas from engineering, management, mathematics, and psychology to apply scientific methods to decision-making. ORC faculty contribute to a wide range of application domains such as energy, engineering, finance, health care, marketing, service industry, and transportation.

Members of the MIT Sloan School of Management Marketing group have pioneered research methods, marketing models, and decision-support systems that have enhanced new product development, identified customer desires, predicted customer behavior, and led to enhanced understanding of marketing strategy. The concept of marketing science, established and popularized at MIT Sloan, remains a critical component of marketing strategy in corporations across the globe.

ROBOTICS / UNMANNED VEHICLES

The **Distributed Robotics Laboratory** work spans: computational design and fabrication of robots; algorithms for perception, planning reasoning and control with guarantees; algorithms for auditable machine learning; and algorithms for collaborating machines and people. The lab's innovations enable new applications in smart living, transportation, healthcare, manufacturing, monitoring, exploration, and much more. The lab's research addresses the development of algorithms and systems that enable collaboration, increase autonomous capabilities, and rethink the ways in which we design and interact with the physical world.

There are three main thrusts to the research in the **Model-Based Embedded and Robotics Systems (MERS) group**: goal-driven interaction with robots, natural human/robot teaming, and robotic reasoning about the environment. When combined, these research topics enable the group to create cognitive robots that can be talked to like another human, can work with a team member to finish a task, can recover from many failures without assistance, and can collaborate with a human to recover from a failure that the robot cannot solve alone.

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 to build social robots that can quickly learn what people want without being annoying or intrusive. 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.

SOCIAL NETWORKS/MEDIA, COLLECTIVE INTELLIGENCE

The **MIT Center for Collective Intelligence (CCI)** conducts research on how new communications technologies are changing the way people work together. CCI draws on the strengths of many diverse organizations across the Institute to conduct its research. Projects range from Combining Human and Machine Intelligence for Making Predictions, to the Climate CoLab, to the Deliberatorium, to Nonlinear Negotiation.

The **Human Dynamics Group** uses Reality Mining to ask how we can use data to better organize companies, public health, and governance, by better understanding how social networks influence people when they make decisions, transmit information, adopt new technologies, or change behaviors. The group's projects have already demonstrated the potential to dramatically improve the competitiveness of companies, and hint at the ability to revolutionize social environments.

The **Laboratory for Social Machines** develops data science methods—primarily based on natural language processing, network science, and machine learning—to map and analyze social systems, and designs tools that enable new forms of human networks for positive change. The lab is mapping the intersection of news, entertainment and social media at scale to better understand the interaction of media and behavior in a range of domains including US national politics and democracy, food behavior, and video based storytelling.

SUPPLY CHAINS / LOGISTICS

The **Center for Transportation & Logistics (CTL)** is widely recognized as an international leader in supply chain management education and research. CTL coordinates more than 100 supply chain research efforts across the MIT campus and around the world, educates students and corporate



INDUSTRY BRIEF

MIT AND CONSUMER PRODUCTS / RETAIL INDUSTRIES

leaders in the essential principles of supply chain management, and helps organizations increase productivity and economic impact while decreasing their environmental impact.

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 Forum's rigorous approach 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.

The **Megacity Logistics Lab** aims to promote new urban delivery models, from unattended home delivery solutions, to smart locker systems, to click & collect services. The group is pushing the limits of existing logistics network designs as future city logistics networks need to support omni-channel retail models, smaller store formats, increased intensity of deliveries, coordinate multiple transshipment points, engage a wider range of vehicle technologies – including electric and autonomous vehicles – and support complex inventory balancing and deployment strategies.

The **Visual Analytics Lab** is harnessing interactive visualization and augmented reality technology to change the way supply chain and logistics data is accessed, understood and utilized.

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.

