

Singapore-MIT Alliance for Research and Technology

Introduction

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 of the major challenges facing society are interdisciplinary in nature, and that solving them requires global collaboration in strategically located centers of research excellence.

The mission of the SMART Centre is to:

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

The SMART Centre currently has five interdisciplinary research groups (IRGs) and an Innovation Centre. Over 100 researchers from MIT and Singapore participate in each IRG. As of now, SMART is a five-year program.

The SMART Centre is MIT's largest international endeavor and it is the 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 of this research include: infectious diseases, such as malaria, dengue and tuberculosis; environmental phenomena, such as the unique equatorial ocean-air coupling and the resulting weather patterns; and the development of microfluidic stem cell technologies in therapeutics for diseases that are most 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 those who are attracted to Singapore from the rest of Asia. It also provides MIT researchers with access to certain dedicated facilities not available on the Cambridge campus (such as the biosafety level three laboratories) as well as to clinical and field work essential to these research problems.

One measure of MIT's strong commitment to SMART 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 continuous stay of six months. During this six-month

stay, the faculty member is not on sabbatical leave or 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 so conducive to their research (one PI stayed for two continuous years). In addition to the PIs, there is a steady circulation of MIT faculty, postdoctoral, and doctoral and undergraduate student researchers via shorter-term visits of a week to several weeks. As a result, 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 being developed in Singapore by NRF, that will be occupied by world-class research universities and corporations. A number of such universities have agreed, like SMART, to set-up research laboratories at CREATE, and several others are finalizing their agreements to do so. It is likely that SMART 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 among the IRGs, as well as collaboration among the various international research entities, in addition to their collaboration with 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. Construction is expected to be complete by March 2012. In the interim, SMART has dedicated laboratory and office space on the campus of the National University of Singapore (NUS).

Interdisciplinary Research Groups

Research at SMART is carried out in IRGs. As of July 1, 2011, SMART has five 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, low-energy electronic systems, will commence in January 2012.

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

The topic and team for each IRG is 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 (comprised of department heads from MIT's School of Engineering and School of Science) reviews these white papers and then asks for full proposals from the shortlisted teams, which typically amount to five. After reviewing the full proposals the advisory committee then picks a single proposal, and this is submitted to the NRF Board for consideration. The process is very competitive with several high-quality proposals

making it to the final pool. The faculty members on the participating teams are among the most research-active tenured faculty at MIT. The key selection criteria include the importance of the problem proposed for study, the interdisciplinary character of the problem, the innovativeness of the proposed approach, and the strength of the faculty team. Other considerations include the importance of the problem to Singapore, and the reasons why the MIT faculty would choose to go to Singapore to work on this problem rather than working on it in Cambridge, Massachusetts.

The research in each IRG is multidisciplinary in nature and consequently draws on faculty from several departments at MIT, and from several NUS and at Nanyang Technological University (NTU) departments, research institutes, and agencies 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, Singapore, 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 in SMART. 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, newspapers, and TV programs.

We summarize below the research problems identified by each IRG.

Infectious Diseases

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

Center for Environmental Sensing and Modeling

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 will integrate a variety of data sources (many from novel sensors) and allow users to understand how changes at any scale impact the overall system. For example, how a rise in sea level would impact meso-scale facilities, like Marina Bay, and small-scale facilities, like waste outflows. Conversely, buildings contribute to a heat-island effect that reflects itself in the atmospheric state; or contaminant discharges reflect themselves in meso-scale water bodies and ultimately in the ocean.

BioSystems and Micromechanics

By merging diverse engineering and bioscience areas, such as microfluidics, nanomechanics, imaging, computational modeling, materials science and biology, the IRG aims to develop disruptive technologies, and with them become better able to diagnose, treat, and mitigate diseases, while simultaneously educating the next generation of biological engineers. The IRG's vision is that it, and Singapore, will become the focal point for translating cutting-edge science into novel technology for human healthcare.

Future Urban Mobility

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 engine will be linked with a range of networked computing and control-technology-enabled mobility innovations, and with operations research-based decision models, to analyze the impacts 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 established an Innovation Centre modeled after MIT's Deshpande Center for Technological Innovation 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 to students, to further develop their ideas with an eye toward the marketplace. A condition for receiving this funding is that the researchers must agree to team-up with "catalysts" — entrepreneurs and/or venture capitalists with experience starting companies. The Innovation Centre has identified and trained a strong group of catalysts in Singapore. 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 the Deshpande Center, increases the chances of product commercialization. Even when an idea does not reach the marketplace the inventors have had an invaluable education on the process of commercialization. The Innovation Centre has drawn together a strong team of catalysts and is developing a network of venture capitalists from both Boston and Singapore.

The Innovation Centre also conducts educational programs that team-up students from NUS and NTU with students from INSEAD, a leading graduate business school in Singapore, 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 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 students in those schools the opportunity to engage in research at the SMART Centre over the summer. The SMURFs work in their faculty supervisors' labs, actively participate in the research projects, and engage with postdocs, graduate students, and other researchers. SMART hopes these opportunities excite student interest in research and encourage students to consider a career in research. Their academic experiences are supplemented with numerous arranged social activities. Based on feedback from the students, the SMURFs greatly value their experiences at SMART and the community ties that form out of the experience.

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, free of charge, and are extremely well attended. In April 2011, professor Doug Hardt gave a seminar titled "The Accidental Entrepreneur." Charles Cooney, faculty director of the Deshpande Center spent a portion of his sabbatical at the SMART Centre and provided guidance on entrepreneurship. The "invisibility cloak," developed by professor George Barbastathis, was voted among the top 10 breakthroughs of 2010 by *Physics World*.

In order to encourage an open and interactive culture as at MIT, SMART has a common lounge where we provide 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 socials to which all SMART participants are invited. These are well attended and they have helped build a SMART sense of community.

SMART has been fortunate to secure funding from the Singapore Ministry of Education (MOE) for 100 MOE-funded doctoral students to work at SMART. The funding provides a four-year grant to cover full tuition/stipend/supplement/travel 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, have co-advisors from their home university and MIT, and have the opportunity to spend six months in residence at MIT.

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

Finally, SMART has set up the SMART Fellows program (modeled after the Humboldt Fellows program) to recruit a few extremely talented postdocs each year to work on

their own research projects, provided the project connects in some way to an IRG theme. The SMART Fellows receive a particularly attractive stipend and research funding of their own. An MIT SMART faculty member serves as a mentor, so that the SMART Fellow has access to mentoring as and when needed.

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