Report of the MIT Global Environment Initiative Planning Group

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November 12, 2012

Charge from Provost Reif

The Global Environment Initiative Planning Group is charged to connect MIT's departmental and faculty efforts and needs to the constituencies that could provide resources to this initiative, including donors, research sponsors, ILP companies, and others as needed and appropriate.

These connections should be developed through discussion with MIT department heads and faculty, and through discussion with MIT resource development personnel, ILP leadership and alumni. As part of the process, the Planning Group should pursue a synergistic relationship with MITEI.

The Planning Group should also lay out a clear name, mission description, and plan of execution for the activity that could be presented to the new leadership of MIT. This would ideally be concise and actionable.

Brief Review of Previous Efforts

Interest in study of the environment has a long history at MIT, with the first formal focus at the Institute-level coming together in 2001 under the auspices of the Laboratory for Energy and the Environment (LFEE), led by Professor David Marks. The LFEE provided a forum for individuals to share interests in research and education and was the first group to promote the study of sustainability at the Institute. The LFEE provided the foundation for the diversity of multi-disciplinary study of the environment at both large and local scales.

Grassroots faculty interest in expanding the scope of activities related to the environment led to the appointment, by Provost Reif in 2007, of the Committee to Assess Environmental Activities at MIT, chaired by Professor Maria Zuber. This committee issued its report[1], aka The Zuber Report, in September 2007. The report identified significant interest in research and education on the environment by faculty, research staff and students and recommended an Institute-wide effort to raise the profile both within and outside the Institute of the extensive ongoing work already underway.

In 2008, an Environmental Research Council (ERC), chaired by Professor Dara Entekhabi, was appointed by Provost Reif to develop an implementation plan for the Zuber Report. To broaden the input into the process, the ERC was reconstituted in 2010, again under the leadership of Professor Entekhabi; and an Energy Environment Board, co-chaired by Professors Ernest Moniz and Andrew Whittle, was convened in order to coordinate environmental activities with the MIT Energy Initiative (MITEI). The ERC Report[2], which was released in April 2012, presented an outstanding and detailed research agenda that highlighted global–scale environmental problems of societal importance.

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[1] http://orgchart.mit.edu/node/6/letters_to_community/report-committee-assess-environmental-activities-mit

[2] http://web.mit.edu/erc-report/

At the time of the release of the Final ERC Report, Provost Reif appointed the Global Environment Initiative (GEI) Planning Group, which includes Professors John Lienhard and Maria Zuber. The group was asked to spend no more than six months preparing a proposal for execution for consideration by the next administration, focusing on coordination of potential future environmental activities across the Institute and plans for resource development. This report is the response to that request.

Process

In order to maintain the momentum established by the efforts of the ERC, our first step was to meet with a number of members of the ERC and the Energy & Environment Board to solicit their input on future implementation of an initiative focusing on the environment.

In May and early June 2012, we then met with various constituencies within MIT's Resource Development Office and Industrial Liaison Program in order to begin consideration of the landscape for possible external interest.

From mid-May through mid-August, we embarked on a "listening tour" of campus in order to identify the extent of faculty interest in environment-related research. A list of all individuals/groups with whom the committee met or otherwise communicated is given in Appendix 1. In summary, we met with (or in a very few cases, due to scheduling challenges, exchanged e-mail with) individuals in all five schools: Architecture & Planning, Engineering, HASS, Science, and Sloan. These included:

- The Deans of all five schools and other members of Academic Council
- The Director of MITEI
- All department heads in the School of Engineering
- Most department heads in the School of Science
- Many department heads in Architecture/Planning, HASS, and Sloan
- Numerous faculty across the Institute

During meetings with Deans and department heads, we asked for "leads" on possible interested faculty, and we subsequently contacted most individuals who were recommended to us. It is important to note that, because of the short, fixed time frame over which this phase of the study was implemented (largely over the summer), it was not possible to compile an exhaustive list of interested individuals or research topics. The goal was to identify, to the extent possible, the breadth of interests in problems related to the environment. The results of our effort are best viewed as a representative sampling of faculty interest. With the Director of MITEI and other individuals who expressed interest, we also discussed organizational relationships with MITEI.

We followed up on our discussions with requests for input, in the form of PowerPoint charts, summarizing faculty research interests. We compiled all input that we received into a master presentation. The content of the presentation is indicative of the faculty who responded to the request rather than the extent of interest at the Institute; nonetheless, that presentation runs to nearly 170 charts.

In mid-August we synthesized the available input and identified a set of broad research themes that are summarized later in this report. Using this material, we developed a preliminary high-level communication strategy for "message testing". During this time, in order to help articulate MIT's unique strengths, we updated our understanding of environment programs at competing institutions from the compendium in the Zuber Report. The current list of competing programs is given in Appendix 2.

From early September through late-October, we discussed the environment-related research agenda with constituencies within and outside the Institute: selected faculty, resource development and ILP, selected alumni, friends, industry and a foundation.

In parallel, on the basis of input received from colleagues in the Sloan School, we engaged Brandslinger Naming Group to assist us with naming the Initiative.

We submitted this final report to the President as charged.

Attributes of a Successful Environment Initiative

Considering past attempts at organizing environmental research at the Institute and the current landscape for multidisciplinary study, we identified attributes for a successful initiative on the environment:

- *Faculty interest across the Institute* – maintain involvement of those with long-term interests directly related to the environment while proactively attempting to identify greater participation. Although engineering and science participation is crucial and central, the engagement of faculty and research staff in architecture, planning, policy, human behavior and other areas of the social sciences and humanities will ensure that the full range of MIT's expertise can be brought to bear on societally-important problems. Most environmental challenges cannot be resolved solely by new technology or by scientific findings.

- *Research themes rooted in MIT's current strengths* – while selective hiring to address an essential new area might reasonably be a matter of negotiation by the leadership of the initiative with the senior administration, the driving purpose of an initiative should be to encourage and identify support for new research by current faculty.

- *Emphasis on practical solutions rooted in strong fundamental science* – the defining attribute of MIT research is that science and engineering are synergistically brought to bear on problems of societal relevance. This process of "mind and hand" distinguishes Institute initiatives from those of its competitors.

- *Potential for raising research support* – as for other MIT initiatives, support for new research must come predominantly from external sources.

- *Active support of key administrators and leadership of DLCs* – this should be automatic if there is sufficient interest from faculty. The engagement of CEE, EAPS, and DUSP is expected to be central to the initiative, but broad participation across the SoE and elsewhere will be necessary for an initiative encompassing local solutions to environmental challenges.

- *Coordination with MITEI* – MITEI already supports some environmental research that is related to energy. The relationship needs to be managed effectively to avoid competing efforts and confusion by sponsors regarding their strategic relationships with MIT.

- *Coordination of relevant efforts with the Woods Hole Oceanographic Institution (WHOI)* – As a consequence of WHOI's joint degree program with MIT, there are several synergistic efforts with environmental relevance already in place that could be productively enhanced.

General Findings

- *Substantial interest and support across MIT* – We identified considerable interest and relevant research ideas in all five schools. There are on the order of 50 core participants with likely participation from a couple of hundred faculty. Of note is the fact that a number of faculty who do not themselves perform research related to the environment expressed the

opinions that MIT should have an active program and that the Institute should take on a position of strong and visible leadership in advancing both the scientific understanding of the environment and the development of environmentally friendly technologies and manufacturing processes.

- *Strong support for a practical solutions-oriented approach* – Unfortunately, in some circles "environmentalism" has the negative connotations of being bad for business and/or hampering progress. By focusing on the solutions to problems that could yield improvement on ~5-year time frames (e.g., developing an environmentally-friendly process to replace an existing one that releases toxins, or understanding and controlling conditions that produce red tide in a particular location), MIT can demonstrate to the world that research on the environment can both help society and create opportunities. Discussion with faculty colleagues inspired the following possible **mission statement**:

    - *To lead the world in innovative, unbiased, solutions-oriented research on environmental challenges, with a firm grounding in science and engineering*

- *Abundant interest in "local solutions"* – The ERC Report emphasized global scientific problems of undeniable importance that are unquestionably worthy of study. However, this focus led a number of colleagues, especially in Engineering but also in Urban Planning and in Science, to feel that there was no place in the ERC agenda for their research, which in many cases aimed to solve particular, focused problems. When asked about interests in topics relevant to the environment with no constraint from any previous report, we received many outstanding ideas both along the lines of those addressed by the ERC Report and beyond.

- *Coordination with MITEI* – A consensus emerged that study of the environment should be separate from but coordinated with the Energy Initiative. At this point, MITEI's identity is well established, and it would be unwise to modify a highly successful brand. MITEI does currently support some environmental research related to the production and use of energy. As a case in point, MIT's successful Joint Program on the Science and Policy of Global Change has a productive relationship with MITEI.

    That said, environmental research currently supported by MITEI sponsors constitutes only a subset of the diversity of problems related to the environment in which faculty have expressed interest. There was a very strong opinion by our faculty that research on the environment at MIT should expand beyond topics relevant to energy concerns, and that such research would benefit greatly from being organized in the context of an environment initiative. Further, the faculty felt that they should be able to accept sponsorship of their research from more than one initiative if sponsors in those initiatives are interested in supporting distinct projects. Again, close coordination of the leadership of MITEI and the environment initiative will be essential in moving ahead.

Themes

The broad themes of climate, oceans, water, ecological resilience, contaminant mitigation, and sustainable societies were discussed in comprehensive detail in the ERC Report from April 2012[3]. Much of that report spoke to the excellent science-based research being done at MIT in connection with characterization of the global environment. We sought interest beyond these large-scale themes in research that addresses specific environmental challenges.

Our conversations with faculty and leadership around MIT asked the question "What are the solutions-oriented efforts in environment in your department or unit?" Essentially, we asked about

[3] The ERC report was presented in a forum held on 15 December 2011, with video archived online: http://techtv.mit.edu/collections/erc/videos

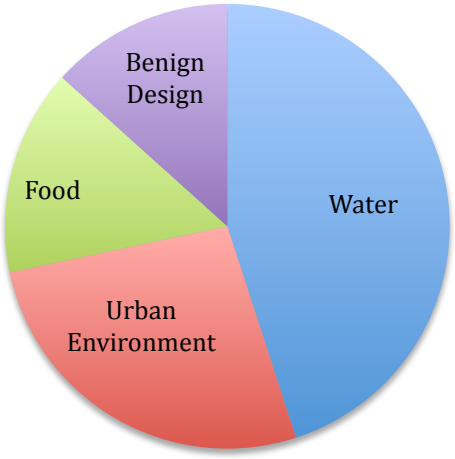
efforts at a level that was not necessarily long-term or planetary in scope. The stories we uncovered were diverse, and they represented how MIT's broad strengths are being applied to an array of problems of environmental relevance.

We heard, in particular, about efforts to solve problems that matter – concerning issues related to water, food, air quality, health, and habitation. We heard of these problems being addressed in contexts that affect our lives – cities, manufacturing, coastal regions, and developing economies. And we heard how these efforts are supported by MIT's core strengths in areas like sensors, nanotechnology, biotechnology, big data, urban environment, policy, Earth systems, benign design, and social science.

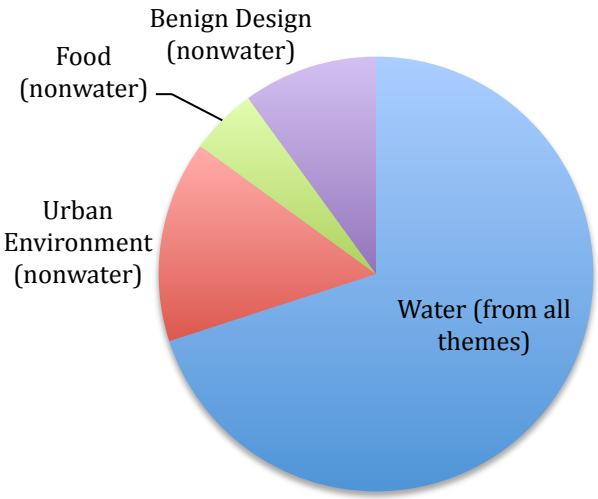
Four broad themes characterize well a preponderance of activities of our faculty, and at the same time cover many areas highlighted in the ERC Report. These are:

- Water
- Food Safety and Security
- Urban Environment
- Benign Design

The relative extent of interest expressed in these topics is summarized graphically by the following:



By a considerable margin, the theme with both the broadest and deepest interest was Water. Research in diverse aspects water is being conducted by individuals in all schools, and the richness of the topic combined with the volume of relevant research already underway indicates that it may be possible to mount an Institute-wide effort anchored by this topic in short order. We also note that water-related research has a very significant presence within the themes of Food (about 65%) and Urban Environment (about 40%). If we aggregate all this water research, the pie chart shifts as shown below:



On the other hand, we note that many faculty working on water-related research self-identify as "environmental" researchers, and they may feel some distance from an initiative that is categorized simply as "water". Additionally, activities such as urban environment research could be less effective if water is separated from other dimensions of the problem. Finally, a focus fully on water would essentially exclude benign design, which forms a core component of the initiative's practical solution thrust.

We summarize the highlights of these four themes below; additional details on all the themes are provided in an accompanying PowerPoint presentation, and several topics are covered at length in the ERC Report. We also note a few areas of intersection with MITEI in which opportunities for collaboration exist.

Water

Topics related to water were described in detail in the ERC Report, and research at MIT in this area is both strong and extensive. It runs from studies of ocean and atmospheric circulation and climate change; through water resources and hydrology, including sensing from AUVs, UAVs, and satellites; to urban water supply, distribution, and leak detection; to water purification and desalination; to arsenic in ground water; to aquatic vegetation and wetland design. In addition, MIT has several large international collaborations in which water research is an integral part (MASDAR, Kuwait, KFUPM, Singapore, etc.).

Understanding ocean circulation at scales from global to local is fundamental to addressing diverse problems ranging from the transport of terrestrial heat to nutrient distributions to contaminant dispersal. MIT's Climate Modeling Initiative, led by Professor of John Marshall in EAPS and with significant participation from Professors Raffaele Ferrari (EAPS), Paul O'Gorman (EAPS), Ron Prinn (EAPS), Dara Entekhabi (CEE/EAPS) and others, provides the modeling infrastructure essential to addressing all manner of environmental problems regarding ocean transport. Expertise at WHOI adds critical observational perspectives to the modeling work.

On the solutions side of water, we may begin with the portfolio in CEE around water supply and distribution. The Whittle group is working on wireless sensor networks for real-time management of water distribution systems; the Thompson group has developed biotechnology for the identification of fecal coliform bacteria in water supply; the Hemond group has developed AUVs for sensing water quality in reservoirs; and hydrologists in the Parsons lab are both modeling watersheds and monitoring them by satellite (Entekhabi and others). Additional work on leak detection in water distribution is being done by the Youcef-Toumi group in MechE. In water purification and

desalination, we find strong efforts in a number of departments: MechE (including the Lienhard, Karnik, Wang, Boyce, Winter, Dubowsky, Yang, McKinley, and Varasani groups); Chemical Engineering (including the Gleason, Hammond, Bazant, and Rutledge groups); DMSE (including the Grossman group); NSE (through the Kazimi group and the Kuwait Center); and EECS (through the Han group). The work on water purification and desalination is driven by new materials (e.g., nanoengineered graphene membranes, ceramic gradient membranes, advanced polymer composite membranes, zwitterionic antifouling iCVD coatings; nanofibrous electrodes for charge storage; nanoporous vapor trapping membranes; hydrophobic surfaces for controlled wetting), by thermal analysis and design of systems and cycles (e.g., solvent extraction technology, membrane distillation systems, carrier gas extraction, bubble column dehumidification, control of scale formation), by system-level concepts for low-cost modular design, and by new manufacturing techniques (layer-by-layer deposition of membranes for high rate production; electrospun membranes; roll-to-roll processing for patterned membranes); and by massively parallel microfluidic separators for ion removal.

The applications of such technology range from first world municipal water supply, through industrial wastewater remediation, to water systems that can be used in small off-grid villages. In water supply to the developing world, we have had student teams in Africa for many years through the CEE MEng program (especially under Susan Murcott). In addition, MIT faculty have been actively engaged in addressing the program of arsenic in ground water that plagues Bangladesh and other areas of South Asia (e.g., the Harvey group in CEE). Faculty are also working to understand how the fluid dynamics of vegetation govern the survival and development of plants in engineered wetlands (Nepf group, CEE).

One major observation is that water treatment research is widely scattered in the School of Engineering, with relatively little of it occurring in the Department of Civil and Environmental Engineering. Our sense is that better coordination of this research offers the opportunity for MIT to have a leading role in a topic of rapidly growing importance in environmental engineering.

The "energy-water nexus" is a topic of ongoing interest to certain MITEI sponsors, and within this area it is expected that there may be some good opportunities for collaboration between the environmental initiative and MITEI, as well as some topics that might primarily interest MITEI. MITEI's current research efforts relate to the water supply needs of energy producers (for power plant cooling, oil and gas extraction, mining, hydrocarbon production, biofuels production, decisions on how water is allocated between competing interests, etc.), the strategic implications of water supply for energy demand, and also include some activities related to energy efficient desalination. As should be clear from the discussion above, numerous problems related to hydrology, water supply, desalination, and water treatment technologies run well beyond "nexus" topics; and it may be noted as well there are substantial efforts outside MITEI on some of the energy efficiency issues.

Food

This theme came as something of a surprise, but it illustrates well how MIT faculty, working from a disciplinary base, naturally bring their interests to bear on substantive issues.

The Swager group in Chemistry has developed low-cost sensors that can detect ethylene, a by-product of fruit decay; this technology is being commercialized to help reduce the vast amounts of food wastage that occur annually. The Gleason group in Chemical Engineering has developed sensors that can rapidly detect bacteria on food, offering the opportunity to identify and contain *e coli* and *salmonella* outbreaks at the source. Nitrogen-based fertilizers for crops have driven agricultural production, but they require large energy inputs and lead to run-off that drives algae and harmful aquatic bacterial growth; as an alternative, the Voight group in BE has worked toward engineering bacteria that can perform nitrogen fixation at the roots of plants, to limit the need for fertilizers. The biology of algae blooms has been studied in detail by the Polz group and others in CEE and at WHOI, and colleagues in MechE have used AUV's and UAV's to locate potentially toxic blooms. Finally, the Makris group in MechE has used acoustic sensing to track fish populations and to aid the

Commonwealth and Federal governments in setting catch limits that are driven by data. Still other faculty (Winter group in MechE) are working on water conserving drip irrigation technology for growing crops in India and elsewhere.

As evident from these topics, an MIT effort in Food Safety and Security would clearly be problem-driven and aligned with MIT's core strengths. It would differ sharply from traditional agricultural programs at other (e.g., mid-western) universities. And it would have high potential to have a near-term impact on problems of social relevance.

Urban Environment

The human-made environments of cities are now home to one-half of all humanity; and cities as entities have enormous intakes of natural resources and enormous outflows of waste products. The design and operation of cities is entirely central to both our experience of the local environment and our impact on the global environment. MIT's strengths in urban planning, architecture, and in the use of information technology to better understand cities will be essential to an effective, solutions-oriented environment initiative.

The design of cities substantially affects the efficiency with which food, water, energy and other resources are used, through considerations such as transportation networks, the relative locations of facilities, the detailed design of buildings and their internal systems, and their ability to perform basic functions such as rainwater management or waste recycling and disposal. Further, established cities require constant redevelopment, as buildings age, as plots of land fall out of use, and as our technology for transportation, utilities, and communication evolve. And the developing world confronts us with megacities which have grown rapidly but which have had relatively little infrastructural development. Understanding how the essential processes of cities can be designed, operated, and/or retrofitted offers us the possibility to produce urban areas that are efficient in their consumption of water, food, and other natural resources, that are pleasant to inhabit, and that can continue to function effectively over very long spans of time.

Research on the urban environment is focused in the School of Architecture and Urban Planning, but also has strong components in CEE and contributions from other schools. The Tehrani group in Architecture has worked to retrofit older structures to produce LEED certified buildings. The Reinhart group examines how the massing of buildings in cities affects daylighting and walkability. The Berger group in Urban Planning has developed constructed wetlands in periurban locations to manage urban and agricultural run-off; and in collaboration with the Nepf group in CEE, they have been designing appropriate vegetation for urban wetlands for water management. The D'Hooghe group in Architecture has worked on durable infrastructures: buildings and public spaces as simple, long lasting structures with maximum flexibility and minimal functional specificity. Such designs reduce the barriers to urban redevelopment as the needs of businesses and city services change over time; these considerations extend to the design of associated multimodal transportation networks. The Wescoat group in Architecture has considered the water conserving designs of buildings, taking lessons from the architecture of historic buildings in South Asia. It is, in fact, possible through thoughtful design to slash the net water consumption of typical buildings by 50% or more. Professor Eran Ben-Joseph (Urban Planning) has worked extensively on urban stream reclamation. The Building Technology Group in Architecture (Glicksman, Norford) has done groundbreaking work on tools and techniques for designing greener buildings. Finally, through the use of modern information technologies, Professors Ratti (Urban Planning) and Pentland (Media Lab/CEE) have developed detailed understanding of human mobility patterns in cities and have proposed means to have smarter, more efficient, more responsive processes within the urban environment.

Close to home, the city of Cambridge is initiating a climate change adaptation study and has expressed interest to be a "living laboratory" for study by MIT. The MIT administration is involved in planning with the city and Jake Jacoby (Sloan) and Steve Hammer (Urban Planning) have so far agreed to participate.

The Urban Ecology Movement itself was sparked by Professor Ann Spirn's 1984 book *The Granite Garden: Urban Nature and Human Design.* Professor Ryan in Urban Design has recently extended these ideas to consider how shrinking cities can address lands that have fallen out of use. Likewise, Professor Judy Layzer has examined how the built environment has impacted rivers, wetlands, and fisheries through channelization, damming, water withdrawals or dumping, and how policies can be modified to better avoid damaging ecosystems.

Because of the obvious importance of energy issues to cities, MITEI also has a substantial interest in the Built Environment and in fact has targeted this area for a chair. This could be an area for a substantial energy-environment joint venture, in which energy, water, mobility, building design, urban planning, and "smart cities" technologies could be simultaneously addressed.

Benign Design

The design of our technologies directly drives the emission of chemicals into the environment, whether these are naturally occurring substances (CO_2, Hg, e.g.) or complex man-made compounds (MTBE, chlorofluorocarbons, synthetic hormones, e.g.). Most often, we identify these hazards after the fact, when health hazards or environmental damage result. Recent thinking has been to develop a more proactive approach to understand and minimize hazards before they arise, with the sober awareness that release and dispersion of industrial chemicals is inevitable.

At MIT, we have extensive, world-class research in all areas of science and engineering that bear upon these issues – fundamental science in chemistry and biology; materials and process design and manufacturing in DMSE, ChemE, BE, and MechE; environmental transport and ecology in EAPS and CEE; and sustainable business practices in Sloan.

Examples of research in this domain are numerous. The Schuh group in DMSE has developed nanostructured "green" coatings for truck bumpers to replace traditional hard chrome plating and its toxic/carcinogenic processing. The Allanore group (DMSE) is working on metals extraction processes that reduce effluents for processes steps and eliminate cyanide-based electrolytes. The Concrete Sustainability hub (DMSE/CEE) is examining how to cut the CO_2 emissions of concrete manufacturing. The Selin group (ESD/EAPS) is studying the dispersion of mercury through the environment and recommending policies to reduce it. The Dincă group (Chemistry) is developing metal-organic frameworks (MOFs) for environmental use. In one branch of that work, MOFs are tuned to fluoresce in the presence of specific complex chemicals, as basis for sensing accidental release in manufacturing operations; in another branch, MOFs act as purifying absorbents for salts in water; and in another branch, MOFs can separate CO_2 from other gases. The Han group (EECS) has adapted microfluidic ion concentration polarization technology for steady flow concentration of contaminants in water, thus amplifying the sensor sensitivity by two to three orders of magnitude. The Jamison group (Chemistry, Novartis Center) is developing continuous manufacturing processes for pharmaceuticals that dramatically reduce the volume of waste relative to traditional batch processing. The Gutowski group (MechE) has long focused on the overall analysis of the environmental impact of manufacturing, and has pioneered a subject on *Environmentally Benign Manufacturing.* In addition, faculty and research staff in Sloan (Sterman, Jay) are developing innovative management practices, business models, and market infrastructures that support effective, sustainable use of natural and human resources.

Execution Plan

To launch an environment initiative, MIT needs to: decide on the scope of the initial effort (a single theme, such as water, or two or more of the four themes); appoint the leadership of the effort; provide seed and operating funding for an initial period; facilitate streamlined and coordinated access to the donor community; and position the effort in a manner that will encourage cooperation from all interested DLCs and which will unite precursor efforts.

The environment initiative has benefitted from over five years of faculty discussions, and, as a result, we see no need for an additional period of focus groups and faculty conversation. Indeed, to be clear, we have had consistent, strong input from faculty that there have been enough committees on this topic and that it is time to get the show on the road. A major near-term step that remains is to strategically consider specific funding opportunities that may be relevant to the upcoming campaign.

Leadership structure

The environment initiative may not grow to as large a scale as MITEI in terms of steady state extramural research support, but on the basis of the feedback we have received we believe it can grow to the level of other successful multi-disciplinary research efforts at MIT. The leadership structure needs to be negotiated but could plausibly consist of a full-time faculty director, possibly a faculty associate director, and an executive director who is a staff appointment with a technical background. Additional support and financial staff can be added if needed as the activity develops, and the leadership arrangement itself can evolve as the funding picture changes.

The director(s) will have a principal responsibility for coordination of the effort across the Institute, for large-scale fund-raising from private donors and from corporations, and for channeling other RFPs to individual faculty. The leadership will represent MIT's overall environment effort both within and outside the Institute, highlighting the work of colleagues, facilitating workshops and other engagement opportunities, and calling attention to our strengths. Fund-raising from traditional Federal sources (e.g., NSF grants) will remain the responsibility of the faculty at large.

The leadership of the effort could plausibly work with an environmental council that will be drawn from the five schools. The council would provide advice to the leadership on various matters, such as the selection of seed grant projects, concepts for resource development, the directions and presentation of the program, educational efforts, and other topics as relevant. Council members would interact with sponsors, and they may lead subtasks as relevant.

An organization chart, in two phases, was given in the ERC Report (Figs. 4.1 & 4.2, pg. 65), and it remains a plausible model for operating an activity of this type.

Coordination with MITEI is essential, and discussions with the Director of MITEI have established a commitment to constructive interaction. Details of this coordination should be discussed among the senior administration and leadership of the Environment Initiative, MITEI, and any other large-scale initiatives that may be formed. Open communication and cooperation among these efforts is the goal.

Environmental Minor: Recently, a template for an undergraduate Environmental Minor was developed by Professors Susan Silbey (Anthropology) and Amy Glasmeier (DUSP). While we were not tasked to address the educational program *per se* we would like to comment favorably on this plan: it provides a sensible starting point for a minor that takes advantage of already-existing courses, and it could be adapted as needed moving ahead. If approved by the Institute, the proposed minor could be launched in coordination with the initiative. The governance of the minor could logically be similar to that of the Energy Minor (which we note was recently modified), and the two should be coordinated to the extent possible, with thoughtful input from CoC and CAP. We hope that, as the minor develops, key subjects will be incorporated into *MITx*.

Why MIT?

Appendix 2 lists a number of leading environmental programs at other institutions. It is important to distinguish an MIT environment program from existing efforts elsewhere. Most of these programs have a heavier emphasis on the social science aspects of environment and on the characterization of environmental damage by human activity. While these are undeniably important efforts, MIT's focus would differ by virtue of the unique composition of our faculty and student body and our institutional outlook.

In particular, an MIT program would be defined and distinguished by:

- A solutions orientation with both local and global objectives
- Explicit acknowledgement that cities are essential in environmental solutions
- A core grounding in engineering and science
- Integration of our strengths in urban planning, policy and management
- Impartiality toward issues that have a history of tension between opposing viewpoints

Branding an MIT Environment Program

A particularly productive suggestion that we received early in the process was to consider selecting a name that delivers the right messages. This suggestion was reinforced by a conversation with an MIT Visiting Committee member who pointed out the strong negative associations that sometimes go with the term "environmentalist". Stereotypically, such connotations include: anti-progress, anti-industry, putting confrontation ahead of consensus building, action based on emotion rather than science, etc.

We took this advice and engaged a branding firm recommended by the MIT Sloan School to assist in finding a name for this initiative. The firm has interviewed a number of administrative and faculty leaders around MIT, and collected information on MIT's environmental profile and that of competing institutions. Their final report was submitted to the President.

In addition to the outstanding research that will emerge from the environment initiative, we hope that a tangible outcome will be MIT sending a positive message about the importance of stewardship and study of the environment and the opportunities that such study creates.

Summary

Interest in the environment at MIT is great, and a considerable amount of world-class research on the topic is already underway. However, MIT does not generally come to the forefront in discussions of universities that have major programs in the environment. An MIT environment initiative would provide the cohesion and visibility required to elevate the recognition of ongoing efforts, and it would undoubtedly nucleate new research of great benefit to the nation and world. This effort has substantial faculty support, and appears to have the interest of potential donors. MIT's effort would be distinctive in its solution-driven, science and engineering based, and unbiased approach to both local and global environmental challenges.

Appendix 1: Global Initiative Planning Group Meetings and Discussions

NAME	DEPT/SCHOOL	Title
Dawn Adelson	EAPS	Sr. Development Officer
Tania Baker	Biology	Department Head
Tuli Banerjee	Global Initiatives	Dir, Global Initiatives
Steven Barrett	AeroAstro	Asst Prof
Martin Bazant	ChemE	Professor
Alan Berger	DUSP	Assoc Prof
Ed Bertschinger	Physics	Department Head
Mary Boyce	MechE	Department Head
Kerri Cahoy	AeroAstro & EAPS	Asst Prof
Claude Canizares	Provost Office	Vice-President for Research
Sylvia Ceyer	Chemistry	Department Head
Elizabeth Chadis	School of Science	Asst Dean for Development
Anantha Chandrakasan	EECS	Department Head
Deborah Cohen	School of Engineering	Sr. Development Officer
Steve Cruickshank	Corporate Relations	Sr. Industrial Liaison Officer
Mircea Dinca	Chemistry	Asst Prof
Alexander D'Hooghe	Architecture	Assoc Prof
Kerry Emanuel	EAPS	Professor
Dara Entekhabi	CEE & EAPS	Professor
Barbara Feldman	School of Architecture	Asst Dean for Development
Deborah Fitzgerald	HASS	Dean
Amy Glasmeier	DUSP	Department Head
Karen Gleason	ChemE	Professor
Todd Glickman	Corp Relations/ILP	Assoc. Dir of Corporate Relations
Leon Glicksman	Architecture	Professor
Jonghyon Han	EECS	Professor
Charles Harvey	CEE	Professor
Lindley Huey	Foundation Relations	Director, Foundation Relations
Tim Jamison	Chemistry	Professor
Klavs Jensen	ChemE	Department Head
Marc Kastner	School of Science	Department Head
Philip Khoury	Provost Office	Assoc Provost
Tony Knopp	Corp Relations/ILP	Sr. ILP Officer
Karl Koster	Resource Develop.	Executive Dir., Corporate Relations
Kent Larson	Media Lab/Small Cities	PRS
Douglas Lauffenburger	BioEng	Department Head

John Leonard	MechE	Professor
Richard Lester	Nuclear Sci & Eng	Department Head
Stephen Lippard	Chemistry	Professor
Richard Locke	Political Science	Department Head
Jenny Zhenli Liu	Global Initiatives	Asst Dir
Richard MacMillan	Philanthropic Partnerships	Dir, Philanthropic Advising
Nick Makris	MechE	Professor
John Marshall	EAPS	Professor
Gareth McKinley	MechE	Assoc. Department Head
Ernie Moniz	MITEI	Director
Whitney Newey	Economics	Department Head
Jeffrey Newton	Resource Develop.	VP
Greg Ornatowski	Corp Relations/ILP	Sr. Assoc. Director of Corporate Relations
Alex "Sandy" Pentland	Media Arts & Sciences	Professor
Jaime Peraire	AeroAstro	Department Head
Martin Polz	CEE	Professor
Ronald Prinn	EAPS	Prof and Director, Center for Global Change Science
Carlo Ratti	DUSP	Assoc Prof of Practice
Kate Reynolds	Foundation Relations	Assoc Dir, Foundation Relations
Graham Rong	Corp Relations/ILP	Sr. Industrial Liaison Officer
Adele Santos	School of Architecture	Dean
Ralph Scala	School of Engineering	Asst Dean for Development
Martin Schmidt	EECS	Prof & Associate Provost
David Schmittlein	Sloan School	Dean
Christopher Schuh	Materials Sci & Eng	Department Head
Noelle Selin	ESD & EAPS	Asst Prof
Susan Silbey	Anthropology	Section Head
Kurt Sternlof	Earth Systems Initiative	Executive Director
Joseph Sussman	ESD	Interim Division Head
Rob van der Hilst	EAPS	Department Head
Chris Voigt	BioEng	Assoc Prof
Ian Waitz	School of Engineering	Dean
James Wescoat	Architecture	Professor
Andrew Whittle	CEE	Department Head
Victor Zue	EECS	Professor
Richard Hope	AECOM	CTO
Steve Johnson	AECOM	Sr. VP Business Development
James Aloisi	AECOM	Sr. Dir. Special Projects

Christopher Baker	Brandslinger Naming Group	CEO
Bruce Cheng	Delta Group	
Yancy Hai	Delta Group	
Paul Hsu	Epoch Foundation	President
Josephine Chao	Epoch Foundation	Vice President
Ivory Hsia	Epoch Foundation	Project Manager
Maggie Yang	Epoch Foundation	Special Asst.
Marc Florette	GDF Suez	Executive VP & Head of Research and Innovation
Dominique Kaczmarek	GDF Suez	Sr. Vice President, Research and Innovation Dept.
Bernard Blez	GDF Suez	Sr. Director, City of Tomorrow and Renewables Research
Carlos Moreno	GDF Suez	Energy Services Division
Marcel Didden	GDF Suez	Director, SMART Energy Management
Edwidge Brossard	GDF Suez	Director, City of Tomorrow
Marguerite Clark	GDF Suez	Director, Research and Innovation Dept.
Sarah Robinson	Practically Green	Founding Partner
Douglas Brown	Seven Seas Water	Chairman of the Board, and Alumnus
Hu Wenrong	Shandong Delegation to MIT	Deputy Director-General and Director, State-owned Assets Supervision & Administration Commission of Shandong Provincial Gov't, General Office of Global Experts Recruitment Leading Group of Shandong Province
Zhang Dayong	Shandong Delegation to MIT	Dir. Of Administrative Committee of Qingdao West Coast New Economic Zone & Dir. Fo Qingdao Economic and Technological Development Zone Administrative Committee
Wen Shugang	Shandong Delegation to MIT	Executive Director and President, Dongfang Electric Corp. Ltd.
Ma Yuxing	Shandong Delegation to MIT	Vice Director, Administration Committee, Jinan Hi-tech Development Zone
Bao Jianying	Shandong Delegation to MIT	Chairman, Shandong Ocean Investment Co.
Wang Chunsheng	Shandong Delegation to MIT	Dir. Human Resources, Inspur Group Co.
Stephen Shu-hung Shen	Taiwan EPA	Minister
Gwo-Dong Roam	Taiwan EPA	Director General

Appendix 2: List of Competitor Programs

College of Natural Resources: University of California, Berkeley
http://ourenvironment.berkeley.edu/

Yale School of Forestry and Environmental Studies
http://environment.yale.edu/

The Earth Institute: Columbia University:
http://earth.columbia.edu/sections/view/9

Stanford Initiative on the Environment and Sustainability
http://multi.stanford.edu/initiatives/environment.html

Woods Environmental Institute at Stanford
http://woods.stanford.edu/

Princeton Environmental Institute
http://www.princeton.edu/pei/

Nicholas School of the Environment and Earth Sciences: Duke University:
http://www.nicholas.duke.edu/

School of Natural Resources and the Environment: University of Michigan
http://www.snre.umich.edu/

Harvard University Center for the Environment
http://environment.harvard.edu/