

# 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 and vision of the SMART Centre is to:

- Be a world-class interdisciplinary research center that maintains the same standards of excellence as those upheld at MIT
- Identify and conduct research on critical problems of societal significance and of interest to Singapore
- Develop robust collaborations with researchers from local universities and institutions in Singapore
- Co-advise local doctoral students and postdoctoral researchers
- Help instill a culture of translational research, entrepreneurship, and technology transfer
- Be a magnet for attracting and anchoring global research talent to Singapore and MIT
- 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. More than 685 researchers and staff from MIT and Singapore participate in SMART. Each IRG has an initial five-year term, and subject to review and approval may receive an additional five-year term. All five IRGs are in their second five-year term.

As MIT's largest international endeavor, the SMART Centre enables MIT faculty members and students to engage in certain types of research that cannot be carried out in Massachusetts. Examples include research into infectious diseases, such as malaria, dengue fever, and tuberculosis; work on 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—for example, 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 fieldwork 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% 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 (more than one PI stayed for two continuous years). In addition to the PIs, there is a steady circulation of MIT faculty members, postdoctoral, and doctoral and undergraduate student researchers, who come on shorter-term visits of a week to up to two months. As a result, the atmosphere at the SMART Centre is most certainly dynamic.

The SMART Centre is located at the Campus for Research Excellence and Technological Enterprise (CREATE) in Singapore. CREATE is a complex of state-of-the-art research laboratories developed in Singapore by NRF, occupied by world-class research universities and corporations. A number of such universities (Ben-Gurion University, Cambridge University, ETH Zurich, Hebrew University, Peking University, Technical University of Munich, Shanghai Jiao Tong University, and the University of California, Berkeley) like SMART, have set up research laboratories at CREATE. SMART is 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 the IRGs' collaboration with Singapore-based universities and research institutions. All five IRGs, the Innovation Centre, and headquarters are located at CREATE.

### **Interdisciplinary Research Groups**

Research at SMART is carried out in IRGs. As of July 1, 2017, SMART had five IRGs focused on the following five topics: infectious diseases, environmental sensing and modeling, biosystems and micromechanics, future urban mobility, and low-energy electronic systems.

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 comprising non-MIT experts in the field of the IRG. The feedback from SABs is meant to nurture the IRGs, especially through constructive criticism, which helps 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 the National University of Singapore (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 members self-organize and submit white papers. The SMART Centre's Advisory Committee (composed 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 number five. After reviewing the full proposals the advisory committee then picks a single proposal, and this is submitted to the National Research Foundation for consideration. The process is very competitive, and several high-quality proposals generally make it through to the final pool. The faculty members on the participating teams are tenured faculty at MIT who are most active in research. 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 the problem rather than work on it in Cambridge, Massachusetts.

The research in each IRG is multidisciplinary in nature and consequently draws on faculty from several departments at MIT, from faculty at NUS and Nanyang Technological University (NTU), and from research institutes and government agencies in Singapore. The total number of participants in a single IRG is roughly 145, including about 15 MIT faculty members. The other IRG participants faculty from the universities in Singapore, senior researchers from Singapore research institutes and agencies, postdoctoral associates (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.

The research problems identified by each IRG are summarized below.

### **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. The infectious diseases IRG will end its second five-year term on December 31, 2017.

### **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 be able to transition seamlessly 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 affect the overall system—for example, how a rise in sea level would impact mesoscale facilities, like Marina Bay, and small-scale facilities, such as waste outflows. Conversely, buildings contribute to a heat-island effect is reflected in the atmospheric state; or contaminant discharges that are reflected in mesoscale water bodies and, ultimately, in the ocean. The Center for Environmental Sensing and Modeling IRG will end its second five-year term on December 31, 2017.

### **BioSystems and Micromechanics**

By merging diverse engineering and bioscience areas, such as microfluidics, nanomechanics, imaging, computational modeling, materials science and biology, this IRG aims to develop disruptive technologies and use them to become better able to diagnose, treat, and mitigate diseases, while simultaneously educating the next generation of biological engineers. The IRG's vision is that both the group and Singapore will become focal points for translating cutting-edge science into novel technology for human healthcare. The IRG was renewed for an additional five-year term, effective January 2014.

### **Future Urban Mobility**

This IRG intends to develop a modeling and 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. Those concepts include 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. The IRG was renewed for an additional five-year term, effective January 2016.

### **Low-Energy Electronic System**

The IRG aims to identify new integrated circuit technologies that can become the new added value for reduced energy per function, lower power consumption, and higher performance in our electronics infrastructure. These integrated circuits of the future are expected to affect applications in wireless communication, power electronics, LED lighting, printing, displays, and computing. The research is performed by teams that have expertise in materials, devices, and circuits, invoking new advances at all levels to produce electronic systems that perform new function while decreasing system energy. The initial technology goals are in the areas of power electronic systems, efficient communications, and multi-functional displays and lighting systems. The IRG has submitted a renewal proposal for an additional five-year term effective, January 1, 2017.

### **Innovation Centre**

In addition to the IRGs that carry out research, SMART has also established an Innovation Centre that is 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 to 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 in 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 if an idea does not reach the marketplace, the inventors will 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 Singapore and Boston, Massachusetts.

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.

Through SMART funding, more than 180 invention disclosures have been filed and 21 companies established.

## **Outreach**

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 students in those schools the opportunity to engage in research at the SMART Centre over the summer. The SMURFs work in their faculty supervisors’ laboratories, actively participate in the research projects, and engage with postdoctoral associates, graduate students, and other researchers. SMART hopes that these opportunities will excite student interest in research and encourage students to consider a career in research. Their academic experiences are supplemented with numerous arranged social activities. On the basis of feedback from the students, the SMURFs greatly value their experiences at SMART, the community ties that are formed from the experience, and the ability to explore Southeast Asia.

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.

To encourage an open and interactive culture, SMART organizes career development and social activities for its researchers, as does MIT. The intent is for researchers from

different IRGs to bump into each other and join in 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 to support the work of doctoral students at SMART. The funding provides a four-year grant, to cover full tuition, a stipend, a supplement, and travel to each of 100 incoming doctoral students. The students must be admitted to NUS or NTU, and must do a significant part of their research at the SMART Centre. They 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 postdoctoral associates from MIT, NUS, and NTU who conduct research at SMART, the IRGs also advertise and recruit postdoctoral associates from around the world, who are employed and based permanently at the SMART Centre.

SMART has also set up the SMART Fellows program, which is modeled after the Humboldt Fellows program, to recruit a few extremely talented postdoctoral associates 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.

## **Looking Forward**

SMART is currently negotiating a new agreement with the Singapore National Research Foundation (NRF). The new agreement would commence on January 1, 2018 and end when the last IRG concludes its five-year term. There are currently two proposals under review by NRF, and SMART also intends to submit at least one additional proposal to before December 31, 2017.

**Daniel Hasting**  
**Director and CEO**