

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 \(SMART\) 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 MIT's standards of excellence
- Identify and solve 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
- 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 four active interdisciplinary research groups (IRGs) and an Innovation Centre. Approximately 380 researchers and staff from MIT and Singapore participate in SMART. Each IRG has an initial five-year term; subject to review and approval, they may receive an additional five year term. Three IRGs are in their first five-year term, one IRG is in its second five-year term, and one IRG concluded its second five-year program in June 2021.

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 is 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 attracted to Singapore from throughout Asia. It also provides MIT researchers with access to certain dedicated facilities not available on the Cambridge

campus (such as biosafety level three laboratories) and access to data as well as clinical and field work essential to these research problems. The size of the 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 a 5–10-year timeframe. Combined with our 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 MIT researchers spend in Singapore. Each principal investigator (PI) spends at least 20% of their 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 require a leave of absence from MIT. There is a steady circulation of MIT faculty, postdoctoral, doctoral, and undergraduate student researchers via 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 the NRF that is occupied by world-class research universities and corporations. Several such universities like SMART—including Berkeley, Cambridge University, ETH Zurich, Hebrew University, Technical University of Munich, Shanghai Jiao Tong University, and University of Illinois—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 SMART programs, 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, each of the four active 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, 2021, SMART has four IRGs. The IRGs are focused on the following topics: antimicrobial resistance, critical analytics for manufacturing of personalized medicine, low-energy electronic systems, and sustainable technologies for agricultural precision. One IRG, focused on modeling and simulation for future mobility, ended on June 30, 2021.

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 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 and 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 for white papers to all MIT faculty members. Teams of faculty self-organize and submit white papers. In addition, SMART management helps organize and encourages the formation of teams to submit proposals. The SMART Centre's Advisory Committee, comprised of department heads from MIT's Schools of Engineering and Science, reviews these white papers and then asks for full proposals from the shortlisted teams. After reviewing the full proposals, the advisory committee selects proposals and submits them 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 includes 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 faculty at the NUS, Nanyang Technological University (NTU), and the Singapore University of Technology and Design (SUTD), research institutes, and governmental agencies in Singapore. The total number of participants in a single IRG varies from 30 to 75 people; this includes between four and 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.

Research problems identified by each interdisciplinary research group are summarized below.

Antimicrobial Resistance

The Antimicrobial Resistance (AMR) Interdisciplinary Research Group 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. AMR 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 and reduced time

and costs so more patients will have access to promising, approved therapies. The IRG's vision is that it and Singapore will become the focal point for translating cutting-edge science into novel drug discovery for human health care. CAMP began its first five-year term on June 1, 2019.

Disruptive and Sustainable Technology for Agricultural Precision

Disruptive and Sustainable Technology 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 and science facilitates Singapore's agricultural independence and ensures access to high-quality foods for the future, this technology can also be applied around the world—making Singapore a leader in precision agriculture and urban farming. DiSTAP began its five-year term on January 1, 2018.

Low Energy Electronic Systems

Low Energy Electronic Systems (LEES) 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 our electronics infrastructure. These integrated circuits of the future are expected to impact applications in wireless communication, power electronics, LED lighting, printing, displays, and computing. Teams that have expertise in materials, devices, and circuits invoke new advances at all levels to produce electronic systems that perform new functions while decreasing system energy. The initial technology goals are in the areas of power electronic systems, efficient communications, and multifunctional displays and lighting systems. LEES will end its second phase on December 31, 2021, and will submit a proposal to extend part of the research program for an additional three years.

Innovation Centre

In addition to the IRGs that carry out research, SMART has also established an Innovation Centre initially modeled after MIT's Deshpande Center for Technological Innovation. Over time it has adapted to the culture and practices of Singapore and has advanced into a unique translational enterprise. 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 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, and 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, over 271 invention disclosures have been filed and 45 companies have been formed.

Outreach

SMART Centre has established a summer research internship program, the Singapore-MIT Undergraduate Research Fellowship (SMURF) program. Unfortunately, due to the COVID-19 pandemic, SMART has postponed the SMURF program for summer of 2020 and 2021 but anticipates recommencing in 2022.

SMURF 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 postdoctoral students, graduate students, and other researchers. SMART hopes 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. 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 extremely well attended.

In order to encourage an open and interactive culture as at MIT, SMART organizes career development and social activities for its researchers. The intent is for researchers from different IRGs to encounter and interact 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 have helped build a SMART sense of community.

Communications to various communities is an important aspect of successful outreach. In April 2019, SMART engaged a local publication relations firm to communicate more effectively to Singapore, MIT, the United States, and relevant communities in the world. Through their assistance, SMART has generated 861 stories globally, 26 broadcast interviews, 729 press releases, 15 thought leadership articles, and 62 online interviews this year. The MIT webpage covered SMART's research achievements 37 times.

COVID-19

SMART continues to work on COVID-19 promising projects:

1. Inexpensive and rapid paper-based tests for diagnosis of COVID-19. The test aims at detection of the virus specific proteins from bodily fluids. Test results are known within five minutes using very simple procedures. The researchers

anticipate the test can be performed by the general public at a scale of approximately 200,000 tests per day and intend to form a company in 2021.

2. Sewage-based surveillance of COVID-19. Wastewater surveillance can offer a real-time, cost-effective view of a community's health and security that is independent of biases associated with case-reporting.
3. Utilizes CRISPR technology and sample partitioning for rapid, sensitive, and accurate quantification of SARS-CoV-2 nucleic acids. The research teams' assay integrates multiple technologies to collect results in a novel chip-based assay of detection limit of one copy per reaction, all in one hour. This assay has the potential to reduce false negatives and false positives while providing the absolute copy number of the virus.

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

For academic year 2022, SMART will work with the NRF to establish new research programs and develop a new structure for the innovation center.

Eugene Fitzgerald
Director and Chief Executive Officer