

## 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 vision. The [Singapore-MIT Alliance for Research and Technology \(SMART\) 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 are to:

- Be a world-class interdisciplinary research center that maintains the same standards of excellence as MIT
- Identify and conduct research on critical problems of societal significance and 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 six active interdisciplinary research groups (IRGs) and an Innovation Centre. More than 610 researchers and staff from MIT and Singapore participate in SMART. Each IRG has an initial five-year term, and may receive an additional five-year term subject to review and approval. Two IRGs are in their first five-year term, two IRGs are in their second five-year term, one IRG is in a no-cost extension phase, and one new IRG commenced on June 1, 2019.

The SMART Centre is MIT's largest international endeavor and it is the only such research center outside Cambridge, MA. It enables MIT faculty members and students to engage in certain types of research that can be challenging to carry out in Massachusetts. Examples of this research include: solving the growing threat of resistance to antimicrobial drugs; revolutionizing food production for an urban environment; developing world-leading integrated circuits using the industry's global supply chain; 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 access to data and clinical and field

work essential to these research problems. The size of IRG funding allows for scaled, long-term, collaborative research that can be combined with infrastructure investment—something difficult to replicate in Cambridge. SMART’s ecosystem is particularly valuable for moving from early research through translation to market impact within five to 10 years. Combined with the Innovation Centre, SMART offers teams of faculty a unique environment for advancing their ideas for impact.

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 may include 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. There is a steady circulation of MIT faculty, postdoctoral researchers, doctoral students, and undergraduate students via shorter-term visits of at least a week and 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, that is occupied by world-class research universities and corporations. A number of such universities (Berkeley, Cambridge University, ETH Zurich, Hebrew University, Technical University of Munich, and Shanghai Jiao Tong University), 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 has led to stronger collaboration among the IRGs, as well as collaboration among the various international research entities. This is evident by the number of multi-organization research grants awarded to SMART. In addition to their collaboration with Singapore-based universities and research institutions, all six active IRGs, the SMART Innovation Centre, and SMART headquarters are located at CREATE.

### **Interdisciplinary Research Groups**

Research at SMART is carried out in IRGs. As of July 1, 2019, SMART has six IRGs. Five of the IRGs are focused on the following topics: antimicrobial resistance, critical analytics for manufacturing of personalized medicine, future urban mobility, low-energy electronic systems, and sustainable technologies for agricultural precision. One IRG, focused on developing tools to understand cell and tissue diseases biosystems, will wind down on December 31, 2019.

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) composed of non-MIT experts in the field of the IRG. The feedback from the IRG SABs is meant to nurture the IRGs, especially through constructive criticism, which help the IRGs 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 provost/deputy 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 to all MIT faculty members for white papers. Teams of faculty self-organize and submit white papers. In addition, SMART management helps to organize the formation of teams to submit proposals. 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. After reviewing the full proposals, the advisory committee submits select proposals to the NRF board for consideration. 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, MA.

The research in each IRG is multidisciplinary in nature and consequently draws on faculty from several MIT departments, NUS, Nanyang Technological University (NTU), Singapore University of Technology and Design (SUTD), research institutes, and Singaporean governmental agencies. The total number of participants in a single IRG varies from a low of 60 to a high of 200. This includes between four to 15 MIT faculty members participating in an IRG. 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.

We summarize below the research problems identified by each IRG.

### **Antimicrobial Resistance**

The Antimicrobial Resistance Interdisciplinary Research Group (AMR IRG) is a unique translational research and entrepreneurship program aimed at solving the growing threat of resistance to antimicrobial drugs. AMR leverages the scientific and clinical strengths of MIT and Singapore to develop transformative technologies to identify, respond to, and treat drug-resistant microbes. AMR projects address the threat of drug-resistant microbes by developing diagnostics and drugs based on synthetic biology; defining new resistance mechanisms in biofilms and dormant infections; developing anti-resistance drugs and drug delivery strategies; and exploiting host immunity to combat resistant microbes. AMR will also accelerate the pace of drug development by streamlining clinical trials and regulatory practice. The AMR IRG began its five-year term on January 1, 2018.

### **Critical Analytics for Manufacturing of Personalized-Medicine**

Critical Analytics for Manufacturing Personalized-Medicine (CAMP), focuses on ways to utilize living cells as medicine delivered to humans (instead of today's approach of powdered pharmaceuticals), leading to improved health outcomes, reduced time and costs, and more access to promising approved therapies for patients. The IRG's vision is that together with Singapore, the IRG will become the focal point for translating cutting-

edge science into novel drug discovery for human healthcare. The IRG began its first five-year term on June 1, 2019.

### **Disruptive and Sustainable Technologies for Agricultural Precision**

Disruptive and Sustainable Technologies for Agricultural Precision (DiSTAP) aims to revolutionize how food is produced to meet the demands of a growing population in an increasingly resource-constrained world. While this technology facilitates Singapore's agricultural independence and ensures access to high-quality foods for the future, it can also be applied around the world—making Singapore a leader in precision agriculture and urban farming. The DiSTAP IRG began its five-year term on January 1, 2018.

### **Future Urban Mobility**

The Future Urban Mobility 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, including real-time information systems, real-time 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 has been renewed for an additional five-year term and will end phase two on December 31, 2020.

### **Low Energy Electronic Systems**

The Low Energy Electronic Systems IRG aims to identify new integrated circuit technologies that become the new added value for reduced energy per function, lower power consumption, and higher performance in electronics infrastructure. These integrated circuits of the future are expected to impact 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 functions while decreasing system energy consumption. The initial technology goals are in the areas of Power Electronic Systems, Efficient Communications, and Multi-functional Displays and Lighting Systems. The IRG was renewed for a second phase and will end on December 31, 2021.

### **BioSystems and Micromechanics**

By merging diverse engineering and bioscience areas, such as microfluidics, nanomechanics, imaging, computational modeling, materials science and biology, the BioSystems and Micromechanics 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 together with Singapore, the IRG will become the focal point for translating cutting-edge science into novel technology for human healthcare. The IRG has received a no-cost extension until December 31, 2019 to wind down the research.

## Innovation Centre

In addition to the IRGs that carry out research, SMART has also established a center initially modeled after MIT's Deshpande Center for Technological Innovation. Over time, the SMART Innovation Centre has adapted to the culture and practices of Singapore and has advanced into a unique translational enterprise in Singapore. Its mission is to instill a culture of translational research, entrepreneurship, and technology transfer.

The SMART Innovation Centre provides funding for teams of faculty, students, and researchers to further develop their ideas with an eye toward the marketplace. A condition for receiving this funding is 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).

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.

Through SMART funding, more than 209 invention disclosures have been filed and 36 companies have been formed.

## Outreach

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, SUTD, 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 research careers. Their academic experiences are supplemented with numerous social activities. Based on feedback from the students, the SMURFs greatly value their experiences at SMART, the community ties that form out of 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.

In order to encourage an open and interactive culture like at MIT, SMART organizes career development and social activities for its researchers. The intent is for researchers from different IRGs to network with each other, leading to social or technical conversations. In addition, SMART holds monthly afternoon socials to which all SMART participants are invited. These are well-attended and they have helped build a sense of community.

SMART has been fortunate to fund a fellowship program for doctoral students. The funding provides a four-year grant to cover full tuition, stipend, supplemental expenses, and travel. The students must be admitted to NUS, NTU, SUTD, or Singapore Management University; 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 postdoctoral researchers from MIT, NUS, and NTU who conduct research at SMART, the IRGs also advertise and recruit postdoctoral researchers from around the world who are employed and based permanently at the SMART Centre.

SMART has set up the SMART Postdoctoral Scholars program (modeled after the Humboldt Fellows program) to recruit a few extremely talented postdoctoral researchers 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.

Communications to various communities is an important aspect of successful outreach. In April 2019, SMART has engaged a local public relations firm to communicate more effectively to Singapore, MIT, the US, and relevant communities in the world.

### **Leadership Change**

In January 2019, Eugene Fitzgerald, the Merton C. Flemings-SMA Professor of Materials Engineering in the Department for Materials Science and Engineering replaced Professor Daniel Hastings as the SMART Director and CEO. Professor Fitzgerald has a three-year term subject to renewal for an additional three-year term.

### **Looking Forward**

SMART renegotiated a new agreement with the Singapore National Research Foundation in May 2019. The new agreement applies to any IRG that began after May 2019, and will expire in the fifth year of the last approved IRG.

**Eugene Fitzgerald**  
Director and CEO