MIT innovation initiative

Final Report of Community Feedback and Recommendations

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INTRODUCTION

"MIT already anchors a remarkable hotbed of innovation … With the right facilities, alliances, and programs … we can build on that lead and continue to serve as one of the most powerful engines of innovation … in the world."

— MIT President Rafael Reif, Inaugural Address, September 21, 2012

Innovation—identified by MIT Nobel laureate Robert Solow as "the driver of long-term, sustainable economic growth and prosperity"—has been a hallmark of the Massachusetts Institute of Technology since its inception. The initial vision of MIT's founder, William Barton Rogers, was to foster an environment that would aid in "the advancement, development, and practical application of science in connection with arts, agriculture, manufactures, and commerce." MIT honors Rogers' vision by attracting and educating exceptionally talented students, scholars, and researchers whose insight, creativity, and ingenuity have led MIT's community to develop groundbreaking concepts and products, from radar, GPS, the microchip, and inertial guidance for space travel to lasers, PET scans, and controlled-release drug delivery. These have not merely influenced the economy and society; they have played an instrumental role in shaping the modern world.

One hundred and fifty years after Rogers' vision was articulated, MIT has the capacity—and the responsibility—to carry the advancements of humanity forward and to devise and develop imaginative solutions to its most daunting problems in energy, climate, health care, education, food and water scarcity, and more. In this spirit, in the fall of 2013, MIT President Rafael Reif called for the creation of an MIT Innovation Initiative.

The MIT Innovation Initiative is an Institute-wide agenda to strengthen the existing and evolve new pathways for the MIT community and its partners to move ideas to impact. It builds upon MIT's foundation of fundamental research excellence and the MIT community's aspirations for moving ideas to impact in many domains. The Initiative combines hands-on "innovation education and practice" opportunities for building expertise in the innovation process with insights developed from the evidence-based "innovation research and policy." Pursued together, the interplays between innovation education and practice and innovation research and policy will accelerate our community's ability to transform ideas and fundamental research into substantive social and economic impact,

and direct us on how to adapt our actions to the ever-evolving innovation environment. MIT will always be defined by its central focus on education and research. Innovation and discovery drive MIT's mission. The following pages document the imperatives for the MIT Innovation Initiative today, as well as its aspirations. These have been developed through consultation with the MIT community, alumni, and partners (their comments are summarized in Appendix I of this report).

Two factors are shaping the Initiative:

New generation of students immersed in a rapidly changing world. The focus of the Millennial Generation on leading lives motivated as much by social conscience as by personal gain has been well documented. At MIT, our students are demanding career preparation that positions them to make a positive difference early in their lives. They come to MIT to learn the basic principles of science and engineering, and build capabilities in innovation so they can go on to provide solutions that scale rapidly and achieve broad impact, whether through making and commercializing new discoveries, developing innovative businesses within global corporations, or launching new ventures.

However, many MIT students report that they feel underprepared to transform their formidable discipline-based capabilities into high-impact innovations. For MIT to continue to attract the world's most technically adept, ambitious, and creative students, it must augment academic offerings, co-curricular programs, infrastructure, and facilities to meet the demand for courses, spaces, social pursuits, and intellectual activities that nurture students' innovative and entrepreneurial drives.

The innovation paradigm has shifted. Images of the solitary scientist toiling for years in a corporate lab or the billion-dollar venture launched in a garage are no longer the only models. Rather, an increasingly hybridized model of innovation has emerged that requires complex physical, virtual, and computational resources, as well as access to diverse collaborators—from classmates and corporate executives to risk capitalists, policymakers, and entrepreneurs in communities around the world. Investing in these resources and fostering these relationships will help MIT accelerate the advent of ideas that can be developed and implemented at scale, to deliver tangible real-world benefits.

The present report outlines the four key activity areas that will help MIT achieve its overarching goals around innovation:

1. **Innovation Education & Practice:** Expanding curricular and co-curricular activities at MIT that enable students, research staff, and faculty to develop and apply expertise in the innovation process at all stages of their education, and expanding opportunities for those beyond MIT (including alumni and other likeminded innovators).

2. **Innovation Research & Policy:** Establishing and advancing the "science of innovation" (the systematic analysis of the factors shaping innovative outcomes through research and policy advocacy with diverse stakeholders and thought leaders.

These two activities will be supported through the following:

3. **Innovation Communities:** Cultivating communities that enhance our innovation education and practice and innovation research and policy activities—on campus and around the world—to strengthen our connection to the full range of stakeholders who enable the innovation economy.

4. **Innovation Infrastructure:** Equipping the MIT community with the physical and digital infrastructure—on campus and around the world—to create solutions to 21st century challenges with speed and focus.

The preliminary MIT Innovation Initiative report (released to the MIT community in December 2014) emphasizes that the enhancement of MIT innovation resources starts with a more intentional integration of innovation-related activities already taking place on campus and beyond. These are then augmented by new activities—programs, infrastructure, and communities—for promoting innovation at MIT. In response, several pilot programs have been launched or enhanced in 2015 (outlined in Appendix I).

The report that follows comprises two main sections:

1. **"A Legacy of Transformation"** traces the arc of innovation at MIT—from an early focus on manufacturing and industry, to technological innovations associated with the wartime effort of the 1940s, the advent of the digital age and the biotechnology revolution in the late 20th century, the emergence of social entrepreneurship at the beginning of this century, and the era of nanotechnology innovation now underway.

2. **"MIT Innovation Initiative Strategy"** describes in detail the Initiative's four key areas of focus defined and developed through our community engagement, as per the Faculty Advisory Committee's direction. Throughout, we note the ways in which this strategy builds upon and complements existing activities.

For their support and participation in the development of the MIT Innovation Initiative report, we are indebted to President L. Rafael Reif, Provost Martin Schmidt, Sloan School of Management Dean David Schmittlein, and School of Engineering Dean Ian Waitz, as well as the Innovation Initiative Faculty Advisory Committee and Provost's Innovation Leadership Group.

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A LEGACY OF TRANSFORMATION

"With an interdisciplinary attitude and an appetite for hands-on problem-solving, we define compelling new questions, attack them in novel ways—and bring our students with us every step. Analytical, practical, economically realistic, environmentally attuned and globally aware, we instinctively work across boundaries and use the power of human organizations to deliver useful innovation to the world."

— President Rafael Reif, "Presidential Charge to the Committee to form an MIT Innovation Initiative," October 17, 2013

MIT has never been an ivory tower where learning and research occur in isolation from real-world challenges and problems. Rather, MIT has reflected, responded to, and in many cases, anticipated the evolving needs of the world. From the industrial age to the biotech revolution, MIT has continually positioned itself to promote transformative, high-impact innovation to meet the challenges of our times. Throughout its existence, one constant remains: the commitment of the Institute, its faculty, staff, and students to perform groundbreaking research and advance the frontiers of both fundamental and applied knowledge in service to humanity. As we chart the future of innovation at MIT and define the mission of the MIT Innovation Initiative, the committee is inspired by the myriad ways in which MIT has reimagined its role in building innovation upon its foundation of research and education excellence.

A Founding Vision Rooted in Innovation

William Barton Rogers founded MIT in 1861 to serve the technical needs of the emerging U.S. industrial revolution by training engineers through "the most earnest co-operation of intelligent culture with industrial pursuits."[1] Rogers saw the need for a new kind of institute that would integrate sound training in the foundations of natural sciences with hands-on learning in practical arts. The key academic innovations that he advanced involved bringing engineering to science and practice to scholarship. He observed the "ever-enlarging web" woven from connections between scientific discovery and the growing industries of the day—farming, manufacturing, and railroads[2]—and sought to create an institution where students would understand as well as practice the entire innovation process from discovery to impact.

[1] http://libraries.mit.edu/archives/mithistory/pdf/objects-plan.pdf.
[2] http://libraries.mit.edu/archives/mithistory/pdf/objects-plan.pdf.

Thus began MIT's tradition of positioning itself to serve the world, by translating knowledge into solutions to real societal problems. This vision was realized through a then-novel integration of education and research, with spaces emphasizing laboratory instruction—thereby connecting theoretical learning with hands-on application: *mens et manus*. As the Institute's physical footprint expanded over time, so did its innovation-enabling infrastructure. For more than a century, large-scale tools such as the MIT Wright Brothers Wind Tunnel and the MIT Towing Tank have proven instrumental in pushing technology's boundaries. In the mid-20th century, student demand led to the creation of new "maker spaces" such as the Hobby Shop—places where any MIT student, regardless of major or experience, could work on a wide range of well-maintained machines and tools, and receive instruction as well as practical design and building advice.

MIT's expansion was catalyzed by progressively stronger partnerships with industry—a decision described in then-President Richard Maclaurin's "Technology Plan" of 1919. The change was also affected by MIT's move to a location in Cambridge dominated by industrial (rather than residential) activity. With leaders from General Electric, Bell Labs, and others serving on Institute advisory committees, the evolution of MIT's partnership model ensured that Institute research focused on questions relevant to the real world, and that students were well trained for making an impact in the corporate workforce.

Ultimately, MIT emerged as an innovation powerhouse in the late 1920s and 1930s when MIT's ninth president, Karl Taylor Compton, insisted that this keen industrial awareness be paired with exceptional institutional strength in advanced scientific research. This commitment to basic science as the foundation for education and innovation remains central to MIT's mission and identity.

The War Effort

In the early 1940s, MIT distinguished itself at a time of global crisis. Only months prior to the attack on Pearl Harbor, President Franklin Roosevelt created the Office of Scientific Research and Development, naming as its director Vannevar Bush, a former professor and dean of MIT's School of Engineering. In that role, Bush harnessed the power of MIT to provide America's military research with both a sense of direction and a sense of urgency.[3]

MIT responded to the call for accelerated innovation in emerging technologies by organizing the now-legendary radiation and instrumentation labs, which contributed some of the most foundational technical ideas of the 20th century. Wartime radar,

[3] Dizikes, Peter, "A Difference Maker," MIT News, February 16, 2011, http://web.mit.edu/newsoffice/2011/timeline-bush-0216.html.

inertial guidance systems, microwave technology, and the framework for modern-day personal computing all grew out of these efforts—not to mention the guidance and computer systems that enabled NASA's Apollo rockets to take our astronauts, including MIT alumnus Buzz Aldrin (ScD '63), to the moon and back safely and reliably. After the conclusion of the war, the Radiation Lab was succeeded by the Research Laboratory of Electronics (RLE) and MIT Lincoln Laboratory; the Instrumentation Lab became Draper Lab, a nationally recognized nonprofit research and development laboratory.

Engaging for Impact in the Late 20th Century

While the Institute had deepened its ties to government in service to war research needs, by the late 20th century its labs re-engaged more directly with industry—pioneering approaches to intellectual property rights and welcoming to the MIT campus, corporate employees who were dedicated to participating in joint research and education projects with the MIT community. MIT had begun to reinvent itself again—in this instance, through experiments in new forms of stakeholder engagement that would fuel cross-disciplinary research, help shape the digital age, and usher in the biotech revolution.[4] MIT's groundbreaking Microsystems Technology Laboratories (MTL), Media Lab, and Biotechnology Process Engineering Center (BPEC) are but a few of the MIT research centers founded or reorganized during this period.

The era also saw the growing engagement of entrepreneurs and corporate partners focused on launching MIT ideas into the marketplace with an emphasis on impact. From this new entrepreneurial focus came two distinct approaches to innovation:

1. Partnerships between large corporations and particular laboratories or faculty members focused on addressing the innovation and hiring needs of individual organizations; these are supported by groups that include the MIT Industrial Liaison Program, Office of Sponsored Research, and Technology Licensing Office.

2. Tight links between MIT faculty and the risk capital[5] community that help to spur the transfer of MIT-generated ideas from the laboratory to the marketplace through the creation of startups. This activity is currently supported through centers and offices that include the Martin Trust Center

[4] Not coincidentally, the 1980 Bayh-Dole Act was passed early in this formative period, "awarding the rights to [federally funded inventions to] institutions, like universities." This Act reversed decades of government policy retaining title to federally funded inventions and only licensing them non-exclusively, which had left companies with little (and perhaps negative) incentive to commercialize government-funded research. The passage of the Bayh-Dole Act enabled academics to "push patents into practical use," spurring new forms of engagement with industry and new avenues of impact through commercialization for universities. See, "The Fair Rewards of Invention," The New York Times, June 7, 2011, http://www.nytimes.com/2011/06/08/opinion/08wed3 html?_r=0.

[5] Risk Capital refers to debt of equity funding, which can include venture capital, private equity, bank debt etc. In this context, we consider government as providing early stage funding through grant-based mechanisms.

for MIT Entrepreneurship, Deshpande Center for Technological Innovation, Legatum Center for Development and Entrepreneurship, Technology Licensing Office, and Venture Mentoring Service.

These new models for collaboration helped align MIT research more closely with real-world problems in areas ranging from materials science and computer science to cognitive science.[6] Research collaborations between MIT and corporate partners have led to advancements in fields that include nuclear technology, microelectronics, battery technology, bioengineering, solar technology, information displays, 3D printing, robotics, and medicine.

Confronting Another Pivotal Period

During each period of its history, MIT has remained true to Rogers' founding mission to provide an education and activities "conducive to the progress of invention and the development of intelligent industry." We now find ourselves at the onset of yet another pivotal period, one where the challenges of our time must be met by the capabilities of our students and faculty working with everything from nano-scale materials to terabyte-sized data stores. Despite the already rich array of innovation and entrepreneurship (I&E) focused centers and programs on the MIT campus and throughout our extended community, collection of extensive feedback (summarized in the next section) compels us to again mobilize to expand existing approaches and implement new ones that will enable MIT to remain at the forefront of innovation education and practice.

Innovation practice programs, communities, and infrastructure, together with developments in the science of innovation advanced through the MIT Innovation Initiative, will prepare our students, research staff, and faculty to confront the significant global challenges we face in areas ranging from energy and climate change, to healthcare and poverty, to food and water scarcity, and more. They will therefore complement MIT's new and ongoing initiatives in research and education, providing broad support for innovators throughout our community, across all five schools, our alumni community worldwide and the broader community of likeminded innovators.

[6] The Center for Learning and Memory (1994) – which was folded into and expanded through the Picower Institute for Learning and Memory (2002), the McGovern Institute (2001), the Broad Institute (2003), and the Institute for Soldier Nanotechnologies (2003) were all established in the decades that followed, building on and pushing forward these successful experiments in braiding advanced multi-disciplinary research with deeper and broader collaborations with industry and other stakeholders.

MIT INNOVATION INITIATIVE STRATEGY

Four-part strategy:

1. **Develop capabilities through enhanced innovation education and practice opportunities.** MIT should strive to become the world leader in fostering idea-to-impact education—an approach to teaching and learning that provides hands-on experiences that build our students' capabilities to develop ideas for solving real-world challenges and bring them to fruition. Our strong research activities should be supplemented with activities and programs designed to further extend beyond publication to include practical solutions that can be scaled and brought to problem-rich settings through appropriate organizations, partnerships, and policies.

2. **Develop the science of innovation in ways that inform practice and policy.** The drivers and outcomes of innovation warrant rigorous, multi-disciplinary analysis that increases our understanding of how to generate innovation more constructively, efficiently, and effectively. Examination, quantification, and qualification of the science of innovation will increase MIT's convening power in the global innovation economy and provide evidence-based recommendations for the design of our own innovation practice programs. The findings will also inform corporate and policy leaders, broadly engaging MIT with global decision-makers.

Our work in innovation practice and science will be supported by targeted efforts to:

3. **Extend innovation communities.** We must foster vibrant communities (locally and globally) that connect MIT students and faculty with external partners across sectors. These innovation communities will bring together five stakeholder groups—entrepreneurs, academics, policymakers, corporations, and risk capital providers—to engage in problem exploration, problem solving, and implementation of scalable solutions.

4. **Revitalize innovation-centric infrastructure**. We require new infrastructure to support our innovation education and research—places where innovators can realize their plans for solving problems and scaling solutions while on campus. New physical spaces are required to enable our innovation education and practice programs in a more global context.These spaces will be complemented by new digital infrastructure to link our community together (and enable sharing of tools and equipment) and to link our MIT-based community with alumni and others in key global hubs of innovation.

In the following pages we describe a series of programs and activities that are intended to accomplish all four parts of this strategy.

INNOVATION EDUCATON & PRACTICE

While MIT is already regarded as a leader in idea-to-impact education, if we are to tackle the world's most daunting problems and achieve our ambitious goals, we must ensure that our students, postdocs, and faculty have a way to further their abilities to define problems, scale solutions, and design organizations and policies to deliver them. This can be accomplished by expanding the capacity of existing I&E opportunities (such as D-Lab courses, the Trust Center's Global Founders' Skills Accelerator program, StartMIT, GEL, and others), as well as the creation of new opportunities that fill current gaps in the student and faculty innovation 'roadmap.'

Educating the next generation of global innovators will require a formal curriculum with new classes that integrate expertise in innovation with existing, discipline-based training. We must pioneer a new approach to innovation education focused on having students build a "problem-solving portfolio" of ever more realistic real-world engagements on campus and beyond. These can take the form of curricular activities, but we must also make room in students' lives for extracurricular innovation projects. In that spirit, we recommend the creation of new programs that span undergraduate, graduate, and postdoctoral education:

- **Undergraduate Innovation Programs.** Our students have asked for a more innovation-focused education that aligns with their course of study and complements—rather than competes with—time spent on their discipline-based education. We propose a new undergraduate innovation and entrepreneurship minor (presently under development by the Task force for an Undergraduate Minor in Entrepreneurship) to ensure our students can engage more deeply with the engineering, scientific, economic, and social dimensions of their innovation projects.[7] It will include foundational classes providing the skills needed to design and scale solutions, build organizations to deliver solutions, and understand the context in which innovation drives economic and social welfare. Electives may be drawn from existing capstone courses already offered across a wide range of MIT departments. Across the minor, students will have the opportunity to develop their problem-solving portfolio, linking their experiences to real-world problems.

  In addition, we recommend expanding the newly piloted "innovation diplomacy" program that builds on our students' global experiences (through MISTI and other programs) and uses them as a platform to learn how different ecosystems enable or limit innovation around the world. Through the program, students link their global internships to their innovation education via visits,

[7] Luis Perez-Breva, Douglas Hart, and Fiona Murray, "Proposal for New Undergraduate Minor."

analysis, and stakeholder interviews, preparing a generation of MIT "Innovation Diplomats" to engage for impact worldwide.

- **Graduate Student Innovation Programs.** Feedback from the community indicated a clear demand to increase leadership and I&E programming for graduate students. We recommend the creation of a Graduate Leadership Program (inspired and led by the experience of the Bernard M. Godon-MIT Engineering Leadership (GEL) Program). And, building on the experience of graduate education led by the Martin Trust Center for MIT Entrepreneurship, the creation of an E&I Graduate Certificate that could be built upon the foundational courses of the undergraduate minor.

- **Postdoctoral Innovation Programs.** There are significant opportunities for postdoctoral researchers to assume an essential role in bringing innovative ideas closer to impact. We recommend that MIT design and develop postdoctoral Innovation Fellowships that recognize and support researchers working to advance innovations beyond discovery to real-world impact. Existing models include the Translational Fellows Program, which provides postdocs funding to focus 20% of their time on the commercialization of a technology originated in MIT research. The recently launched IMPACT Program focuses on advancing postdocs' abilities to shape and create career opportunities in academia and industry. Together these programs serve as a model for education and training activities that focus on how innovations can be made real by understanding the problem context of research projects and taking steps towards meaningful impact.[8]

- **Student Innovation Fund.** Across all levels—undergraduate, graduate, and postdoc—there is great demand for increased access to small amounts of funds for student-led innovation projects. The establishment of a Student Innovation Fund would allow students and postdocs to extend their problem-solving abilities by providing modest funding (from $1,000 up to $20,000). Funding to deepen problem understanding, or to develop solutions (e.g. in the form of maker funds) would serve as a key co-curricular complement to the undergraduate minor for students to develop their leadership capabilities and gain experience in managing development budgets and schedules. The fund would provide for the expansion of an enhanced set of co-curricular educational programs such as the highly successful StartMIT and StartIAP short courses to a greater number of departments.

- **Innovation Year.** This program will address a key challenge identified by students, faculty, and alumni: While enrolled, students struggle to find the time needed to fully dedicate themselves to an I&E project. And yet, immediately after graduation

[8] This recommendation is based on a proposal piloted and developed by Professor Yoel Fink, Director of the RLE.

they are cut off from resources (e.g., MIT I&E coures, building/shop/tool access) as well as basic needs (health care, housing, foreign student visas). The Innovation Year is imagined to be a post-graduation opportunity for MIT students to pursue an I&E project, while maintaining an affiliation with MIT. Projects may be entrepreneurial, but also more innovation-oriented (extension of UROP explorations or projects from 'passion projects' classes). This program would build upon the experiences of the Global Founders' Skills Accelerator, D-Lab Scale-Ups, and Media Lab E14 Fund, which provide alumni (and in some cases current students) with funds and mentorship needed to pursue larger scale investment.

- **Faculty-led Innovation Research Support.** Given our faculty's continued calls for support in bringing ideas-to-impact, we recommend expand ing the Desh - pande Center's grant funding for proof-of-concept research, extending its "catalyst" mentoring program, and linking its work ever more closely with educational activities for faculty and students of all levels. This could include the formalization of funding student and postdoctoral translational research projects through the creation of "Innovation Fellowships" that could take the form of innovation Undergraduate Research Opportunity Program (UROP) positions (I-UROPs), Graduate Innovation Assistantships, or even faculty endowed innovation fellowships. It might include the expansion of the Innovation Teams class.

Throughout these programmatic activities, the Initiative will be committed to linking the practice of innovation with the emerging science of innovation so that activities take place with the full benefit of an evidence-based approach to the innovation process. The Initiative will also strive to facilitate communication between leadership of complementary existing I&E programs, centers, and courses across MIT.

INNOVATION RESEARCH & POLICY

Building upon a robust body of scholarly and practical knowledge related to innovation, MIT is uniquely positioned to pioneer the emerging science of innovation—a field we define as "the systematic analysis and understanding of the conditions that shape innovation outcomes." These outcomes may happen rapidly or over long periods; arise at the level of individuals, organizations, regions, or nations; and be influenced by a broad range of economic, social, psychological, and physical factors.

The MIT Laboratory for Innovation Science and Policy (which has been initiated with the formation of the MIT Innovation Initiative, and is referred to below as the "Lab") will serve as a center that unites multidisciplinary talent from all MIT schools to develop new evidence-based knowledge of the innovation process. Its activities will promote new data, methods, and metrics related to innovation science; translate evidence-based insights into practical recommendations for industry and policy partners in the form of an Innovation Science Series, Challenges of the Innovation Economy Symposia, and Innovation Metrics Conferences. We will also follow MIT's tradition of turning an analytical lens on its own practices by examining the innovation practice programs outlined in the previous section, the I&E activities of our alumni (as captured in the Alumni Innovation survey) as well as related initiatives taking place in Massachusetts, in the organizations of our corporate partners, and in different contexts around the world.

Developing the Science of Innovation

Our efforts to lead the science of innovation will be aided by seed research funds that bring fresh multidisciplinary perspectives to bear on our understanding of innovation-related processes and outcomes. The extended global reach enabled by the MIT Regional Entrepreneurship Acceleration Program (MIT REAP) executive education, as well as MIT's global innovation nodes, will allow us to engage with a range of worldwide stakeholders, examine the effectiveness of innovation policies, and explore innovation programs in a range of comparative international settings.

We will encourage collaboration between the MIT Sloan School of Management and the School of Humanities, Arts and Social Sciences, where a critical mass of faculty in this area are housed, and will utilize the domain-based expertise of faculty in the School of Engineering, the School of Science, and the School of Architecture and Planning. We propose to emphasize deeper links among groups in the Program in Science, Technology and Society; the HASTS program; Sloan's Technological Innovation, Entrepreneurship and Strategic Management Group; and the Department of Urban Studies and Planning. In addition, we will encourage the involvement of

Visiting Innovation Partners and other key stakeholders, most notably individuals from our corporate partnerships and institutional partners such as the World Bank and USAID.

The Lab will undertake a targeted set of initial activities central to its mission. Each represents an actionable strategic priority that will engage stakeholders, catalyze research, and immerse the study of innovation in its practice:

- **Innovation Scholars.** The Lab will catalyze innovation science research by developing programs for Innovation Scholars—students in Masters or PhD programs developing the underlying academic foundations for the effective study of innovation science. These programs will foster students' ability to contribute to this emerging field by supporting them to complete an independent thesis in innovation science under the supervision of an advisor and linking them to a monthly seminar of other scholars.

- **Research Seed Fund.** The Lab research seed fund will bring faculty together to study the process of innovation using novel approaches to data/metrics and visualization, as well as new experimental approaches including program evaluation, online experiments, and novel survey instruments. Available to faculty across MIT, the fund will support research projects with the potential to build systematic evidence about how the innovation process works and the factors that affect its rate, direction, and trajectory.

- **Challenges of the Innovation Economy Symposia.** The Lab (together with its Innovation Scholars and Visiting Innovation Fellows) will convene multi-stakeholder symposium (in Massachusetts and around the world) to share insights and define the most challenging areas for new research across key themes, and develop pathways of action (based on research and practice).

Key Themes for the Science of Innovation

Initial themes have emerged from conversations with faculty across the Institute and with our corporate and policy partners. They represent particularly salient opportunities to further the science of innovation and address key questions confronting the future of the innovation economy:

- **Innovation Metrics.** We will establish MIT as a world leader in the development of robust and relevant innovation metrics. Our objective is to push forward both research and practice, generating novel forms of measurement and visualization that will advance our assessment of the innovation process. Our research will allow for broader convening and will proceed

on parallel, but overlapping, tracks—ecosystem-level, firm-level, individual/team-level—each convening industry and policy leaders with scholars from MIT and around the world to set objectives, design the innovation science agenda and track research progress.

- **Policies and Programs for Innovation Ecosystems.** Much of the innovation-driven economic activity takes place in highly concentrated regions often referred to as innovation ecosystems. However, across many regions in the global innovation economy, challenges, bottlenecks, and barriers arise. Through our focus on innovation policy and innovation program evaluation, the Lab's research will identify and assess potential interventions that enable regions and organizations to have more effective economic and social impact. These may include: novel financing approaches for the earliest stages of the innovation process; policy changes (e.g. foreign student visa policy); the effective use of programs such as accelerators and prizes to accelerate innovation and enable cultural change. In pursuing this theme the Lab will build upon current research activities that are part of the MIT REAP executive education program, the Industrial Performance Center, and Samuel Tak Lee MIT Real Estate Entrepreneurship Lab. Its approach will integrate perspectives from areas as diverse as political science, urban planning, and network analysis. The perspectives and insights of partners engage throughout the MIT Innovation Initiative will play a central role in this theme.

- **Participation in the Innovation Economy.** This theme considers the role of underrepresented minorities and women in the innovation economy, with an emphasis on understanding the barriers to full and equal inclusion. Building on a tradition of research in these topics by MIT's own faculty and collaborators, it will examine how students, faculty, and alumni forge influential careers, both as inventors and as entrepreneurs. The theme will build on the research conducted by faculty in anthropology, management, science, and the Technology & Society Program, and with representatives from MIT's schools of Science and Engineering who are addressing these issues.

- **Advanced Manufacturing and Production in the Innovation Economy.** Building on and supporting the work of Production in the Innovation Economy (PIE) and Advanced Manufacuring (AMP 2.0), this theme will provide a setting for faculty teams to promote collaborative research and analysis that would deepen MIT's understanding of how emerging production platforms can be scaled in ways that can help shape entire economic sectors.[9] These communities

[9] This may include the study of safety and policy impacts of these technologies. See: Autor, Levy and Leonard, "Understanding the Labor Market Impacts of Computerized Work" – White Paper to MIT Innovation Initiative & Leveson, Sussman, Carroll, Stephanopoulos and Finklestein, "Multidisciplinary research in system safety and security" – White Paper to MIT Innovation Initiative.

> will engage stakeholders that include entrepreneurs, investors, academics, policymakers, corporate partners, external research organizations, and internal stakeholders such as representatives from MIT Lincoln Laboratory. We will begin this effort by involving external partners as well as the MIT-Massachusetts Advanced Manufacturing Collaborative, which focuses on multidisciplinary topics such as developing and scaling transformative technologies, workforce strategies, and government policies.

In response to faculty demand, the Lab may also establish specific projects to examine how these issues affect MIT's own innovation infrastructure. Throughout the Innovation Initiative feedback process, MIT faculty have asked for the Institute to self-reflect on policies that govern technology licensing, conflict of interest, the tenure process, and corporate relationships.

INNOVATION COMMUNITIES

The innovation education and practice and innovation research and policy efforts outlined above represent the 'mind and hand' of the MIT Innovation Initiative. To accomplish these goals, our conversations with students, faculty, and external stakeholders have indicated that cultivation and strengthening of innovation communities is needed. Many described the process of engaging with MIT's I&E resources, programs, and activities—both locally and globally—as fragmented. In response, we propose tighter integration of innovation communities that support the collaboration and the coordination required to define problems precisely, generate compelling ideas, and translate those concepts into impact.

We envision three types of communities:

1. Student/postdoc communities focused on linking our students and postdocs with shared interest in I&E across campus to one another and to key mentors.

2. External partner communities focused on linking MIT more closely to corporate partners and entrepreneurs.

3. Global impact communities focused on embedding MIT with key stakeholders in problem- and solution-rich innovation hubs worldwide. In each instance, a key area of emphasis will lie in connecting our more than 130,000 MIT alumni to the core of these communities.

Student/Postdoc Communities

Based on student feedback, we recommend the following activities to support vibrant innovation communities that enhance collaboration among students and postdocs of various backgrounds, academic departments, and interests:

- Each semester, convening the leadership of the more then 40 MIT student clubs focused on I&E activities, to discuss areas of collaboration and gaps in extracurricular support.

- Supporting the expansion of the Trust Center's Practice Leaders Program, that identifies I&E student leaders in a range of sectors (health, energy, fintech) and provides them with resources to create new programming for their peers.

- Creation of an online tool that maps student pathways (courses, funding opportunities, extracurricular activities) related to innovation and entrepreneurship on and off campus.

- Complementing the online pathways map by training and deploying Innovation Advocates (including staff members, alumni, and others) who will devote their time to working with students to provide guidance on MIT's relevant I&E resources.

Corporate and National Lab Partner Communities

When it comes to capitalizing upon innovation, MIT's partners (whether they are local or located around the world) face challenges that galvanize the MIT community. To more rapidly deliver innovations with lasting impact, they, like the Institute, must recognize global problems, build solutions that are reliable at scale, and structure their organizations and collaborative models to yield maximum impact. Through the Innovation Initiative we seek to strengthen our links with external partners with several new elements

- **Designing Collaborations for Impact.** We will invite our partners to join us in structuring and implementing productive university/industry/government partnerships that deliver global impact at scale. As we deepen our collaborations, we will invite our partners to spend time in our labs and centers—building on the experience of programs such as the industrial partnerships of MTL—to bring them closer to our fundamental research and lending their expertise to proof-of-concept and proof-at-scale activities. We also aim to deploy small teams of undergraduates, PhDs or postdocs to collaborate on key innovation projects at external organizations: these may be structured as part of classes, extracurricular activities, clubs or other types of engagements.

- **Sharing Global Problems.** Both on campus and throughout our global network, we will engage with industry and other organizations in ways that enrich and inform the problems on which our community chooses to focus. Potential efforts in this area include "challenge days" attended by faculty, students, postdocs, and partners to prioritize areas of joint interest. An understanding of shared challenges enables follow-on elements; e.g., jointly engaging in hackathons and idea challenges (as pioneered by the MIT Public Service Center) that promote clearer problem definition and rapid ideation, as well as company projects. Through these interactions our students and faculty will be working more closely with partners, allowing more effective deployment of human capital and opening of other potential avenues for accelerating translation of ideas-to-impact.

- **Proving Solutions.** Through proof-of-concept Seed Grant funding mechanisms supported by our partners, with proposal calls structured around clearly defined global problems, we will deepen our ties to external partners through ongoing research. Other modes for proving solutions with partners include support of

Innovation Fellows and exchanges of human capital, both on the MIT campus and at partner facilities.

- **Collaborating on Solutions.** In order to design effective collaborations, we will not just define programs, but also engage with external partners and offices across MIT (especially the Industrial Liaison Program) to develop a shared language for integrated engagement. We will also deepen our partnership with MIT Lincoln Laboratory and develop additional interactions with the National Lab system, military laboratories, U.S. government agencies, and multilateral development agencies that can serve as key partners for many of these activities.

- **Visiting Innovation Partners.** Modeled after the existing Entrepreneur-in-Residence program at the Trust Center and the Designer-in-Residence program at D-Lab, short-term Visiting Innovation Partners would work direcly with MIT scholars to better understand the complex processes involved in taking innovation beyond invention to address urgent global problems. These thought and action leaders would be drawn from policy, corporate, risk capital, and entrepreneurial settings. We expect to engage key research staff from MIT Lincoln Laboratory as part of this program, and benefit from their demonstrated ability to identify the most fertile ground for ideas across a broad range of technological problems.

- **Women in Innovation, Science and Entrepreneurship Program.** In both industry and academia, women are significantly underrepresented in I&E activities. Empirical evidence suggests that this stems in part from systemic barriers and challenges that both frustrate individual ambitions and deprive the world of potential talent. We recommend establishing the Women in Innovation, Science and Entrepreneurship (WISE) Program that links undergraduates, graduates, and postdoctoral women, and is dedicated to promoting the role of women in innovation and entrepreneurship. Opportunities might include engaging risk capital stakeholders interested in ensuring the role of women leading and funding entrepreneurial organizations, and women leading entrepreneurial ventures and large corporations who can serve as role models and mentors to others.

Global Innovation Communities

Consistent with the community recommendation to deepen global engagements focused on innovation, the Innovation Initiative will identify opportunities for members of our community to engage with likeminded innovators in problem- and solution-rich areas around the world. In doing so, there is an opportunity to build on the long tradition of “science diplomacy” that forged mutually beneficial relationships

among scientists around the world (often in times of political conflict) to inspire an era of "innovation diplomacy" that brings innovators, entrepreneurs, corporations, and policymakers together to focus on shared global challenges.

Structured Innovation Engagements

The Initiative proposes engaging with global regions through a structured, leveled approach meant to invite participation from I&E centers and programs across MIT:

- **Level I - Student Connection & Innovation Capacity Building:** These activities focus on direct connections among MIT students and those from innovation partner regions. Examples include MISTI experiences,D-Lab and MIT Sloan Action Learning courses, IDEAS Global Challenge prizes, Land the Trust Center's GFSA international engagement.

- **Level II – Identifying Regional Innovation Champions:** The next level of partnership for an innovation region is to engage in programs that identify and educate innovation champions from across the major stakeholder groups in the regional ecosystem—academia, government, corporations, entrepreneurs and risk capitalists. Examples include MIT Sloan Executive Education and MIT Professional Education programs, international Visiting Innovation Partners, and innovation visits for MIT faculty.

- **Level III – Catalyzing the Region's Innovation Ecosystem:** A region with innovation champions will be ready for deeper engagement focused on catalyzing their entire ecosystem by participating in the MIT Regional Entrepreneurship Acceleration Program (MIT REAP). Additional catalytic activities may entail the transfer of signature MIT models and programs into the region, which may include Deshpande Center-inspired translational research funding, the creation of structured competitions and hackathons, and development of mentor networks modeled after the Venture Mentoring Service.

- **Level IV – Building Lasting Infrastructure through MIT Global Innovation Nodes:** The deepest level of relationship would create MIT global innovation nodes ("Nodes"). This unique proposal to develop a small number of Nodes (outlined in more detail below) is an approach that will expand MIT's footprint into regions with strong I&E leadership, whose social and economic challenges (and/or resources) are of particular interest to MIT students and faculty. The Nodes will enhance MIT's ability to have global impact through innovation, while also building innovation communities with diverse partners.

Global Innovation Nodes

Inspired by several decades of global engagement with international partners, we propose establishing a set of MIT global innovation nodes that will serve as focal points for MIT's global innovation programs. By engaging with academics and other key corporate, government, and entrepreneurship stakeholders in key innovation hubs around the world, we will build a stronger community and provide significantly enhanced opportunities to our faculty, students, and partners, as well as our alumni.

We envision the Nodes as vibrant, small-scale centers that expand MIT's innovation footprint. MIT could ultimately develop a network of Nodes in regions that offer geographic diversity and reach, as well as distinctive, problem- and solution-rich environments that further the idea-to-impact goals of our students and faculty.

Focus of the Nodes is on bringing programs from the MIT campus out into the world for the benefit of our students, faculty, alumni, and partners. While each center's design and emphasis will vary regionally (consistent with the specific challenges and opportunities in that region), all will be physical spaces where students, faculty, alumni, and partners gather for events and co-working, as well as for week- to summer-long programs focused on building innovation capabilities.

Sample Node activities:

- Nodes may host courses and events for current MIT programs, such as D-Lab, and house the international expansion of I&E programs such as the GFSA and StartMIT—possibly with a range of local academic partners. Nodes could also provide global locations for professional development and executive education programs.

- Current MIT students may travel to Nodes to develop a global perspective on innovation and become immersed in ecosystem-enhancing programs such as MISTI's internship program, D-Lab Study Abroad, PSC Fellowships, the Innovation Diplomats Program, Media Lab activities, and G-Lab projects with local corporate partners and other stakeholders.

- Nodes may provide a home base where MIT faculty can engage in sustained collaborations with international Visiting Professors/Fellows of Innovation focused particularly on global proof-of-concept or access to location-specific test-bed infrastructure (building on the experience in Singapore).

- Nodes may enable remote alumni and other key stakeholders to support on-campus innovation programs via tele-presence mentoring and innovation advocacy. They may host ongoing MIT Alumni Association events and serve as a co-working space for MIT alumni building local entrepreneurial firms.

Global Innovation Education

There is significant demand for MIT's unique, evidence-based approach to innovation and entrepreneurship by individuals, organizations, regions and nations around the world. Several efforts to expand MIT's reach are already underway (such as MIT REAP) and the Innovation Initiative will support their expansion and growth in partnership with offices across campus, including MIT Sloan Executive Education and MIT Professional Education.

MIT's Office of Digital Learning (ODL) can also serve as a key partner in ensuring that the Innovation Initiative is enabled to 'educate the next generation of global innovators' wherever they may be around the world. This generation of innovators includes individuals around the world inspired to have impact through I&E, as well as K-12 students experiencing hands-on STEM learning for the first time. The online approach can complement the physical footprint of the global innovation nodes and the other programs within the Initiative's leveled engagement approach. We envision collaborating with MIT ODL as well as other professional education offices on campus on some of the following activities:

- **MITx Innovation & Entrepreneurship Courses.** Following the success of the MITx 15.390x course led by Trust Center Managing Director Bill Aulet (which attracted more than 40,000 participants), we propose to expand the set of courses focused on I&E. We envision online courses emphasizing MIT's expertise in engaging with innovation ecosystems, hands-on making, and management of manufacturing enterprises.

- **MITx in the Global Innovation Nodes.** One of the key benefits of MITx in building idea-to-impact capabilities is the ability to develop hybrid educational approaches that engage innovators around the world. Through effective use of MITx materials, as well as the physical bases enabled by the Nodes, we will empower many innovators well beyond the current reach of MIT.

- **Innovation MIT K-12.** MIT has a commitment to inspire K-12 students to be innovators and inventors. Current K-12 outreach programs at MIT include the Lem--elson-MIT Program, the Edgerton Center, the MIT+K12 Videos Project, Scratch, OEOP, SEPT, MIT Museum, and many more. The Office of Digital Learning has taken initial steps to promote effective communication across K-12 Programs and enhance support for all organizations. We will work with ODL to support these organizations, and engage on K-12 I&E efforts on campus and throughout the network of global innovation nodes.

A Note Regarding Alumni[10]

MIT's community of more than 130,000 global alumni constitutes a powerful source of positive social and economic impact. This alumni population is deeply embedded in each of the innovation communities the Initiative will cultivate—corporate, entrepreneurial, and policymaking. And it is widespread across the globe, but particularly in the sites of potential global innovation nodes. Establishing new forms of alumni engagement through our innovation activities will create opportunities to tap into their passion and talents in multiple dimensions: coaching and mentoring current students, serving as champions within corporate communities, and collaborating in our global innovation education.

We recommend more active efforts to reach both "concentrated" and geographically dispersed alumni who are interested in and possibly already involved in I&E. The envisioned network of global innovation nodes provides a key set of hubs to further coalesce our alumni and enhance existing MIT-led alumni engagements (e.g. StartMIT and GFSA pitch sessions). Additional opportunities will arise through targeted global outreach to alumni interested in serving as innovation advocates and engaging with innovation at MIT via the Translational Fellows Program, the Innovation Diplomats Program, the Venture Mentoring Service, and other in-person and virtual activities.

Alumni entrepreneurs are a "special interest" constituency at MIT who would also benefit from the establishment of affinity groups organized around practice areas such as energy, sustainability, and healthcare. The Institute might also consider creating an Innovators Society based on established criteria. This group would include regional chapters throughout the U.S. and around the world with one or two assemblies held annually for the entire membership.[11]

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[10] This proposal for alumni engagement is based on the input (and experience) of Professor Ed Roberts.

[11] A first move in this direction was taken in loose connection with MIT's 125th anniversary - "Event 128: A Salute to Founders" was held in Boston on April 29, 1989, led by then-President Paul Gray, honoring 100 Massachusetts entrepreneurial alumni. Its obvious success led to a second "honoring event" just a few months later in Silicon Valley. But MIT has not organized any similar event in the past 25 years.

INNOVATION INFRASTRUCTURE

In addition to enhanced communities, advancing MIT's innovation practice programs and innovation science research will require expanded capacity and deeper connectivity of infrastructure across campus. Information and communication technology have reduced the cost and complexity of remote collaboration; however, physical space and geographic proximity still play a major role in all stages of the idea-to-impact continuum. Research shows that campus buildings layouts significantly influence both the generation and diffusion of new ideas.[12] MIT's current environment has a considerable impact on our capacity for collaboration—and on the innovations that result. Therefore, we must build additional innovation-focused spaces to provide for our needs in the coming decades.

We recognize the need to greatly expand our hardware-oriented "maker spaces" across campus where students can create, prototype, and build innovations at every scale with a broad range of materials—either on their own, working in teams, or in collaboration with faculty mentors. We also envision the need for expanded spaces optimized for venture-building, to complement and expand the spaces provided by the Trust Center. In a similar vein, the Legatum Center, Tata Center, and D-Lab, can serve as extended collaborative spaces that support students focused on solution and venture creation in the developing world.

MIT.nano. In June 2014, responding to both the intense demand from faculty and students for maker spaces, and the enormous growth and opportunity in science and technology enabled by nano-scale materials and solutions, MIT broke ground on the 200,000-square-foot MIT.nano. When it opens in 2018, MIT.nano will be able to support over 20% of MIT campus research (more than 2,000 researchers annually) in disciplines from health and life sciences to energy, sustainability, information technology, and quantum engineering. Beyond advancing basic discovery, MIT.nano is designed to combine advanced nanofabrication and nano-scale imaging technologies with the prototyping space needed to transform the inventions into innovations. With its broad ability to impact innovation, MIT.nano will also become a convening point for a diverse worldwide community of researchers, industrial partners, entrepreneurs, and others who are committed to making a large-scale impact with nano-scale discoveries. The projected impact of MIT.nano reflects a broader desire by faculty to reinvigorate their relationships with external partners in areas that include taking conversations to an even deeper level before being matched with partners, entering into relationships that are more productive and less "transactional," and having deeper engagement with corporations, governments, and other organizations working in problem-rich settings.

[12] Christian Catalini, "Microgeography and the Direction of Inventive Activity," University of Toronto Rotman School of Management, Working Paper No. 2126890, October 31, 2012; Lila Guterman, "Space Odyssey," The Chronicle of Higher Education, December 10, 2004.

In addition to the above efforts, the following recommendations present a vision for spaces designed to meet the projected needs of the MIT community in coming years. Given the scope and scale of the projects involved, we propose the formation of an Innovation Spaces Subcommittee that will develop a detailed plan of action:

- **Establish Innovation East.**[13] The proposed East Campus Innovation Hub will provide expanded collaborative space concentrated on problem solving and and venture-building. The hub will house the Trust Center, the Legatum Center, the Tata Center, and key activities related to the Innovation Initiative, such as the Laboratory for Innovation Science and Policy, elements of the student project fund, and the undergraduate minor. Conveniently, this space could be a part of the East Campus redesign, serving as a link to entrepreneur ial activities occurring throughout Kendall Square. The building could include office space run independently of MIT, as is the case at the Cambridge Innovation Center, as well as space for the Technology Licensing Office and for Media Lab entrepreneurship projects.

- **Establish Innovation West.**[14] The proposed West Campus Innovation Hub, which will be located in the vicinity of the Stratton Student Center, will provide extensive and much-needed maker spaces for students and project-oriented classes in engineering. Close to the residential heart of the campus, the space might additionally provide an effective location for the GEL Program, elements of the student project fund, an outpost of the Trust Center, and base of operation for innovation-oriented student clubs.

- **The Infinite Innovation Corridor Connector.** In response to student and researcher requests to link physical spaces through a digital presence, the Innovation Initiative will develop Mobius, an online platform that connects all spaces along the "Infinite InnovAtion Corridor" and allows students to find the spaces, equipment, and expertise they need. Mobius will also enable booking, training, and certification on different types of equipment. Mapping the Infinite Innovation Corridor will also enable MIT to balance supply and demand for new spaces and equipment.[15] Efforts to develop and maintain Mobius will also compel dialogue between departments across MIT about best practices for sharing equipment and spaces that consider issues of accidental damage, use of expendable resources, and priority of scheduling for the 'home' department.

[13] This proposal is consistent with the vision for the East Campus/Gateway and the Kendall Square Initiative.

[14] We are grateful to the Dean of the School of Engineering – Professor Ian Waitz, Richard Amster (Director of Facilities, Campus Planning, Engineering and Construction) and Laura Tenny (Senior Campus Planner) for the work that they have shepherded to enable this option for expanded Innovation space to be explored.

[15] These efforts will build upon the work that has been initiated by Professor Martin Culpepper in the Department of Mechanical Engineering.

Future phases of infrastructure development could include the creation of a network of smaller maker spaces throughout campus where students could convene to work on personal projects that do not require larger facilities.[16] The Institute-wide Taskforce on the Future of MIT Education has stated that, "maker spaces at MIT could bring to personal fabrication, in the next decade, exactly what Project Athena did for computation at the end of the last century."[17] Part of this network could include Lincoln Laboratory's Beaver Works.

[16] The Undergraduate Association Innovation Committee has submitted a proposal to pilot the creation of a single space during the 2014-2015 academic year.

[17] Ibid.

FROM VISION TO ACTION

This report articulates a vision and an extensive set of recommendations for the MIT Innovation Initiative. As they are refined and implemented, they have the potential to position the Institute for leadership in the 21st century innovation economy. More than one hundred and fifty years after MIT's founding, our analysis and stakeholder feedback have left us energized by our entire community's commitment to honor MIT's mission of "generating, disseminating, and preserving knowledge, and to working with others to bring this knowledge to bear on the world's great challenges."[18] Innovation is an element of this mission, one that amplifies and extends our focus on education and research. Once realized, the MIT Innovation Initiative will leave the Institute's innovation engine transformed for continued impact in the decades to come, and ready to further adapt to oncoming changes.

Achieving the ambitious goals set out in this document will require a sustained, coordinated effort among both internal and external stakeholders, as well as significant resources.

Organization

After extensive feedback and consultation with the MIT community, the Innovation Initiative was created as a small, nimble organization reporting directly to the Provost (given its remit across education, research, and external engagement). It will continue to have joint leadership from the School of Engineering and Sloan School of Management, with input from the Innovation Initiative Faculty Leadership Team composed of faculty from all five MIT Schools. Its staff and faculty leaders will focus on standing up key prioritized programs that broadly serve the MIT community (rather than focus on programs that narrowly serve individual schools). The MIT Innovation Initiative organization will continue to closely coordinate and support key programmatic leaders whose emphasis lies in advancing innovation and entrepreneurship at MIT. It will also engage with MIT leadership in resource development, and coordinate with the MIT media and communications office to highlight MIT I&E accomplishments.

Governance

We propose several elements of governance to ensure a full range of engagement and ongoing advice from key stakeholders.

- **Faculty Leadership Team:** We propose the creation of an MIT Innovation Initiative

[18] http://web.mit.edu/facts/mission.html

Faculty Leadership Team (with members from each school and from Lincoln Laboratory) in order to ensure that the Innovation Initiative continues to benefit from a range of advisory perspectives.

- **External Advisory Board:** We propose the creation of an External Advisory Board that represents all key stakeholders. This entity will also take input from a new Lincoln Laboratory group designed to identify opportunities, encourage partnerships, and promote MIT technology at Lincoln.

- **Student Advisory Board:** This board would be drawn from student I&E leaders.

Prioritization and Timeline of Activities

The Initiative proposed in this document is a multi-year agenda that will span a wide range of stakeholders and geographic regions. Initial activities will emphasize:

- Coordination and collaboration among existing MIT programs.

- Piloting educational projects that will serve as experiments and inform the implementation of the longer-term vision for the Initiative; new courses for the undergraduate minor, pilots of the Translational Fellows Program and the IMPACT Program, and a pilot of the Innovation Diplomats Program. In each case we will emphasize cross-school engagement.

- Continued engagement with key external stakeholders to define and refine priorities for engagement. We will also undertake pilot projects with external stakeholders (especially corporate partners) including the staging of hackathons, challenges, and any additional programs that will enable us to learn and refine these novel modes of engagement.

- Close coordination with the development of MIT.nano maker space, which will allow us to test the establishment of on-campus innovation communities, as well as enable the extension of collaborations with outside innovation partners.

- The further definition of the scale, scope, and strategy for global engagement through the development of appropriate and detailed plans for the global innovation nodes—in terms of the criteria for location selection, the portfolio of locations, and the business plan for each location.

APPENDIX I: MIT COMMUNITY ENGAGEMENT AND PILOT PROGRAMMING

The scope and focus of the Innovation Initiative was defined through consultations with a Faculty Advisory Committee comprising representatives from all five of MIT's schools. This group met over four working sessions in November and December of 2013, provided ongoing feedback on ideas and report drafts, and reconvened in March 2015 following release of the preliminary report. Comments and advice that shaped this report were also received from the Provost's Innovation Leadership Group of senior faculty members and the Student & Postdoc Advisory Committee of MIT undergraduates, graduates, and postdocs. Additional feedback reached us in a variety of ways, including:

- A range of student feedback activities (questionnaires, interviews) that generated over 300 comments on MIT's strengths and weaknesses in fostering I&E on campus.
- Convening leadership of over 40 student groups devoted to I&E.
- Presentations to MIT department heads, Academic Council, and the MIT Corporation.
- Responses to an open call for faculty white papers (16 including one from MIT Lincoln Laboratory) describing multidisciplinary research areas and novel innovation activities that MIT could pursue in the short term (5-10 years) and long term (10-30 years).
- Presentation to President Reif's recently formed CEO Council and a follow-up presentation to the CTO Council.
- Over 75 presentations to MIT alumni groups, universities, and corporations in Cambridge and around the world (including accompanying the MIT Executive Committee and President Reif to present to alumni in Singapore and Hong Kong).
- Open community feedback events upon release of the preliminary report (December 2014) and on updates of high-priority pilot programs and ideas (March 2015).
- Over 200 individual student, alumni, and external partner feedback conversations undertaken by Innovation Initiative staff and faculty leadership.

Our deliberations drew upon the work of the Boyce Committee for Innovation & Entrepreneurship, which in 2012 completed an 18-month effort, jointly sponsored by the Deans of Engineering and the Sloan School of Management, which assessed the state of MIT's resources in the areas of innovation and entrepreneurship.

The key theme that emerged from these discussions was a clear sense that many on the MIT campus and beyond already take tremendous advantage of MIT's innovation-oriented resources. They are doing substantive work to solve important global challenges and take pride in the Institute's legacy of innovation and its contributions to the global innovation economy.

True to that legacy however, there was widespread agreement that we can and should do more to enable our community of innovators to have even greater impact while on campus and throughout their careers.

Student Feedback

Our students are enormously excited by the potential of innovation to solve important problems and by the power of entrepreneurship to bring those ideas to the marketplace quickly, effectively, and at scale. They demonstrate their interest in I&E through extensive participation in a broad range of curricular and co-curricular activities that build their capabilities:

- There are more than 50 course offerings in I&E subjects across all of MIT's schools, representing an enrollment of more than 3,000 students each year.[19]

- The MIT Undergraduate Professional Opportunities Program (UPOP) attracts more than 50% of MIT sophomores to pursue industrial experiences in the summer and during the academic year.[20]

- The MIT $100K business competition attracts more than 1,000 student participants in over 250 teams each year.[21]

- The Bernard M. Gordon-MIT Engineering Leadership (GEL) Program provides immersive activities to develop the character, initiative, and self-efficacy of over 20% of engineering undergraduates, many with aspirations to lead the innovation process.

- The Martin Trust Center for MIT Entrepreneurship, which provides an important cornerstone for advising current students as they explore

[19] The Committee for Innovation & Entrepreneurship, 11/15/12 Draft Report, 27-28.
[20] http://upop.mit.edu/for-students/
[21] Data from 2014 Launch Competition.

entrepreneurship opportunities on campus, has seen a four-fold increase in student demand.

- More than 225 MIT students from all schools and degree programs applied to the Summer 20145 Founders' Skills Accelerator Program designed and led by the Trust Center.

- In 2015 the IDEAS Global Challenge, run by the MIT Public Service Center, received 59 entries with over 200 team members, with approximately 20% undergraduates, 42% graduate students, and 37% external collaborators from around the world.

- Up to 300 students engage with D-Lab each year through courses and UROPs in over 20 countries in Africa, Central and South America, the Caribbean, and South and East Asia.

- Student maker spaces are heavily oversubscribed. For example, the Edgerton Center Student Machine Shop currently has a backlog for shop training of approximately 200 students—a six-month wait.[22] Similarly, the class offerings by the Glass Lab are among the most over-subscribed hands-on academic activities at MIT.

- Since tracking began in 1994, the MIT Hobby Shop has attracted over 4,700 students, faculty, staff, and alumni members. There were 89 new members in fall 2014 alone.[23]

While many students leverage the variety of I&E opportunities and resources currently available at MIT to remarkable effect, the Institute cannot currently meet the extraordinary level of demand that students have to build their innovation capabilities. With increasing demand for physical resources such as maker spaces and collaboration spaces, for financial resources for prototyping and entrepreneurship projects, and for field-based engagements with potential employers, customers and mentors, current offerings are increasingly oversubscribed and overstretched.

However, student feedback informed us that many are still unaware of the breadth of the resources available to them to pursue I&E projects. Or they are unable to effectively navigate and access them in a way that creates meaningful pathways to competence and mastery. Others emphasized limitations such as the lack of I&E-centered curricula for engineers and scientists, and the absence of an undergraduate I&E minor.[24]

[22] Dr. Jim Bales, Assistant Director of the MIT Edgerton Center.
[23] Ken Stone '72, Director, MIT Hobby Shop.
[24] Committee for Innovation and Entrepreneurship Report Draft, 14.

Students called for a "constructive program to openly innovate, i.e. explore their ideas and design prototypes, as well as start companies" that would count towards their coursework or graduate research.

The most commonly cited need, however, was for MIT to foster more effective collaboration across schools, departments, skill sets, and experience levels. Students called for leadership to "help bring together the many small and siloed MIT entrepreneurship clubs and innovation activities across campus" and bridge the perceived disconnect across the Institute's schools as they sought to build project teams to solve critical problems.

A broad range of student groups highlighted an opportunity to expand the application of MIT's ideas and ingenuity to developing-world challenges whether through entrepreneurship, not-for-profits or community-based partnerships. To that end, students recommended building closer links and more opportunities for expanded engagement with the Legatum Center for Development and Entrepreneurship, Tata Center, D-Lab, and IDEAS Global Challenge.

Students also raised concerns that MIT's academic environment "felt disconnected from the outside world and its pain points," noting that "the problems we face now are complex and often times difficult to identify without engaging the public" and that "Connecting the exceptionally gifted problem solvers at MIT with the places and people in society facing these problems is essential to foster the next wave of innovation at MIT."[25] Many of the activities proposed for the Innovation Initiative focus on connecting our students (and faculty) to problem-rich settings around the world through new, more embedded modes of engagement.

Researcher and Faculty Feedback

Consistent with the Institute's history and mission, MIT faculty are passionately engaged in basic research that deepens our understanding of the world around us, uncovers the mysteries of the universe, and expands the frontiers of knowledge. However, many also seek to discover opportunities to bring this new knowledge to bear on the world's most critical challenges. Our request for ideas elicited proposals for the translation of fundamental research into impact-at-scale in biomedical engineering, materials, robotics, infrastructure, poverty alleviation, and other subjects. Several common themes emerged. The first was a desire for increased support for idea-to-impact research. The second was the continued recognition of the need for new interdisciplinary collaborations (both within and beyond MIT). Third and more unexpected, faculty from across all Schools suggested that MIT's own scholarly insights into the innovation process—from experience on campus, in Kendall Square, and

[25] Student/Postdoctoral Committee to Innovation Initiative.

from research projects around the world—could be effectively codified and shared with others to establish MIT as a thought leader in the emerging area of innovation science.

In addition, faculty noted that while many basic research projects have unanticipated impact opportunities that emerge during initial investigations, a variety of constraints preclude or slow such research-derived opportunities from being realized. These include limitations in our infrastructure such as funding, space limitations, contractual challenges, and cultural issues.

When asked for their specific views regarding MIT's current innovation infrastructure, many researchers and faculty spoke of constraints on their pursuits imposed by the scope of their funded projects, which often fail to generate innovations beyond initial scientific discoveries. Some feel discouraged from pursuing innovations that "don't fit" within the scope of their funded lab research. The Deshpande Center, which provides funding (typically individual investigator grants) and mentorship to researchers for projects explicitly focused on idea-to-impact research, was founded to meet many of these needs. Yet due to insufficient resources (as compared to demand), only 21% of applications submitted between 2002 and 2011 received funding. Greater resources are needed to broaden the innovation pipeline and lift constraints.

Others raised concerns that they are less able to innovate in "traditional innovation spaces" such as laboratories that are "too structured" or not equipped with tools that enable them to develop their discoveries to more meaningful scales. The resources that exist to test proof-of-concept, build prototypes, and manufacture in small scale remain limited for some constituents. In our many meetings with faculty, several themes have been repeatedly articulated:

- Host more industry and policy experts on campus for extended periods of time.
- Enhance the engagement of researcher talent in the lab, including new roles as "translation" leaders or innovation assistants.
- Facilitate and expand opportunities for faculty sabbaticals with global corporations to more deeply understand industry challenges.
- Involve large corporations in funding startups as well as sponsoring research and instituting a faculty entrepreneurial training program.
- Suggest that in promotion processes, MIT include consideration of success in moving ideas to impact.

MIT researchers expressed a desire to enhance their capabilities through additional I&E courses or projects that build fundamental skills in technology transfer and

entrepreneurship. They felt that these activities, combined with additional professional development support through initiatives such as industry mentorships, would enhance their ability to make an impact at MIT and beyond. One example for collaboration came from MIT's Lincoln Laboratory, which recommended establishing partnerships with on-campus groups that would leverage Lincoln's experience in, and infrastructure for, executing large-scale projects.

At the same time, faculty asserted that MIT should not lose sight of the power and importance of basic science research and fundamental discoveries. The campus-wide effort in innovation should strike a balance between applied activities and the Institute's core emphasis on foundational science and research.

Industry Partner Feedback

While global, innovation-driven corporations have many avenues for connecting with MIT, they often find the process of engaging with the Institute to be fragmented and at times confusing. Few companies, with the exception of those with long-established ties to MIT, have a coherent and consistent approach to their relationship with MIT. For example, while many large corporations recognize the value provided by the Industrial Liaison Program, they are less certain on how to connect with other relevant organizations within MIT, particularly student-led groups. Faced with a large number of possible MIT touch points, they mentioned that they would benefit from having a focal point to help them navigate MIT—both a physical gateway into MIT (particularly at Kendall Square, where many corporate visitors arrive) and a virtual portal with a guide to MIT that features a clear roadmap to engagement and best practices.

Two other themes emerged:

1. A number of companies felt that the atmosphere to find common ground for collaboration with MIT was limited and that there exist legal barriers to discussion on both sides. In addition, occasional difficulty in finding shared agreement on intellectual property agreements hampers formation of some corporate partnerships. Such challenges undermine MIT's ability to be an engaged partner in innovation.

2. Companies appreciate the tremendous talent pool represented by MIT students, but they are not always adept at accessing that talent base. They would like to engage with students not only through hiring, but also through short-term, intensive engagements, such as corporate-sponsored hackathons, graduate and undergraduate internships, student mentoring, and consulting engagements for post-doctoral students.

Alumni Feedback

As part of our efforts to gather feedback, we conferred with alumni in and around Cambridge and the San Francisco Bay Area, as well as in Britain, Israel, Singapore, China, and other locations. We also consulted with the leadership of the Alumni Association. There was widespread enthusiasm for, and commitment to, the MIT Innovation Initiative. Alumni appreciate MIT's long history of innovation, their own contributions to innovation and entrepreneurship (as documented through the MIT Alumni Innovation Survey and the December 2015 report on MIT's global entrepreneurial impact[26]), and the activities of current students.

At the same time, there was a strong sense that MIT does not fully leverage the talents of its alumni base and its desire for engagement. Many regard I&E as a means to deepen engagement with alumni who are eager to connect with MIT students and activities. Alumni made a variety of suggestions:

- Many alumni—particularly those in the San Francisco Bay Area—expressed a desire for MIT to expand its physical presence more broadly by developing global innovation centers that would provide a convening place for the alumni community; for example, by offering co-working space for recently graduated MIT entrepreneurs and acting as a focal point for cross-generational alumni mentoring.

- Alumni asked for better digital tools to connect to one another as well as to current students on campus whom they may mentor and support in their innovation activities.

- Many expressed a desire to provide funding support for MIT students and recent graduates looking to transform ideas into impact through start-ups. Suggestions ranged from an MIT alumni crowdfunding platform to targeted giving focused on entrepreneurs.

Local and Global Stakeholder Feedback

When we consulted with members of our broader community—entrepreneurs, risk capital providers, and policymakers—about the Institute's engagement with local and global innovation ecosystems, they cited numerous opportunities to expand and improve our efforts. Our conversations revealed that MIT can and should do more to propel innovation beyond discovery and to position its students, faculty, staff, and external community to discover and develop innovative solutions that reflect global concerns, implement rapidly to scale, and deliver positive, substantive impact.

[26] Entrepreneurship and Innovation at MIT, Continuing Global Growth and Impact, by E.B. Roberts, F. Murray and J.D. Kim.

Achieving progress on these multiple fronts will require enhancements to our culture and campus that allow stakeholders to work more collaboratively through spaces and programs that support efforts to conceive, prototype, and scale for the next generation of innovation. The following recommendations are focused on Kendall Square:

- Gathering, meeting, and conference spaces available to both the MIT and Cambridge/Boston communities.

- Spaces for company incubation, acceleration, and wet labs to support early-stage ventures focused on scaling or prototyping MIT inventions.

Our conversations with entrepreneurs echoed those of large corporations, asking how they could more easily access MIT's vast array of talent and energy around the world to help confront their problems and challenges. Those in leadership roles in local communities close to Kendall Square, but without the benefit of its rich local ecosystem, pushed us to consider new ways of bringing the MIT community into their problem- and solution-rich settings well beyond the boundaries of our campus. And around the world, many asked us to consider how to engage as partners with our students and faculty to explore problems in distinctive global contexts.

Another key theme that emerged was the need for MIT to use its convening power more forcefully to engage in evidence-based policy conversations. Citing examples from the Production and the Innovation Economy (PIE) study, AMP 2.0, and the MIT Regional Entrepreneurship Acceleration Program (MIT REAP), policymakers welcomed the idea of deeper engagement with MIT on issues of innovation policy. Suggestions focused on both MIT's voice in shaping the innovation economy of Massachusetts and its thought leadership in understanding and supporting innovation ecosystems worldwide through the advances made by MIT's research community in building the foundations of innovation science.

Pilot Programming

In its first year, the Innovation Initiative tested a series of programming ideas by running a set of pilots that reflected the feedback we received and the objectives of the recommendations that follow in this report. These pilot programs are beginning to establish the Innovation Initiative as an entity that will experiment with new program ideas, support cross-campus collaboration, and evolve to meet the changing needs of the MIT community. These efforts included:

- Supporting Professor Yoel Fink (Director of the Research Laboratory for Electronics) to grow the Translational Fellows Program from 5 fellows (in 2013 cohort) to 16 fellows (in 2014 cohort) to 28 fellows (in 2015 cohort) across the Research Laboratory

of Electronics (RLE), Microsystems Technology Laboratories (MTL), Electrical Engineering and Computer Science, Biological Engineering, Mechanical Engineering, Materials Science and Engineering, and Engineering Systems Division.

- Partnering with Professor Martha Gray on the design and launch of the MIT IMPACT program for postdocs, drawing in 2014, 50 applications (from 15 departments) for 12 spaces in the pilot.

- Building collaboration among the Innovation Initiative, MISTI, and MIT REAP to launch the Innovation Diplomats Program, piloting with 3 students in summer 2014 and drawing 46 applications (from 18 departments) for 30 spaces in summer 2015.

- Establishing the foundations for the Lab for Innovation Science and Policy and using it to convene four Challenges of the Innovation Economy Roundtables that drew over 300 combined attendees.

- Hosting former Massachusetts governor Deval Patrick as the Initiative's first Visiting Innovation Partner, and renowned MIT alum, inventor, and entrepreneur Professor Robert Metcalfe as the second Visiting Innovation Partner.

APPENDIX II: ADDITIONAL CONTRIBUTORS

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In addition, the following individuals made essential contributions to the ideas and recommendations contained within this report.

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