Singapore–MIT Alliance for Research and Technology

On July 1, 2007, in partnership with the National Research Foundation (NRF) of Singapore, MIT launched a new research center with a bold and unique vision. The Singapore–MIT Alliance for Research and Technology Centre (SMART Centre), was founded on the premise that several major challenges facing society are interdisciplinary in nature, and that solving them will require global collaboration in strategically located centers of research excellence.

The mission of the SMART Centre is to:

1. Be a world-class interdisciplinary research center that maintains the same standards of excellence as does MIT
2. Identify and conduct research on critical problems of societal significance
3. Develop robust partnerships with local universities and institutions in Singapore, and, in particular, integrate research with graduate and post-graduate education through co-supervision
4. Be a magnet for attracting global research talent to Singapore
5. Help instill a culture of translational research, entrepreneurship, and technology transfer
6. Be a platform for Singapore and MIT to develop global interactions within and beyond Singapore

The SMART Centre currently has four interdisciplinary research groups (IRGs), which will grow to five IRGs in about a year, and an Innovation Centre. More than 100 researchers from MIT and Singapore participate in each IRG. As of now, SMART is planned as a five-year program.

The SMART Centre is MIT's largest international endeavor and its only such research center outside Cambridge, Massachusetts. It enables MIT faculty members and students to engage in certain types of research that cannot be carried out in Massachusetts. Examples include work on such infectious diseases as malaria, dengue, and tuberculosis; on some environmental phenomena, such as the equatorial ocean–air coupling and resulting weather patterns; and on developing microfluidic stem cell technologies in therapeutics for diseases that are prevalent in the Singapore region, e.g., certain liver diseases. The SMART Centre gives MIT access to the deep pool of research talent in Singapore as well as to researchers who are attracted to Singapore from the rest of Asia. It also provides the MIT researchers with access to certain dedicated facilities not available on the Cambridge campus [such as biosafety level three laboratories] as well as the ability to conduct clinical and field work essential to these research problems.

One measure of MIT's strong commitment to the SMART Centre is the amount of time that MIT researchers spend in Singapore. Each principal investigator (PI) spends at least 20 percent of his or her time at the SMART Centre during the life of the IRG, and this

must include at least one stay of six continuous months. During this six-month stay, the faculty member is not on sabbatical leave or on a leave of absence from MIT. Moreover, at least one PI from each IRG is in long-term residency in Singapore at all times (except for professional trips that she or he might normally make). Some faculty members have chosen to stay longer because they found the environment highly conducive to their research (one PI stayed for two years). In addition to the PIs, there is a steady circulation of other MIT faculty and of postdoctoral, doctoral, and even undergraduate student researchers on shorter-term visits to the SMART Centre. The atmosphere at the SMART Centre is most certainly dynamic.

The SMART Centre will be located at the Campus for Research Excellence and Technological Enterprise (CREATE) in Singapore. CREATE is a complex of state-of-the-art research laboratories, now being developed by NRF, that will be occupied by world-class research universities and corporations. A number of such universities have agreed to set up research laboratories at CREATE, and several others are finalizing their agreements to do so. It is likely that the SMART Centre will be the largest research entity at CREATE in terms of participants and space. This co-location of several research teams from several research organizations will lead to stronger collaboration between the IRGs, as well as collaboration between the various international research entities and collaboration between these entities and Singapore-based universities and research institutions. CREATE is currently under construction and is expected to have approximately 60,000 square meters of laboratory and office space when it is completed in December 2011. In the interim, SMART has dedicated laboratory and office space on the campus of the National University of Singapore (NUS).

As of July 1, 2010, the SMART Centre will have four IRGs focused on the following four topics: infectious diseases, environmental sensing and modeling, biosystems and micromechanics, and future urban mobility. The fifth and final IRG is expected to begin work in January 2012 on a topic yet to be determined.

The SMART Centre maintains high quality through the careful selection and subsequent nurturing of the members of each IRG. Each IRG receives substantial funding and other resources needed to carry out its work. Its progress is periodically evaluated by IRG-specific scientific advisory boards comprising (non-MIT) experts in the field of the IRG. Feedback from the IRG advisory boards is meant to nurture the IRGs, especially through constructive criticisms that help the IRGs grow stronger. In addition, the SMART Centre presents semiannual reports to its governing board, which is cochaired by the provost of MIT and the former president of NUS.

The topic and team for each IRG are selected through an annual MIT-wide competition that begins with an open call for white papers to all MIT faculty members. Teams of faculty self-organize and submit white papers. The SMART Centre's advisory committee (composed of department chairs from MIT's School of Engineering and School of Science) reviews these white papers and then asks for full proposals from the shortlisted teams (typically about five teams). After reviewing the full proposals the committee picks a single proposal that is submitted to the NRF board for consideration. The process is very competitive, with several high-quality proposals being in the final pool.

Faculty members in the participating teams are among the most active researchers with tenure at MIT. Key selection criteria include the importance of the problem proposed for study, the interdisciplinary character of the problem, the innovative quality of the proposed approach, and the strength of the faculty team. The importance of the problem to Singapore and the reasons why MIT faculty would want to work on this problem in Singapore rather than in Massachusetts are also important considerations.

The research in each IRG is multidisciplinary in nature and consequently draws not only on faculty from several departments at MIT but also from several departments, research institutes, and agencies at NUS, at Nanyang Technological University (NTU), and in Singapore. The total number of participants in a single IRG is roughly 130, including about 15 MIT faculty members. The other IRG participants are faculty from the universities in Singapore, senior researchers from Singapore research institutes and agencies, postdoctoral researchers from MIT, NUS, NTU, and the SMART Centre, doctoral students (from MIT and the universities in Singapore), and even undergraduate researchers (from both MIT and Singapore) during the summers.

Faculty members participating in SMART have received numerous honors and awards both before and during their participation. The honors include election to the National Academy of Sciences, election to the National Academy of Engineering, a Guggenheim Fellowship, and several awards won by SMART's junior researchers.

The SMART Centre has been featured prominently in several magazines and newspapers, and on TV. We particularly note the article on globalized graduate education and research in the *Chronicle of Higher Education* (October 5, 2009) and the article on Spotlight Singapore in the online edition of Scientific American (2010).

We summarize below the research problems identified by each IRG.

Infectious Diseases IRG

The major goals of this IRG are to advance basic understanding of pathogen–host interactions at the cellular and molecular levels; to develop technology platforms that will be useful for studying infectious diseases; to use this basic knowledge to develop diagnostics, prophylactics, and therapeutics for specific infectious diseases; and to train a new generation of leaders for academia and the pharmaceutical/biotechnology industry.

Center for Environmental Sensing and Modeling IRG

The ultimate goal of this IRG is to develop an accurate and predictive model of the natural and built environment of Singapore that would seamlessly transition between different scales, from the level of a single building or facility to the level of the state, including the surrounding ocean. This model would integrate a variety of data sources (many from novel sensors) to permit users to understand how a change at any scale can affect the overall system. For example, the model would show how a rise in sea level would affect mid-sized facilities, such as Marina Bay, and small-scale facilities, such as waste outflows. Conversely, buildings contribute to a heat-island effect that is reflected in atmospheric changes, and contaminant discharges are reflected in mesoscale water bodies and ultimately in the ocean.

BioSystems and Micromechanics IRG

By merging diverse engineering and bioscience areas, such as microfluidics, nanomechanics, imaging, computational modeling, materials science, and biology, this IRG aims to develop technologies that can disrupt disease processes. With such technologies it will be possible to improve diagnosis, treatment, and mitigation of disease while simultaneously educating the next generation of biological engineers. The IRG's vision is that it will become a focal point for translating cutting-edge science into novel technology for human healthcare.

Future Urban Mobility IRG

This IRG intends to develop a modeling/simulation platform with an integrated model of human and commercial activities, land use, transportation, environmental impacts, and energy use. This modeling platform will be linked with networked computing and control-technology-enabled mobility innovations, and with operations-research-based decision models, to analyze the effects of various novel concepts, including real-time information and management systems and innovative mobility services, such as mobility-on-demand and green logistics. This will yield a new paradigm for the planning, design, and operation of future urban mobility systems in and beyond Singapore.

Innovation Centre

In addition to the IRGs that carry out research, SMART has also set up an Innovation Centre, which is modeled after MIT's Deshpande Center but adapted to the culture and practices of Singapore. Its mission is to instill a culture of translational research, entrepreneurship, and technology transfer.

The SMART Innovation Centre provides funding for faculty, as well as students, to develop their ideas with an eye to the marketplace. A condition for receiving this funding is that the researchers must agree to team-up with "catalysts"—entrepreneurs or venture capitalists with experience in starting up companies. Three types of awards are given: Ignition Grants (for very early proof-of-principle development), Innovation Grants (for further proof-of-concept development), and Explorer Grants (for student teams).

This approach, borrowed from MIT's Deshpande Center, increases the chances of product commercialization. Even if an idea does not reach the marketplace, its inventors have had an invaluable education on the process of commercialization. The Innovation Centre has identified and trained a strong team of catalysts in Singapore and is developing a network of venture capitalists from both Boston and Singapore. The Innovation Centre also conducts educational programs that match students from NUS and NTU with students from INSEAD Singapore business school and Singapore Management University.

The first SMART-based company, Visterra, was incorporated in Singapore on July 1, 2010. This biotechnology startup will focus on delivering improved diagnostics, therapeutics, and vaccines for infectious diseases. This company is an outcome of SMART-funded research in the infectious diseases IRG.

Outreach

Through generous gifts, the SMART Centre has established a summer research internship program: the Singapore MIT Undergraduate Research Fellows (SMURFs) program. It is open to all undergraduates at NTU, NUS, and MIT, and gives them the opportunity to engage in research at the SMART Centre over the summer. The SMURFs work in their faculty supervisors' labs, actively participate in research projects, and engage with post-doctoral students, graduate students, and other researchers. SMART hopes these opportunities will engage the interest of the SMURFs and that they will consider careers in research. Their academic experiences are supplemented with numerous arranged social activities. Feedback from the students suggests that the SMURFs greatly value their experiences at SMART and the community that forms among them.

Another way in which SMART has engaged the wider research, technology, and entrepreneurial communities in Singapore is through outreach in the form of special symposia, short courses, and seminars given by eminent members of the MIT community. These are open to the public (at no charge) and extremely well attended. In January 2009 we held a symposium, called "Challenges and Opportunities in Energy: Perspectives from MIT," where the speakers included professor Ernest Moniz, director of the MIT Energy Initiative. In October 2009 we presented a short course, "Immunology for Engineers and Scientists," taught by professor Arup Chakraboty. In January 2010 we kicked off the first in a series of seminars, "Imagine, Inspire, Innovate: Lessons from MIT," which was given by Nate Ball, an alumnus of MIT who now runs his own company and is the founding host of a US public television program on engineering aimed at junior high school students. In April 2010 we held a symposium for the entrepreneurial community in Singapore, "Building Business Opportunity from Technology Innovation," where the speakers included Charles L. Cooney, faculty director of the MIT Deshpande Center.

To encourage an open and interactive culture, like the one that prevails at MIT, SMART has a common lounge with free cookies, tea, and coffee. The lounge has chalkboards, small-group tables, and comfortable couches. Researchers from different IRGs will often bump into each other here, leading to social or technical conversations. In addition, SMART holds monthly Friday afternoon social gatherings to which all SMART participants are invited. These are well attended and they have helped build a SMART-wide sense of community.

SMART has been fortunate to secure funding from the Singapore Ministry of Education for 100 doctoral students. The funding provides a full four years of a tuition/stipend/supplement/travel grant to each of 100 incoming doctoral students. The students must be admitted to NUS or NTU, must do a significant part of their research at the SMART Centre, must have co-advisors from both their home university and MIT, and must have the opportunity to spend six months in residence at MIT.

In addition to the postdoctoral students from MIT, NUS, and NTU who conduct research at the SMART Centre, the IRGs also advertise and recruit postdoctoral students from around the world. These recruits are employed and based permanently at the SMART Centre.

Finally, the SMART Centre has set up the SMART Fellows program (modeled after the Humboldt Fellows program) to recruit a few extremely talented postdoctoral students each year to work on their own research projects, provided the projects connect in some way to an IRG theme. The SMART Fellows receive an attractive stipend and research funding of their own. An MIT SMART faculty member serves as a mentor, so that the SMART Fellows have access to mentoring as and when needed.

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More information about SMART can be found at http://web.mit.edu/smart/.