Sustainability and the City: CCNY's New M.S. Program

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Reforming curricula has been likened to relocating graveyards. The implication, presumably, is that curricular reform should be done only when necessary, should be carried out respectfully, and demands a good deal of time and care. The creation of a new Sustainability in the Urban Environment program at City College of New York (CCNY)—a program that will graduate its first class in June 2011—certainly exhibited these characteristics. Given the dramatically increasing interest in sustainability and cleantech—in the academic world, the corporate world, the media world, and the planet in general—some sort of serious academic offering in sustainability seemed a virtual necessity. Of course it had to be done respectfully, given that much of the terrain of sustainability was at least partially covered, in differing ways, by existing programs and/or courses in environmental studies, earth sciences, environmental engineering, economics, management, law, and policy. We had to make clear that a new master's degree program in Sustainability is not in any sense a replacement of existing disciplines, but rather a new focal point that draws heavily from the insights of these existing disciplines and juxtaposes these insights in ways that can be extremely useful in working toward solutions of real-world problems.

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Slow But Steady

The creation of the program did indeed take a good deal of time and care. It began in 2006 with a flash of insight that was immediately transformed—as such insights tend to be in academia—into a committee. Things do not proceed at breakneck pace in academia for some good reasons, among others. CCNY had to assure itself that there were sound reasons for a wholesale introduction of sustainability into the curriculum, as opposed to a piecemeal flavoring of existing courses. Academia strives to be a House of Precise Definition, so how should we handle a term like "sustainability," which tends to elude precise definition? Does it suffice to say that it is an inherently unfocused concept that contains a cluster of meanings—on the model of "liberty" perhaps? Is it a temporary packaging of current concerns, or will it hold up (*sustinere*) over the long haul? In short, is sustainability academically sustainable? It is easy to answer such questions in 2011, when the Association for the Advancement of Sustainability in Higher Education (AASHE) listing of Academic Programs in Sustainability attests to a remarkable proliferation, and when the National Science Foundation (NSF) is infusing hundreds of millions of dollars into 10 NSF directorates and offices with its SEES program—Science, Engineering, and Education for Sustainability. It was much less clear a mere five years ago.

Tripartite to the Core

From the outset, the CCNY committee strove to equally represent architecture, engineering, and sciences. Why these three? In some respects, we were playing to CCNY's strong suit, i.e., the Bernard and Anne Spitzer School of Architecture, the Grove School of Engineering, and a tradition of strength in the physical sciences. In addition, we sensed that these are academic areas one would naturally want to consult when designing solutions to many sustainability challenges. It thus seemed intuitively sensible to create a single multidisciplinary sustainability program that would be tripartite to the core, assigning equal weight to architecture, engineering, and science (in alphabetical order!). Moreover, in light of the urban environment emphasis of the program, architecture and engineering seemed perfectly appropriate. Nothing on planet Earth is more a product of engineers and architects than our urban landscapes. As for the importance of the science component, one might adapt what Einstein purportedly said in connection with religion, and simply note that sustainability without science is blind.

The City's the Thing

Our program gravitated toward Sustainability in the *Urban* Environment due to several direct or indirect influences. Beginning in 2008, for the first time in human history more than half the world's people have been living in what we would classify as cities. In China alone, astoundingly, there are more than 160 cities of a million or more people. And while cities account for two-thirds of global energy

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use and over 70 percent of global carbon emissions, they also can and do serve as sources of solutions to global sustainability challenges. The actual or potential "greenness" of cities—their potential to accelerate sustainable development—has been increasingly stressed in high-profile environmentalist writings, e.g., Stewart Brand's *Whole Earth Discipline*.[1] What made a focus on the urban context practically irresistible for CCNY, of course, is our location right in the middle of a certain big bright-lighted city. As we explain to potential applicants who inquire about our program and its overt focus on the urban environment, "CCNY is sitting amidst a rather rich laboratory for such a focus." Some very real experiments are now underway in this urban laboratory, most under the aegis of PlaNYC: A Greener, Greater New York—the long-term plan (looking toward 2030) developed by Mayor Bloomberg's Office of Long-Term Planning and Sustainability.[2]

Creative Tensions

Interdisciplinarity has many variations. In some cases, advances in related fields cause a particular field to undergo what appears to be a natural unfolding, an expansion from within. Examples might include bioinformatics, sociobiology, econometrics, and biochemistry. The interdisciplinarity of CCNY's Sustainability in the Urban Environment program is of a different sort—namely, the interdisciplinarity that arises when solutions to complex worldly problems call for the integrated expertise of several disciplines.

Teamwork among like-minded people is hard enough. Among those with differing disciplinary perspectives, it can be even more challenging. There may be some truth to the stereotype that architects strive to be high-minded visionaries, driven by esthetic and cultural intuitions, while engineers strive to be feet-on-the ground realists, with great respect for performance and efficiency. And that consequently the two professions tend to inhabit opposite sides of the *corpus callosum*. But of course the twain certainly do meet, both in our M.S. in Sustainability degree program and in countless real-world construction projects. If anything, sustainability concerns shared by architects and engineers are providing an additional arena for creative collaboration. Just the buildings of New York City—the electricity, heating, and hot water we consume in them—account for 75 percent of the city's entire greenhouse gas footprint[3]. There is a great deal of interdisciplinary work to do.

Our program has also presented challenges with respect to creating a viable academic administrative structure. The program executive committee draws from the three disciplines—architecture, engineering, and sciences. This means that top-level decisions require the involvement of all three of the respective deans. With regard to processing and making decisions on applications, we have moved in the direction of program autonomy by devising and relying upon an independent M.S. in Sustainability process, not pre-existing processes within the three schools/divisions. This is a work in progress that can be expected to evolve with the program. Also evolving are our efforts to solve the serious logistical challenges relating to scheduling courses and assigning instructors. We have learned that the management of a new interdisciplinary program—perhaps ironically, but not surprisingly—demands administrative discipline and single-mindedness.

Curricular Basics

Our program is designed primarily for students with undergraduate degrees in architecture, engineering, or science. A few students with degrees in other fields have been accepted, based on their exceptional records and experience. We keep our curricular structure in line with other graduate programs at CCNY: The M.S. in Sustainability degree requires 30 credits, earned in either full-time or part-time study. The program has two concentrations: architecture and engineering-science. All students must take four three-credit core courses, plus a year-long six-credit capstone interdisciplinary team project, for a total of 18 required credits. For their remaining 12 credits, students select four elective courses, three from within their concentration, and one from the other concentration. (See the sidebar on page 68 for an overview of the core courses and electives.)

In designing the core courses, one challenge was to adequately cover the scope of sustainability. We decided to include one course designed by architecture (Cities and Sustainability), one designed by engineering (Industrial Ecology and Life Cycle Analysis), and one by sciences (Sustainable Aquatic, Terrestrial, and Atmospheric Systems). To these, we added Economics of Sustainability and the capstone interdisciplinary project.

For all courses, the team of faculty who designed the syllabi keep in mind certain assumptions about the value-added by university coursework. Sustainability is by its nature focused on practical concerns, but this does not mean that sustainability courses should merely replicate this level of practicality. Rather, they should work at a higher level of abstraction, conveying the conceptual and analytic tools that will stand

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Sustainability in the Urban Environment

Overview of Curriculum for M.S. in Sustainability at CCNY

I. Required Core Courses

- Cities and Sustainability
- Sustainable Aquatic, Terrestrial, and Atmospheric Systems
- Industrial Ecology and Life Cycle Analysis
- Economics of Sustainability
- Capstone Interdisciplinary Team Project

II. Architecture Electives

- Environmental Planning
- Urbanism
- Low-Energy Buildings
- Case Study in Sustainability
- Integrated Building Systems

III. Engineering-Science Electives

- Sustainable Transportation
- Energy Systems Engineering for Global Sustainability
- Climate and Climate Change
- Water Resources and Sustainability
- Green Chemistry
- Design of Mechanical Systems for Sustainable Buildings
- Solid Waste Reuse and Recycling
- Sustainability in Infrastructure

a graduate in good stead for years to come and in a variety of sustainability contexts. Thus, for example, our industrial ecology course focuses on life cycle analysis; and our economics course on cost-benefit analysis, externalities, public goods, and the like. Our Sustainable Aquatic, Terrestrial, and Atmospheric Systems core course takes a somewhat different tack. It in effect is an intensive course in environmental science, based on the reasonable assumption that solutions to all sustainability problems require a refined awareness of the intricacies of Spaceship Earth's life-support system (with a nod to Buckminster Fuller)[4].

We have had a very positive response to our basic curriculum to date. When potential applicants inquire about the program, we routinely send them a 15-page description of the core and elective courses, including basic course syllabi. More than a few times, the response has been something akin to, "I would like to take every single course in the curriculum." The burden now falls upon us to ensure that the quality of course delivery matches the attractiveness of course content.

Capstone Course Projects

Capstone courses and projects have become so institutionalized that one forgets about those old nonmetaphorical capstones—the finishing or protective stones that form the top of an exterior wall or building. We would like to think that our Capstone Interdisciplinary Team Project course is a finishing or crowning feature of the M.S. degree program. And in keeping with the nature of the program itself, we require that capstone course projects be interdisciplinary: The topic must involve at least two of the three program disciplines, and the team of students (typically, three) must include students of mixed concentrations (architecture and engineering-science). The projects culminate in a single final report submitted by the team as a whole.

Undergraduate engineering courses have been incorporating capstone design courses for decades, and upper-level architecture courses rely heavily on studio design courses. But even if sustainability program faculty are thus already familiar with the basic concept of capstone projects as pedagogical tools, they do not necessarily implement them in the same ways. Moreover, the interdisciplinary nature of an M.S. in Sustainability capstone project forces the faculty supervisors (we call them mentors) to oversee work that is at least partly outside their disciplinary comfort zone. This is never easy. It certainly requires confidence, imagination, and a spirit of adventure.

Capstone Project Design Challenges

Creating a truly compelling capstone project presents its own set of challenges. The topic should focus on a substantial real-world sustainability issue or problem that invites an interdisciplinary approach. It should be difficult, but not so daunting that students cannot hope to make some meaningful headway in about nine months of work. It should offer some avenues for substantial academic research, possibly of a sort that could be published in a journal. And ideally it would culminate in a proposed solution to the sustainability problem.

Seven of our faculty members from architecture, engineering, and science have designed 22 diverse capstone projects that are already leading students into some complex real-world sustainability problems. Several of these capstone projects are linked with the Solar RoofPod—the prototype solar pavilion and green roof assembly that will be CCNY's entry as a finalist in the 2011 Solar Decathlon, a biannual international competition among schools of architecture and engineering. (See the sidebar on page 69 for a listing of these 22 capstone projects.) We would be gratified if our colleagues from other sustainability programs find these capstone projects of interest as potential models. CCNY's M.S. in Sustainability webpage, under Program of Study, includes a list of these capstone projects, with direct links to project summaries.

But Will I Get a Job?

Quite rightfully this is a leading question, especially in a lingering recession. We often hear it from potential applicants who are making initial inquiries into

Solar Decathlon team member with model RoofPod

our program and are thinking ahead. We cannot overpromise, or suggest probabilities that are not yet supported by sufficient data. Nor can our program offer—at least not yet—internship possibilities of the type that can turn into employment.

But we can point to various professional settings for which an M.S. in Sustainability degree could be a real asset: local, state, and federal governments; nongovernmental organizations; firms that plan, design, and construct sustainable buildings; consulting firms; regulatory agencies; sustainable energy technology firms; education. We can point out some of the new job titles that are beginning to emerge as organizations of diverse types start to more systematically address sustainability issues: Sustainability Manager, Director of Energy Efficiency, Clean Air/Clean Energy Specialist, LEED Manager, Life Cycle Modeling Specialist, Renewable Energy Consultant, Sustainability Analyst, Green Building Coordinator. And we can reasonably forecast that Mayor Bloomberg's PlaNYC—with its scores of major initiatives to be carried out between now and 2030—will generate demand for hundreds of people schooled in the knowledge and skills that our M.S. program develops.

Becoming More Social

We have a growing sense that our M.S. in Sustainability program could gain considerably from more emphasis on the social science aspects of sustainability. One of our core courses is Economics of Sustainability, but aside from this, the curriculum tends to give the social sciences relatively short shrift. It does not offer much overt treatment of sustainability-related law and policy issues, for example. We have concluded that our program could be enriched by courses that examine sustainability issues from a somewhat broader base. Sound solutions to problems of environmental sustainability can only be developed and created within our social environment—which encompasses law, policy, sociology, and other social science areas. Moreover, a fair number of those who inquire about CCNY's program are students with social science backgrounds and current interests in policy, law, and sometimes management-related aspects of sustainability. For all of these reasons, CCNY has decided to expand the curriculum to include a third social science concentration (working title).

We are now in the midst of this program-expansion, and it is too early to discern how the process will play out. CCNY's Division of Social Sciences is enthusiastically on-board. In devising a new set of elective courses, we are being guided by three approaches, each with its leading question: 1.) the ideal approach: What would be the academically ideal way to infuse social sciences into the M.S. curriculum, assuming unlimited resources (somewhere, over the rainbow)? 2.) the existing resources approach: How can CCNY most effectively leverage its existing social science graduate programs and associated institutes and centers? 3.) the emerging conventions approach: How have other universities with graduate programs in sustainability integrated social sciences into their curricula?

In our analysis of how other universities have accomplished this integration, the AASHE listing of Academic Programs in Sustainability[5] has been tremendously helpful, both for its general inventory of degree programs and its lists of discipline-specific programs in sustainability. It has helped shape the very tentative outlines of our proposed new set of elective courses, which may include courses in sustainability-related law, planning, urban studies, development studies, economics, and business/management. As the new concentration takes more specific shape, we will also be finding ways to give it the urban environment focus that informs our M.S. in Sustainability program in general.

The Long View

This profile of CCNY's M.S. in Sustainability program has tried to set out its basic trajectory: how the program began, its growing pains, its current configuration, and its future directions. We will end with a thought that arguably is relevant not only to the perennial issue of whether our graduates will get good jobs, but perhaps to sustainability education generally.

Capstone Course Projects

- A Systems Approach to Urban Community-Scale Composting
- The Solar RoofPod: Implications for New York City's Long-Term Sustainability Plan
- High-Performance Glazing for Energy-Efficient and Bird-Safe Buildings
- Food Grinders and Sustainable Food Waste Disposal
- Low-Tech Global Reuse and Recycling in a Local School
- Factors Affecting the Decision to Demolish or Deconstruct an Existing Building
- Carbon Trading Markets
- Analysis of Household Energy Consumption Choices
- Separating Risks to Cash Flows for Heating/Cooling
- The City College Waste Stream, Part I: Food Rescue and Recycling
- The City College Waste Stream, Part II: Removing Barriers to Paper Recycling
- Green Wall Technologies
- Using Pyrolysis to Convert Unused Urban Biotic Material into Bioenergy and Biochar
- Plant and Soil-Based Carbon Sequestration in Urban Areas
- Reconfiguration of Manhattan Bus Stopping Frequency
- Designing an Urban Food-Vending Stand
- Designing Urban Green Roofs for Modularity and Recyclability
- Design of a Modularized "Smart" Façade System
- Water Use Reduction in Buildings
- Optimizing Building Energy Use
- Sustainable Construction Material
- Using Natural Zeolite-Based Sorbents to Remove Contaminants during Groundwater Recharge with Reclaimed Municipal Wastewater

Summaries of these capstone projects are viewable at:
http://www1.ccny.cuny.edu/prospective/sustainability/program.cfm

We have a growing sense that our M.S. in Sustainability program could gain considerably from more emphasis on the social science aspects of sustainability.

Sustainability-related knowledge and skills will be in demand far beyond the working lifetimes of our current students.

The idea is that we should take to heart the historical viewpoint of someone like Vaclav Smil, whose bracing book, *Energy Transitions*,[6] asserts that we have just started into another great human energy transition—to carbon-neutral and renewable energy sources. However, the historical evidence that Smil expertly marshalls supports the view that our current transition, like those that came before, will take many decades. This is hardly comforting from a global warming perspective, but it certainly suggests that sustainability-related knowledge and skills will be in demand far beyond the working lifetimes of our current students. And it underscores that our task—as curriculum creators and revisers—is to move one level past the immediately practical and vocational, and find and refine the basic conceptual and analytic tools that will stand our sustainability graduates in good stead for years to come.

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References

1. Brand S. *Whole Earth Discipline: An Ecopragmatist Manifesto*. Viking Penguin, New York, 2009.

2. PlaNYC, main website: http://www.nyc.gov/html/planyc2030/html/home/home.shtml (Last accessed on April 7, 2011.) On Earth Day 2011, a new version of New York City's sustainability plan is set to be released.

3. First page of the New York City Greener Greater Buildings Plan (part of PlaNYC): http://www.nyc.gov/html/planyc2030/html/plan/buildings_plan.shtml. (Last accessed on April 7, 2011.)

4. Strictly speaking, it is not known for sure who coined the term Spaceship Earth. But Buckminster Fuller certainly gave it wide currency via his talks and writings, including his shorter work, *Operating Manual for Spaceship Earth* (Lars Müller Publishers, Baden, Switzerland, 2008).

5. For a direct link: http://www.aashe.org/resources/academic-programs-sustainability (Last accessed on April 7, 2011.) For the homepage of AASHE: http://www.aashe.org/.

6. Smil V. *Energy Transitions: History, Requirements, Prospects*. Praeger Publishers, Santa Barbara, CA, 2010.