

MIT Media Laboratory

MIT Media Laboratory
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**enabling technologies
for learning and expression
by people and machines**

The MIT Media Laboratory occupies a unique position in the rapidly evolving landscape of new media and information technologies. It was founded by MIT Professor Nicholas Negroponte and the late Jerome Wiesner (former science adviser to President John F. Kennedy and former president of MIT), who foresaw the coming convergence of computing, publishing, and broadcast, fueled by changes in the communications industry.

Since opening its doors in the fall of 1985, the Media Laboratory has pursued an educational and research mission that has helped to create now-familiar areas such as digital video and multimedia, and has brought together disciplines such as cognition, electronic music, graphic design, video, and holography, as well as work in computation and human-machine interfaces.

True to the vision of its founders, today's Laboratory continues to focus on the study, invention, and creative use of digital technologies, and is now exploring new frontiers, such as wireless, "viral" communications; wearable computing; machines capable of common-sense reasoning; new forms of artistic expression; and how children learn. These themes outline a future where the bits of the digital realm interact seamlessly with the atoms of our physical world, and where our machines not only respond to our commands, but also understand our emotions—a future where digital innovation becomes the domain of all.

The Laboratory is beginning the 21st century with plans for a major expansion: a building adjacent—and connected—to the current Media Laboratory, which will double its current space.

Academic Programs

Unlike other laboratories at MIT, the Media Laboratory comprises both a degree-granting Program in Media Arts and Sciences and a research program. The faculty, senior research staff, and visiting scientists working in the Laboratory number more than 40, and close to 100 other staff members support the Laboratory's research, facilities, and administration. Graduate enrollment totals 126, split almost evenly between master's and doctoral students. An additional 36 graduate students are formally based in other MIT departments, but carry out their research at the Media Laboratory. More than 200 undergraduates come to work at the Laboratory each year through MIT's Undergraduate Research Opportunities Program (UROP).

Research Consortia

More than 30 Media Lab research groups are involved in over 350 projects, ranging from games to help us monitor our health to nanofabrication techniques for use in biological systems. Much of this work is carried out within five consortia, funded primarily by corporate sponsors, and is tested and refined through experiments at MIT and in the field, in cooperation with individual sponsor organizations.

Changing Places (CP), a joint Media Laboratory and Department of Architecture consortium, explores how new technologies, materials, and strategies for design can make possible dynamic, evolving places that respond to the complexities of life. It is an expansion of MIT's House_n: The MIT Home of the Future consortium. Central to this research is the development of PlaceLab, a home-scale, occupied "living laboratory"—an agile facility to test new design, construction, and digital infrastructure concepts. PlaceLab will enable ongoing scientific studies into the real-world impact of design and technology for preventative health care,

energy/resource conservation, human-environment interfaces, and links between the home and changing places of healing, work, learning, and community.

Digital Life (DL) conducts basic research on technology that spurs human expression as well as social and economic activity. Research is organized around three themes:

- **Curious Machines**, which explores how to build inventions that work with us in tasks as diverse as helping your grandmother climb stairs to buying a house—machines that are sometimes robots, some times agents, and occasionally just lightweight gizmos;
- **Creative Computing**, which examines how innovations migrate quickly from the engineering bench to the public at large, and how the public become early partners in that process—not just as consumers, but as re-inventors; and
- **Viral Communications**, which looks at how communications will become diffused, embedded in everyday things, personally owned, and incrementally changed—a consumer industry versus a universal infrastructure.

Digital Nations (DN) aims to address major social challenges (improving education, enhancing health care, supporting community development) through the innovative design and use of new technologies. The consortium's ultimate goal is to empower people in all walks of life to invent new opportunities for themselves and their societies. The consortium focuses especially on populations with the greatest needs: children and seniors, underserved communities, and developing nations.

information: organized (i:o) seeks to further innovations in information technology and to understand how digital content can enhance the human experience. As the technologies of the digital age continue to change the way that information is collected, presented, and disseminated to the public, i:o will respond by focusing its core research on three areas:

- description: “intelligent” machinery for describing and analyzing digital content;
- design: new, expressive modes of presentation and visualization of digital content; and
- debate: tools to engage “information consumers” in new types of discourse around digital content.

Things That Think (TTT) brings together a wide variety of sponsor companies and organizations with 25 research groups working toward a common goal: to design and invent the future of digitally augmented things. Research areas range from penny-priced PCs that provide rural market access in developing countries, to powerless switches that wirelessly communicate messages, to clay that provides real-time computational analysis of physical landscape models. From new musical instruments for both children and virtuosic artists, to a new generation of

cars for the digital world, TTT's paradigm-breaking perspective is developing the products and services of tomorrow.

Special Interest Groups

The Laboratory has also organized a number of smaller, more focused special interest groups (SIGs), which deal with particular subject areas.

Counter Intelligence is focused on developing a digitally connected, self-aware kitchen.

e-markets looks at the new forms that transactions may take in a networked world, and explores the new social and economic order that may result.

Gray Matters considers the impact of computation and communication on the lives of older persons.

Personal Fabrication is about using new fabrication techniques, and exploring the future of desktop fabrication.

Silicon Biology explores how micro- and nanoscale fabrication technologies offer fundamentally new ways to probe, understand, and ultimately control complex biological systems.

Center for Bits and Atoms

In July 2002, the Lab announced the establishment of a Center for Bits and Atoms, largely funded through \$13.75 million from the National Science Foundation (NSF)—the largest NSF award ever received by the Laboratory. The center explores how the content of information relates to its physical representation—from atomic nuclei to global networks—bringing nanofabrication, chemistry, and biology labs together with rapid mechanical prototyping, electronic instrumentation, and industrial-scale assembly workspaces. This unprecedented, integrated suite of resources should enable researchers simultaneously to shape the information in both a system and its physical embodiment—from microscopic to macroscopic scales—and could radically change how we look at information technology and its impact on daily life. (<http://cba.mit.edu>)

Media Lab Europe

In 2000, the Laboratory began a 10-year collaboration with the Republic of Ireland to establish Media Lab Europe in Dublin. The current research agenda of this independent, university-level, not-for-profit research institute is defined by three broad themes: augmenting senses, enhancing thinking, and connecting people. In 2002, Media Lab Europe launched a series of “Open House” events, designed to provide existing and potential partners with an opportunity to learn more about the Lab and to meet with academic and industry leaders in specific fields of interest. To facilitate the free exchange

of information, the MIT Media Laboratory and Media Lab Europe are sharing all intellectual property developed at both locations over the initial 10-year period. (<http://www.medialabeurope.org>)

Facilities

The Media Laboratory houses a gigabit fiber-optic plant that connects a heterogeneous network of computers, ranging from fine-grained, embedded processors to supercomputers. The rapid prototyping resources include 3-D printing, injection molding, and PC board fabrication. There are studios for audio and video, and laboratories for DNA labeling, new sensors, micro-encapsulation, quantum computing, and perceptual studies.

Financial Support

The Lab's annual budget comes from a combination of corporate sponsors, government funders, nonprofit organizations, and subcontracts with other universities. A focus on corporate support reflects the Laboratory's commitment to collaborative research that has possibilities for a wide range of applications, and to technology transfer that moves research results out of the Laboratory and into worldwide use.

Sponsorship

Many sponsors find the Laboratory to be a uniquely valuable resource for conducting research that is too costly or too "far out" to be accommodated within a corporate environment. The "multiplier" effect of joining a community of sponsors to support advanced research has impressive results. For less than the cost of one senior scientist's salary plus benefits, a sponsor can gain access to the work of a 300-person research laboratory. Currently, there are several levels of sponsorship available:

Consortium sponsorship is the most frequently selected option. A consortium connects a group of sponsors with a group of Laboratory faculty and research staff focused on a common agenda. The cost of joining a consortium is \$200,000 per year, for a minimum of three years. Consortium sponsors receive full intellectual property rights—license-fee free and royalty free—to all work developed in the Laboratory during their sponsorship years. For an additional \$200,000 per year, a consortium sponsor may also have an employee-in-residence at the Laboratory.

Other forms of sponsorship include:

Affiliate sponsorship, at \$100,000 per year for a minimum of three years, which introduces sponsors to the overall work of the Laboratory, or allows attendance at a consortium's semi-annual research meetings.

Sponsors may move on from this basic level (which includes limited access to intellectual property) to a higher level of sponsorship at any time.

Special interest group sponsorship, which offers more focused research agendas. The cost of individual SIG membership varies by program.

Graduate fellow sponsorship, which provides the sponsor an opportunity to connect with specific students and research groups, in areas of particular interest. The cost of supporting each fellow is \$75,000 per year. Student fellows can carry the sponsor's name, and can rotate annually.

Directed research, which offers a parallel funding track to accommodate federally sponsored research and large-scale contracts.

The highest level of expendable support is the **corporate** or **strategic research partner**, at \$750,000 or more per year. Such partners fund larger agendas at the Laboratory, including fellows programs or special Laboratory facilities. Corporate or strategic research partners automatically become members of all consortia and SIGs, and have the right to an employee-in-residence at the Laboratory.

Consortia and SIGs have their own scheduled activities, including group meetings twice a year. In addition, sponsors are welcome to visit the Laboratory at mutually convenient times, to see research in progress and discuss areas of common interest. Faculty members and students also travel to sponsor sites.

From time to time, the Laboratory organizes special events around particular themes, or events that are open to representatives from all sponsor companies. In addition to offering presentations by outstanding speakers, such events provide an ideal environment for sponsors who share an interest in new technologies to meet one another.

The Laboratory maintains an extensive Web site (<http://www.media.mit.edu>) and publishes a newsletter, FRAMES, to keep sponsors up-to-date with research developments. Sponsors also receive e-mail communications to keep them apprised of Laboratory news, and have access to **insite** (<http://www.media.mit.edu/insite>), a password-protected hub for non-public Laboratory technical documentation, Webcasts, theses, and other information.

Intellectual Property

The Media Laboratory is unique among laboratories, centers, and research programs at MIT in that sponsors of the Laboratory at the consortium level or higher have the opportunity to share in the Laboratory's intellectual

property, license-fee free and royalty free. Non-sponsors are precluded from making use of the Laboratory's developments for at least two years after the filing of a patent or copyright.

As a result, the Laboratory is an intellectually open environment where ideas are readily exchanged, and is a community in which sponsors are entitled to acquire non-exclusive licensing rights to all intellectual property that is conceived, developed, or reduced to practice. Over the years, this policy has fostered a large number of unexpected and highly successful solutions that have led to new technologies and products, greatly benefiting both sponsors and the world community.

A Sampling of Research Activities

Ripley, a sensor-rich conversational robot that—at least to a limited degree—can interact with people using grounded, spoken language. Ripley is not programmed with scripted speech, but rather learns the meaning of words, much as a young child does.

GOOSE, a goal-oriented search engine that uses common-sense reasoning to adapt to the user's style of inquiry, rather than vice versa.

A **fully instrumented car** that collects data on a driver's mental workload and emotional state. The goal is to design a car whose enhanced features will interact with the driver in non-intrusive ways, making everyday driving safer and less stressful.

Collaborative (viral) communication schemes that use bandwidth and energy far more efficiently than traditional point-to-point wireless technology.

An **autonomous, synthetic pup**, that demonstrates a practical approach to real-time learning for autonomous, synthetic characters. This animated pup learns from experience and can be trained with the same techniques used for real dogs.

A **robotic, sea anemone-like creature** to help us learn what aesthetic, behavioral, and interactive qualities give a robot life-like presence, and how people relate to an "alien" creature that seems organic but is not anthropomorphic.

New ways of joining the physical environment and cyberspace by making "**tangible bits**" accessible through everyday, physical surfaces like walls or desktops. One project, **Sensetable**, allows the user to easily explore how one—or several—changes will affect a system by projecting graphic representations of complex computations directly onto the surface of a table.

ALF, an inexpensive, expressive plastic head that provides children with an easy-to-use introduction to programming and mechanical design.

A unique graphical display, **Genomic Cartography**, which focuses on new ways to represent complex information from very large data sets—like the human genome—through dynamic, 3-D images.

Toy Symphony, a multi-year project involving children, soloists, composers, and symphony orchestras around the world, which aims to radically alter how children are introduced to music, and to redefine the relationship between professional musicians and young people.

Inexpensive, wireless motion sensors that are worn or held by people and transmit a short radio frequency pulse. These inexpensive sensors can be used to sense a crowd's energy and, for example, change music in response to it. They can also have numerous applications for health care, signaling when an elderly person opens a medicine cabinet, or alerting relatives when there is a lack of motion.

A new technology that exploits the reduced melting point and high solubility of nanoparticles to produce **super-cheap transistors** by printing them directly onto a flexible, plastic substrate.

A **melody retrieval** system for the Web, which can find a piece of music based on a few hummed notes.

Responsive window technology, which turns any ordinary window into an interactive display by using contact piezoelectric pickups to record the arrival of bending waves created when someone taps on the window.

Wearable computing that allows us to move beyond PCs and laptops and wear our computers as we would eyeglasses or clothing. One project, **MITHril**, combines lightweight RISC processors, a single-cable power/data "body bus," and high-bandwidth wireless networking in a package that is nearly as light, comfortable, and unobtrusive as ordinary street clothing.