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As citizens, college graduates will face choices that are framed in scientific, technological, and quantitative terms. What we surely need, at both the high school and college levels, is a fresh look at the goals for STEM learning within this civic and global context.

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Science Education for Everyone: Why and What?
By James Trefil
What exactly constitutes good science education, and how can we recognize when our students have received it? Once we have answered this question, the answer to the “what” question—the actual content of the curriculum—is relatively easy to find.

Transforming Undergraduate Programs in Science, Technology, Engineering, and Mathematics: Looking Back and Looking Ahead
By Jeanne Narum
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Preparing a New Generation of Citizens and Scientists to Face Earth’s Future
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ADAM, MY YOUNGEST, has now finished college, but readers of Liberal Education can be sure that, while there, he was frequently quizzed about every one of AAC&U’s high-priority topics—including the subject of this issue, college-level learning in science.

“Why do you suppose your college made you take two semesters of science as part of your graduation requirements?” I asked Adam one day over dinner.

“Well,” he said, all too used to this odd line of conversation, and kindly giving the question a moment’s thought, “I think they wanted me to try it one more time before I finally decided against it.”

“Well, possibly,” I parried, “but I think there was more to it than that. Most colleges, and certainly yours, also think that, whatever you major in, you need some level of scientific literacy as a citizen—the knowledge and judgment to evaluate policy choices where scientific analysis is part of the question.”

Adam was polite but firm. “I don’t think that can possibly be the case,” he said. “At least, that’s not the way they taught it.”

When AAC&U commissioned student focus groups on college learning as part of our LEAP initiative, it turned out that Adam was perfectly in tune with the views of his peers—though they were far less tolerant of faculty requirements than he has learned to be. The focus group participants were given a forced-choice exercise in which each was asked to circle his or her top personal priorities for college learning from a list of options, and also to circle the least important personal priorities. In the final two focus groups, informed by faculty discussion of the results from earlier groups, we added “expanded understanding of science” to the list of possible college outcomes. And in both groups—one of high school seniors, and one of college juniors—students unhesitatingly identified “expanded understanding of science” as their least important goal for college learning.

“Why rank science so low?” the focus group leader pressed the students, after the results were tallied.

“We already took science in high school,” the students responded with considerable indignation. “We’ve already decided against it. So why do they make us take it again? What a waste!”

As I read these findings, I thought again about Adam’s observation that a citizen’s understanding of science was surely not the goal of his science courses. “At least that’s not the way they taught it.” I also thought about the mounting national concern that Americans are losing ground when it comes to comparative international achievement in science, technology, engineering, and mathematics, the so-called STEM fields.
“Our platform is burning,” one business leader on the LEAP National Leadership Council has said repeatedly, referring to STEM literacy. Employers generally agree. In AAC&U’s 2006 LEAP employer survey, 82 percent recommended that colleges and universities place more emphasis on science and technology learning. In marked contrast to the students, the employers in this national survey ranked science and technology as the most important goal for improved college-level achievement. (The complete survey, and a second employer study conducted in 2007, can be found online at www.aacu.org/leap.)

As careful readers may already be thinking, two different agendas need to be sorted out in the national debate about STEM learning. The first concerns how to encourage many more students to choose STEM majors and, eventually, STEM careers. Employers do want to see a dramatic increase in the total number of college students who major in STEM fields. The United States ranks very low internationally in the total number of its graduates who do so, and that shortfall certainly puts us at risk as countries with high STEM emphases raise their overall college graduation levels. This ought indeed to be a top policy priority.

The second question, however, concerns how to help every American student, STEM major or not, discover the value and significance of scientific literacy to the lives they hope to lead. A high-priority goal in its own right, emphasizing the societal significance of science may also prove to be a catalyst for reversing the shortfall in STEM majors and career choices.

As citizens, college graduates will face choices that are framed in scientific, technological, and quantitative terms. What we surely need, at both the high school and college levels, is a fresh look at the goals for STEM learning within this civic and global context. If the goal is for students to recognize the importance of scientific inquiry, how should STEM fields be taught in high school? How can systematic scientific investigation and discovery be connected to the larger contexts in which scientific findings actually change lives? How do we help students discover the wonder of science so that the words “waste of time” cannot possibly apply?

That’s not the context in which I learned science (and turned away from it), and apparently it’s not the context in which my son much more recently took a combined five years of science courses in high school and college. But as we work to reverse the STEM shortfall, it is surely the case that we need to help all students grasp that larger civic and global context in which STEM literacy has become essential rather than optional.

Through two ongoing AAC&U projects, Shared Futures: General Education for Global Learning and The Educated Citizen and Public Health, faculty members are collaborating across disciplines and divisions to find common curricular ground. They’re creating, and often team-teaching, courses on such topics as global climate change, epidemics, food and hunger, and energy and war. These courses do not simply bring in science to bolster arguments about civic issues; rather, they frame “big questions” from social and scientific perspectives simultaneously. And in doing so, they enable students to see the point, as well as the power, of STEM learning.—CAROL GEARY SCHNEIDER

Students unhesitatingly identified “expanded understanding of science” as their least important goal for college learning.
With increasing frequency, scientific literacy is being identified among the most essential outcomes of undergraduate education. This does not mean that every student must now major, double-major, or even minor in one of the sciences. It will always be vitally important for colleges and universities to prepare specialists of every stripe to pursue the answers to scientific questions most of us will never know enough even to frame, but we do not all need to be trained as scientists. Instead, the social mandate to produce scientifically literate citizens—scientists included—calls upon higher education to provide the kind of broad scientific knowledge and understanding necessary to civic participation and personal decision making. But just what kind of knowledge and understanding is that, and how exactly should colleges and universities go about providing it?

The Featured Topic section of this issue considers these curricular and pedagogical questions. James Trefil leads off by discussing the reasons why a liberally educated person should know some science, why it is necessary for college graduates to be “comfortable handling science-related issues that arise in public debate.” He then proceeds by contesting the proposition, often asserted as a corollary, that students should learn science by “doing” science. If citizenship is the goal of general science education, then, Trefil argues, the ability to “do” science at some level is more or less irrelevant. Next, in light of the developments of the past decade, Jeanne Narum revisits the predictions and recommendations made in a 1999 report from Project Kaleidoscope. Narum’s stocktaking provides an overview of the key changes to undergraduate teaching and learning in the STEM disciplines as well as a roadmap for the future. The Featured Topic section concludes with an examination of recent developments that are transforming the field of earth system science. Within this context, the authors make the case for raising the status of earth system science within college curricula.

There is strong agreement that the United States must make science achievement a top priority. More successful science graduates are urgently needed, and so too are liberally educated graduates, regardless of their majors, who can evaluate and use scientific information in their everyday lives. The question of how colleges and universities can best respond to these needs will be taken up by members of the AAC&U community in November 2008 at the Network for Academic Renewal conference “Engaging Science, Advancing Learning.” There, participants will explore ways to increase the quality and level of students’ engagement and achievement in science and scientific research. Information about the conference can be found online at www.aacu.org/meetings/engaging_science.—DAVID TRITELLI
CCAS Endorses the LEAP Report
The Board of Directors of the Council of Colleges of Arts and Sciences (CCAS) by unanimous decision has endorsed the recommendations and findings of College Learning for the New Global Century, the 2007 report from the National Leadership Council for Liberal Education and America’s Promise. AAC&U President Carol Geary Schneider will deliver the keynote address at CCAS’s 2008 annual meeting, where a session will be devoted to the LEAP report. The full text of the CCAS endorsement can be found online at www.ccas.net.

CHEA and AAC&U Release Accountability Statement
Major educational associations, including the American Council on Education and the Association of American Universities, joined the Council for Higher Education Accreditation (CHEA) and AAC&U for the formal release of New Leadership for Student Learning and Accountability: A Statement of Principles, Commitments to Action at CHEA’s 2008 annual conference. The release followed a plenary address from Senator Lamar Alexander, who also endorsed the statement. At the release event, CHEA president Judith Eaton noted that the statement provides a platform through which institutions of higher education can strengthen their leadership role while addressing important public accountability and transparency expectations. The full text of the statement can be found online at www.aacu.org/about/statements.

New Survey of Employers
As part of the Liberal Education and America’s Promise (LEAP) initiative, AAC&U recently released the results of a national survey of employers. The survey reveals that employers see a need for significant improvement in the skills and knowledge recent college graduates are bringing to today’s workplace—especially in the areas of global knowledge, self-direction, writing, and critical thinking. The employers surveyed find college transcripts unhelpful, and they reject multiple-choice tests and institutional assessments in favor of qualitative evaluations of internships, senior projects, and the results of individual essay tests that measure students’ abilities to write, solve problems, and think analytically. A full report of the survey, as well as other public opinion research sponsored by LEAP, can be found online at www.aacu.org/advocacy/leap.

Upcoming Meetings
May 30–June 4, 2008, AAC&U Institute on General Education, Minneapolis, Minnesota
June 18–22, 2008, Greater Expectations Institute: Campus Leadership for Student Engagement, Inclusion, and Achievement, Snowbird, Utah
JAMES TREFIL

Science Education for Everyone
Why and What?

The notion that a liberally educated person should know some science is well accepted these days. You would have to go pretty far in American academe to find the kind of academics C. P. Snow talked about a half century ago in The Two Cultures—the ones who were proud of their ignorance of the second law of thermodynamics. What I would like to explore in this essay is not so much the “whether” of general science education, but the “why.” What exactly constitutes good science education, and how can we recognize when our students have received it? Once we have answered this question, the answer to the “what” question—the actual content of the curriculum—is relatively easy to find.

Before going on, I need to make one point. There are (at least) two different kinds of things that go under the name of “science education.” One involves the education of future scientists and engineers—an endeavor that is, I think, in pretty good shape (although improvements are always possible). The other involves the education of what I call “the other 98 percent”—the students who will not go on to careers in science and technology. It is this latter sort of education that I want to discuss. In particular, I want to ask what sort of education the other 98 percent should get in the sciences.

There is a long history of thought on this subject in both the United States and England. John Dewey set the stage for our current debate in 1910, when he argued that the proper goal of science education (what we would call today general education in science) was to create a “scientific habit of mind.” Dewey was somewhat vague on the details of this goal, although his...

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The main motivation seemed to be social utility (what I will call the “Argument from Civics” below). By the 1930s, however, University of Wisconsin educator I. C. Davis had expanded Dewey’s notion as follows:

We can say that an individual who has a scientific attitude will (1) show a willingness to change his opinion on the basis of new evidence; (2) will search for the whole truth without prejudice; (3) will have a concept of cause and effect relationships; (4) will make a habit of basing judgment on fact; and (5) will have the ability to distinguish between fact and theory. (Davis 1935, 117) Who can argue with that?

The problem with this sort of goal—a goal that, I suspect, the great majority of academic scientists would endorse—is that it is both completely unrealistic and totally out of line with the way science is evolving. If we have this sort of goal in mind, we will treat the purpose of general science education as being the production of students who are, in effect, miniature scientists. “If we can’t make you into a full-fledged scientist,” the argument seems to go, “we’ll get you as far along that track as we can.” In the words of Nobel Laureate Carl Weiman of the University of British Columbia, scientists engage in the general education of students because “we want them to think like us.”

The result of this attitude is the almost universal general education science requirement of “eight hours of science,” with or without a laboratory, that we find in American academe. Departmentally based, these courses typically are of the “Physics (or Chemistry or Astronomy or Biology) for Poets” type, aiming to get the students through a simplified version of the main concepts of a single discipline. The problem, of course, is that anyone who has spent time in the trenches knows that very few students are going to acquire a “scientific habit of mind” in these courses, and the majority of them can be counted on to forget most of what they learned shortly after the final.

The Argument from Civics

My sense is that the main problem with general education in the sciences is that we have set ourselves the wrong goal. Rather than think about the problem of producing miniature scientists, let me advance a Modest Proposal for an alternate goal: Students should be able to read the newspaper on the day they graduate. What I am suggesting is that we think about the way our students will use their science education in later life, and then adopt goals that support those uses.

As my Modest Proposal suggests, I think that the most important use our students will make of whatever science they acquire will be in their future role as citizens. Pick up a newspaper or listen to a news broadcast any day and you will find issues that relate to science—global warming, stem cells, food additives, genetic engineering, and new advances in medicine, to name just a few examples. These sorts of issues form part of the public discourse that is the fabric of our democracy, and one of the most important goals of education is to prepare students to be active participants in it. The idea that the primary goal of general science education is to prepare students to assume the role of active citizens is what I call the “Argument from Civics.”

It is important to realize that the kinds of issues that arise in public debate rarely involve scientific questions alone. Instead, the science acts as a kind of entrance ticket into the debate—a necessary background that allows a person to get to the real issues involved. Take the ongoing stem cell debate as an example. A person who has no concept of the molecular machinery of life is going to have a hard time understanding what a stem cell is and why it is important. An elementary understanding of some basic modern biology, however, allows that person to enter the real debate, which, until recently, was inextricably bound up with the moral and religious issue of whether the sacrifice of a week-old embryo to harvest stem cells was ethically justifiable. This is not a scientific question at all, but the point is that you cannot bring your personal moral calculus to bear on the issue until you know enough science to understand what a stem cell is.

As of this writing, it looks as if this particular issue may be resolved by a scientific advance (basically, the newfound ability to manipulate DNA to turn mature skin cells into functioning stem cells). I would like our students to understand the collective sigh of relief that went up in the scientific and religious communities when this result was announced in the fall of 2007.

When we take as our goal the production of students who are comfortable handling science-related issues that arise in public
debate, two propositions follow immediately, both of which are profoundly out of tune with the current academic consensus: (1) the students need to know something about all areas of science, rather than a lot about a single area; and (2) the students do not need to be able to “do” science.

Take the current debate over global warming as an example of this first proposition. It involves the burning of fossil fuels (chemistry), the effect of carbon dioxide on the earth’s energy balance (physics), the changes this may produce in the climate (earth sciences), and the effects that those changes may or may not have on the biosphere (biology). All of this has to be understood before we can get to the real issues in the debate, which involve questions about the level of obligation we have to future generations, the level of stewardship we should show toward the planet, and so on. Or take another subject like the debate over the long-term storage of nuclear wastes. This involves things like the understanding of radioactivity (physics), the question of the long-term stability of the Yucca Mountain facility (geology and hydrology), and the possible consequences of the release of radioactive materials (biology).

As these examples show, if we are to equip our students to function as citizens in the increasingly complex world we are building, we will have to teach them something of all the sciences, and not have them specialize in a single discipline. I would argue that a student who takes a Physics for Poets course, and who leaves the university without hearing the term “DNA” uttered in a classroom, has been poorly prepared to carry out his or her role in American democracy. (I would say the same about a student who satisfied his or her science requirement by taking a biology course, and who never heard the term “alternate energy” in a classroom.) It seems self-evident that if we expect our students to be able to deal with the kind of complex interdisciplinary problems that arise in public debate, the very least we can do is teach them the basic principles that underlie these problems.

A common response to the notion of teaching all of the sciences is the claim that the standard type of courses really teach something called the “scientific method,” and that this will magically give students the background they need to read the newspaper on the day they graduate. This argument is so silly that I scarcely know where to start commenting on it. If it were applied to any other field, its vacuity would be obvious; after all, no one argues that someone who wants to learn Chinese should study French, acquire the “language method,” and learn Chinese on his or her own. If we expect our students to understand the basic principles of ecology or geology, we should...
teach those principles explicitly. To do otherwise is to indulge in what I call the “teach them relativity and they’ll work out molecular biology on the way home” school of thought.

Incidentally, the notion that there is a magical “scientific method” explains a bizarre feature of the modern scientific community. I am referring to the fact that, outside of their fields of specialty, professional scientists, as a group, are probably the most scientifically illiterate group in the United States. The reason is simple: scientists are never required to study science outside of their own fields. The last time a working physicist saw a biology textbook, for example, was probably in high school. If you do not believe me, ask one of your scientific colleagues how he or she deals with public issues outside of his or her field. Chances are you’ll get an answer like “I call a friend,” a technique I refer to as having recourse to the Golden Rolodex.

Thus, the kind of education offered in the modern, departmentally based university is not really designed to give our students—even science students—the sort of background they will need to function as citizens. The same can be said for the notion that the purpose of general education is to produce scientifically literate citizens, but also with the way science itself is developing. Over the last thirty years, a revolution has occurred in the way research scientists carry out their jobs—a revolution whose consequences have not even been considered by those concerned with general education. I am talking about the impact on science of the availability of massive computational and data storage capability.

Throughout most of history, the ultimate limitation on the level of complexity with which we could describe the universe was the capability of the human brain. Isaac Newton, for example, was able to describe the motion of a single planet around the sun by solving equations with pencil and paper. His followers struggled (unsuccessfully) for centuries to describe a system of several planets circling a star—and never mind the thousands of moons, asteroids, comets, and other stuff that is actually out there. The point is this: the real world is extremely complex, but our ability to describe that complexity has always been limited.

Until recently, that is. The human mind has produced a tool—the digital computer—that is much better than the human brain at dealing with certain kinds of complexity. Each of us can remember only so much, for example, but somewhere there is a computer (or system of computers) that can tell you every passenger flying on United Airlines tomorrow. A computer can perform in seconds a task that would take a human being hours (think of calculating your income tax, for example). What this means is that today, for the first time, we can access and store huge amounts of information about physical systems, and then manipulate that information in massive computer codes capable of producing predictions for the behavior of systems of unprecedented complexity. And, of course, as science comes to be dominated by these sorts of computer outputs, the kinds of questions that the ordinary citizen has to deal with will change.

The way science is done today
As I suggested above, the traditional view of general education is out of touch not only with the need to produce scientifically literate citizens, but also with the way science itself is developing. Over the last thirty years, a revolution has occurred in the way research scientists carry out their jobs—a revolution whose consequences have not even been considered by those concerned with general education. I am talking about the impact on science of the availability of massive computational and data storage capability.

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Take the current discussion about global warming as an example. The basis for all of the predictions about the future of our planet are computer codes that go by the name of General Circulation Models (GCM). In a GCM the atmosphere and ocean are broken up into millions of boxes, and in each box the known laws of physics and chemistry are applied to predict future behavior. The computer then adds up the results of all of these calculations and makes its prediction about the climate.

To make such a model work, you have to put in thousands of different pieces of data and describe thousands of different processes. For example, ice reflects sunlight while water absorbs it, so the model has to deal with the formation of sea ice—a complex process. Clouds, vegetation, and land use changes all have to be taken into account, as do many other effects, and the final results of the calculation depend on the accuracy of your input data and the validity of your description of the individual processes (such as the formation of clouds), as well as the validity of your description of the interaction among all the processes. This is a calculation of enormous complexity, and I suspect that there is not a single individual in the world who really understands the working of the entire GCM code.

Yet every citizen is going to have to make decisions about public policy and private lifestyle choices based on his or her assessment of the validity of those computer outputs. A moment’s reflection will convince you that the standard lab-based science course is not going to get the student very far along toward this goal. Watching an ice cube melt or dissecting a (real or virtual) frog provides very little understanding of the complexities of modern computer-driven science. It is just too far from that ice cube to the output of a GCM.

There is, however, one educational scheme that I believe forms a necessary prerequisite to tackling issues like global warming. I call it the “Great Ideas” approach to teaching science. It relies on the fact that science is basically hierarchical in nature, with a relatively small number of general principles (conservation of energy, for example) forming the basis for our understanding of a wide range of phenomenon. These Great Ideas form the skeleton, the framework, of our understanding of the universe, and they span all fields of science. I would suggest that an understanding of these ideas and their interactions is what every student needs to know in order to begin acquiring the ability to deal with the issues he or she will encounter as a citizen in the twenty-first century.

The reader may or may not agree with this approach to general education in the sciences, but I think we can all agree that we need to start bringing the system more into line with the way science is done today and the way our students will encounter it in their lives. Time to get to work!

To respond to this article, e-mail liberaled@aacu.org, with the author’s name on the subject line.

REFERENCE
Are new approaches to transforming undergraduate learning in science, technology, engineering, and mathematics (STEM) making a difference? If so, how? How do we know? And what next? These are the questions explored in a 1999 report from Project Kaleidoscope, which concluded by making predictions and recommendations for the coming decade (Rothman and Narum 1999). Now that that “coming decade” is here, it is timely to ask how accurate those predictions were and to offer some new recommendations for the next decade.

The predictions made in 1999 addressed a broad range of issues, from faculty to facilities and more. In each of the scenarios for the future that were developed then, the underlying theme was that attention to learning and assessment would be pervasive in the undergraduate STEM learning environment on campuses across the country. One reason we thought this would be the case had to do with the anticipated impact of How People Learn: Brain, Mind, Experience and School, a seminal report published that year by the National Research Council. The report called for the development of academic cultures where deep understanding about how students learn determines how courses and curricula are planned, technologies selected, spaces designed, and faculty recognized and rewarded. Further, it was a report that could be used as a resource for shaping and sustaining such cultures. There were several other compelling reasons for basing our future scenarios upon the expected emergence of a new kind of learning culture. In 1999, there was growing external pressure—from public agencies, accrediting agencies, funding agencies, and the business community—for greater transparency with regard to student learning outcomes. New accreditation practices for engineering education programs were challenging that community of professionals, and many other STEM communities were giving new or renewed attention to student learning outcomes in their specific disciplines. Moreover, the National Survey of Student Engagement was piloted in 1999.

Equally important was the increasing visibility and maturity of the work of pedagogical pioneers—agents of change whose efforts had been supported by the National Science Foundation (NSF) since the late 1980s. Their experiences and expertise were beginning to inform a generation of what dissemination literature calls “early adapters.” There was a growing body of research-based theory and practice about what works in the iterative cycle of exploring, examining, addressing, and assessing undergraduate student learning goals.

So, where are we today? Where and when are conversations about students and student learning taking place within institutions or scholarly communities? How widespread among STEM faculty and their administrative colleagues is awareness of the work of pedagogical pioneers and of the growing body of research on learning and cognitive science? Is it now possible to articulate a general set of goals for student learning in STEM fields on which local efforts can be built and against which they can be compared? And if so, what recommendations can be made for the next decade?

Current conversations covering the range of issues related to student learning are dramatically different from those of a decade ago. There is a growing national consensus about what students should know and be able to do.
Engineering, & Mathematics
as an outcome of their careers as undergraduate learners. The work of the Association of American Colleges and Universities (AAC&U)—most importantly through its Liberal Education and America’s Promise initiative—has been a significant catalyst in engaging communities in discussions about the kinds of learning needed for a complex and volatile world. Explicit and remarkably consistent goals for student learning have been articulated and promulgated by greatly diverse groups both within and beyond the academy.

The Council on Competitiveness (2005, 76), for example, has called for preparing “a whole generation with the capacities for creative thinking and for thriving in a competitive culture, able to work in multidisciplinary teams, . . . be comfortable with ambiguity, recognize new patterns within disparate data, . . . [and] to be inquisitive and analytical.” The undergraduate neuroscience community has outlined learning goals, including critical thinking and independent thought; communicating effectively in written and oral form as well as with figures, graphs, and through presentation software; and an appreciation of the value of diversity and the ability to work with colleagues from a variety of backgrounds and perspectives (see Wiertelak 2003). The American Chemical Society’s Committee on Professional Training has stated that the outcome of laboratory experiences should “give students hands-on experience with chemistry and the self-confidence and competence to . . . interpret experimental results and...
draw reasonable conclusions, analyze data statistically and assess reliability of results . . . and communicate effectively in small groups and teams. . . " (2003, 10).

Are the conversations taking place within national groups changing the dialogue on campuses? One indication that they are is the fact that colleges and universities across the country are beginning to make public their explicit visions of student learning by publishing them on their Web sites. The public announcement of the specific learning outcomes established by Miami Dade College is one of the most recent and most visible examples of the mainstreaming of attention to setting and assessing student learning goals both within and beyond STEM fields (see the article by Eduardo J. Padrón in this issue of *Liberal Education*).

This brings me to the first of my recommendations for the coming decade, namely that leadership teams on campuses gather and distill lists of learning outcomes articulated by leadership associations such as AAC&U, as well as by other professional and disciplinary societies and corporate leaders, and translate those statements into a coherent and institutionally-appropriate set of goals for student learning that serves their vision for the future. Make those goals, and the actions that advance them, public and transparent.

**Pedagogies of engagement**

The most compelling evidence of the mainstreaming of conversations about how people learn comes from the field. Just-in-Time Teaching, Problem-Based Learning, and Student-Centered Activities for Large Enrollment Undergraduate Programs are three examples of what Russell Edgerton (2001) has described as “pedagogies of engagement,” and they demonstrate the ways in which attention to how people learn is beginning to transform the undergraduate STEM learning environment.

Just-in-Time Teaching (JiTT) involves dialogue between student and student as well as between student and instructor, much of which occurs outside of the classroom—thanks, in part, to the maturation of electronic technologies. Gregor Novak, one of the JiTT pioneers, says that at the heart of the JiTT pedagogy are pre-instruction, Web-based assignments called “warm-ups.” These are short, thought-provoking questions that, when fully discussed, often have complex answers. Students are expected to develop the answers as far as they can on their own, and then the job is finished by working together in the classroom. These warm-ups are submitted electronically just a few hours before class, giving the instructor (just) enough time to incorporate into the upcoming lesson the insights gained from student submissions. Exactly how the classroom time is spent depends upon a variety of issues such as class size, classroom facilities, and student and instructor personalities.

In a JiTT classroom, students construct the same knowledge as in a passive lecture, but with two important added benefits. First, having completed the Web assignment very recently, they enter the classroom ready to engage actively in their learning. Second, they have a feeling of ownership of their learning because the interactive lesson is based on their own
wording and understanding of the relevant issues. “Our goal,” Novak explains (pers. comm.), “is to create and sustain team spirit. We all, students and faculty, work together toward the same objective, that students pass the course with the maximum amount of enduring knowledge, skills, and habits of the mind that are critical for success in STEM communities of learners and practitioners.” Does JiTT work? Consider the following testimony from a student:

It is easy to feel disconnected from a science course as a student. Each day can seem as a new set of notes to take from the instructor’s monologue, another chapter to read, and another problem set to work on, but each unrelated to the previous day—that is, until the exam. The situation changes if the assignments are designed to pose questions that require some real effort and interaction with other students ahead of class, but providing the assurance that the toughest points will be cleared up in the class makes that work worthwhile. Just-in-Time Teaching offers the kind of day-to-day motivation that drives the course forward for me. (Project Kaleidoscope 2007, 2)

Problem-Based Learning (PBL) simulates workplace projects that require mastery of a range of content knowledge as well as the development and application of process skills in an integrative and interesting format. Faculty of the biomedical engineering program at Georgia Institute of Technology, for example, arrived at PBL as the foundation for planning a program from scratch. Theirs was a discipline without a history of pedagogies or a tradition of textbooks. (Admittedly, this can be seen as a luxury when trying to incorporate research on learning into the process of curricular change!) The inherent interdisciplinarity of biomedical engineering drew them into research on cognitive flexibility—that is, the ability to look at problems from a variety of perspectives. Their program was designed to challenge students with the right kind of problems, and the goal was to produce integrative problem-solvers who have the cognitive flexibility to apply engineering analysis and synthesis to problems in the biosciences.

On the impact on student learning, Wendy Newstetter, one of the founding members of the PBL team at Georgia Tech, reports that solving problems on the frontiers of science that other experts are trying to solve at the same time does two things: it motivates students tremendously, and has a very interesting impact on identity. A major problem with students going into the sciences and being sustained is that they don’t identify with the kind of activity they are being asked to do. They don’t see their own personal identities or lives aligned with science. Whereas, when you give them complicated, multi-dimensional, interdisciplinary problems from the real world, their imagination is sparked. They begin to say, “I can see myself doing this.” So problem solving is about motivation and identity, about engaging students through the excitement and fantasy of trying to solve those problems. (Project Kaleidoscope 2006)

Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) is based on the conviction that, in order to understand the science, students must actually do the science as a central activity in studying the science. SCALE-UP overcomes the many barriers to “doing” science in the traditional large lecture class: the isolation of individual students in the crowd of strangers, the competitive atmosphere, and the little one-on-one contact with the instructor. SCALE-UP uses cooperative learning pedagogical techniques with classes of approximately one hundred students, with lecture and lab integrated in technology-rich settings. Active group learning
is promoted within consistent groups, and the grading system requires teamwork to ensure that each student in the group—even the really bright ones—benefits from working together.

SCALE-UP pioneer Robert Beichner reports that substantive evaluation—video and audio recordings, interviews, focus groups, pre- and post-tests, and student profiles—has revealed improvements in students’ ability to solve problems and their attitudes toward science and learning, as well as increases in students’ conceptual understanding. And SCALE-UP reduces failure rates. When asked what impression a visitor would get from walking into a SCALE-UP classroom, Beichner says, their impression would be that the learning space looks more like a restaurant than a classroom, or perhaps more like a banquet hall, because there is much noise from the visibly engaged students. They would see the realization of our idea that social interactions between students and their teachers is the “active” ingredient that works for us. From our own experiences and from research on learning, we knew that as students collaborate on interesting tasks they become deeply and personally involved with what they are learning. The doors of the closets and the walls of the classroom are covered with whiteboards—public thinking spaces—to help them share their learning with each other and their instructor. (Project Kaleidoscope 2005)

What we find in examining the core principles of these and other pedagogies of engagement is that each of them can be seen, in some way, as a grandchild or great-grandchild of undergraduate research, which is surely the epitome of a pedagogy of engagement. Each of these contemporary pedagogies is designed to introduce students to the community of practice in STEM fields and to enhance their personal understanding of how scientists, engineers, and mathematicians make sense of our world. In other words, each invites students to assume the identity of the STEM professional. Each seeks to give students confidence in their ability to pursue study in STEM fields, based on successive (and presumably successful) social interactions within a collaborating community. These are communities in which expert and novice learners come together in the same spaces—sometimes physical, sometimes virtual—to engage in the process of discovery as they move from what is known to what might be known. These are pedagogies designed to help students understand the importance of being a part of a collaborating community with a sense of shared purpose.

Another similarity is that, although most began with support from the National Science Foundation, these pedagogies work for all disciplines, serve all institutional types, strengthen the learning of all students, and reflect societal and disciplinary goals for undergraduate learning. They all call upon instructors to reflect deeply on how to get students to take ownership of their learning, how to transform the learning environment from one of passive transmission of information to active construction of knowledge and skills, and how to monitor the progress of their students’ learning.

**Barriers**

Despite the recognized national need for the kind of problem-solving, critical-thinking risk-takers formed through these pedagogies of engagement, their adoption is not yet

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**Project Kaleidoscope**

Project Kaleidoscope (PKAL) is a leading advocate for what works in building and sustaining strong undergraduate programs in the fields of science, technology, engineering, and mathematics (STEM). An informal alliance, PKAL takes responsibility for shaping undergraduate STEM learning environments that attract students to STEM fields and inspire them to persist and succeed. Such environments give students personal experience with the joy of discovery and an awareness of the influence of science and technology in the world. Resources derived from the work of the extensive PKAL community are available for adaptation by leaders on campuses across the country. Visit www.pkal.org for more information.
widespread. One significant barrier to the spread of contemporary pedagogies of engagement is institutional culture. The compelling research conducted by Charles Henderson and Melissa H. Dancy (2007, 1) examines why “proven strategies are slow to integrate into mainstream instruction” even though, as they document, STEM faculty understand some of the problems with traditional ways of teaching. Henderson and Dancy conclude that situational characteristics consistent with traditional instruction account for the major impediments. Their suggestion, directed at the broader STEM research community, is really for us all: identify both the situational barriers faculty face—bolted-down chairs, large enrollment classes, the need to “cover” content, student lack of experience with active learning, etc.—and the means to removing those barriers. As they say, “after all, getting the chairs unbolted is often a non-trivial task.”

This brings me to the second of my recommendations for the coming decade, namely that leadership teams gather critical information about interest and expertise relative to pedagogies of engagement within their campus community and about local barriers to promoting and adapting those approaches; design and implement an action plan to overcome barriers in the process of adapting pedagogical innovations to serve learning goals for the students for whom they are responsible.

An oft-cited barrier to the mainstreaming of pedagogies of engagement is the lack of evidence of their efficacy. Over the past decade, however, this barrier has been largely surmounted by building on efforts to link research on STEM learning to STEM teaching—efforts that go back many years, at least to the work at the University of Washington by Arnold Arons and Lillian McDermott (see Narum and Rothman 1999). Although these efforts were present and becoming visible in 1999, the past ten years have seen a significant increase in efforts like those of Nobel Laureate Carl Weiman (2007) to take a scientific approach to pedagogical and institutional transformation.

Among those leading these efforts are a cadre of assessment pioneers, who, with support from the NSF’s Assessing Student Achievement (ASA) program, have been deeply involved in research-based initiatives designed to get inside the learning process and gather evidence to document what works and for which students. Some start from what disciplinary content students should know (the Calculus Concept Inventory, the Geoscience Concept Inventory, and Measuring What Students Know about How to Learn Chemistry). Others approach assessment directly from what skills students should acquire (Assessing Problem-Solving Strategies in Chemistry and Assessing Critical Thinking Skills) or from the STEM literacy perspective (Assessing Students’ Value for Science and Math Literacy).

At a meeting of the ASA community in 2006, project principal investigators were invited to share insights from their experiences with colleagues across the country. They urged STEM faculty to recognize that students know and understand less when they emerge from courses than most faculty think they do; that what we teach, despite our best efforts, is not what students learn or how they learn; that student achievement can be increased with effective assessment; and that you can teach better and enjoy it more if your students are demonstrably learning better. This group of experienced practitioners also thought that the situational barriers that keep others from exploring, adapting, and extending their work could be overcome if three conditions were met. First, STEM faculty and their administrative colleagues would need to realize there is no need to reinvent the assessment wheel—an effort costly in both time and energy. Second,
faculty would need to identify themselves as members of the community of STEM pedagogical and assessment practitioners in the same way they feel an identity as a member of a STEM research community. And third, formal opportunities would need to be available at the local level—campuswide, within departments or programs—for conversations about how difficult it is to teach certain concepts or students with different learning styles, conversations that capitalize on the expertise and interest resident in their community by engaging that broader community in asking, what works for our students, and how do we know?

I hesitate to predict what the STEM world will look like in 2019, especially given how different it is today from the way the 1999 Project Kaleidoscope report predicted it would be. And so I will end instead with the third of my recommendations for the coming decade, namely that those with a stake in a robust twenty-first-century undergraduate STEM learning environment step back, take time to work with the communities of which they are a part to agree on outcomes from undergraduate engagement in STEM learning, determine their individual and collective responsibility for ensuring their students achieve those goals, and make it happen.

To respond to this article, e-mail liberaled@aacu.org, with the author’s name on the subject line.

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HOW MUCH will global temperatures rise over the next century? How fast will ice sheets on Antarctica and Greenland melt and raise global sea level? Will rising temperature and acidification of the oceans extinguish corals and other endangered marine ecosystems? Will global warming cause hurricanes more powerful than Andrew and Katrina? What triggers the massive earthquakes that cause large tsunamis such as the devastating 2004 Indian Ocean event? These questions of habitability, sustainability, and survival are driving a surge of research in earth system science, a field that incorporates atmospheric science, earth science, ecology, and oceanography. Moreover, they are transforming the field from one that focused on the past to one that is increasingly forward-looking, aided by major advances in instrumentation and computational power.

As the research interests and the focus of traditional earth scientists are transformed, so too must education in earth system science at colleges and universities across the country change. The required change involved not only the methods we use to teach this new science, but also the essential place of the earth sciences in the panoply of disciplines as traditionally ordered by our academic colleagues.

Preparing a New Generation of Face Earth’s Future

Earth system science must establish its place in college curricula

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Earth system science must establish its place in college curricula to ensure that a new generation of citizens and scientists is prepared to meet future challenges.

To earth scientists, all of this is self-evident. But it is not always so within the broader communities of the academy. We hear, for example, that the twenty-first century will be the “Century of Biology.” Earth science courses, faculty, and departments are often the first casualties of financial exigency and budget insufficiency. Is it possible that in 2050 we will find ourselves wrestling with an earth system we only partially understand as human impacts tip us toward climate, ecosystem, and resource crises of literally life-threatening or apocalyptic dimensions?

We posit that strong research in earth system science and equally strong investments in both teaching the earth sciences and training a new generation of earth system scientists are not optional but essential. The handwriting is on the wall: we have only one earth; we are engaged in a dangerous experiment that involves altering the dynamics of earth systems upon which we are wholly dependent; we do not fully understand how the system works, and we are only beginning to be able to predict our effect on that system.

Global crises

Without doubt, earth system science is the beneficiary of global misfortune. This science is vital to understanding crucial global threats in the coming century: shortages of water (potable and otherwise), declining availability of fossil fuels, coastal inundation, the literal collapse of ecosystems, and of course, global warming—to name the obvious. Global warming threatens to wreak havoc with global agriculture, with particularly strong impacts in tropical and subtropical regions that include a large portion of the developing world. The combination of scarce natural resources and population increase is not sustainable. Overpopulation, largely in
Citizens and Scientists to
developing countries and especially in Africa and Southeast Asia, places people directly in harm’s way as towns and cities are built in areas prone to natural disasters. The 2007 report of the Intergovernmental Panel on Climate Change (IPCC) projects that, by 2080, one hundred million people will be affected each year by rising sea levels. These issues are not simply matters of scientific interest; they will fundamentally drive national and international politics in the twenty-first century.

Consider a specific example. There is probably no greater threat to global stability and human health than that posed by limits to available supplies of clean drinking water. The horror of Darfur is certainly about politics, but it is also about water. As the United Nations said in a recent report, “exponential population growth and related environmental stress have created the conditions for conflicts to be triggered and sustained by political, tribal or ethnic differences [in Darfur]” (Polgreen 2007). Recent discoveries of huge subsurface water resources in western Sudan suddenly alter the political equation in Darfur. Yet, recent news articles and op-eds are uncertain as to whether this will be a curse or a blessing to the victims of conflict in the Sudan.

Is this one small example, or is it the harbinger of our future? Estimates suggest that with the global population likely doubling by 2050, current supplies of clean drinking water will be overwhelmed and demand for water for agriculture and industry will compete directly with the supply of water for human consumption. We will have to develop new ways to clean contaminated water or convert large volumes of nonpotable water from other sources (seawater, for example) in an economical fashion. This is earth system science. It is science that is not only exciting to students, but that also has deep and complex ramifications for public policy that will demand a workforce and citizenry well-educated about the earth.

**Advances in technology, computing, and informatics**

There are some who argue that the earth sciences—especially geology—are relics of nineteenth-century modes of inquiry, that they belong to an era of discovery and classification. Nothing could be further from the truth. Major advances in technology and a surge in computational capacity and speed have provided an enormous boost to research on the earth system. Just as gene sequencing has allowed the biosciences to understand genetics and molecular processes in living systems, advances in the earth sciences give us the ability to employ remote systems to acquire powerful data sets for prediction and for understanding planetary systems.

For example, EarthScope, funded by the National Science Foundation, includes a vast and highly sensitive global positioning–system array that can measure tiny motions of the plate boundary along the San Andreas Fault. This array will help us understand the buildup of forces in the earth’s crust that will ultimately trigger the next large earthquake in California. Incredibly sensitive optical remote sensing data (Light Detecting and Ranging, or “LIDAR”), collected by satellites or from aircraft and championed by NASA and the United States Geological Survey, can determine changes in coastal zone elevation on the order of a centimeter. These data can help geologists forecast the long-term effects of future storms on the coastal zone. Ice-penetrating radar and seismic experiments have the potential to determine the basal conditions of the large ice sheets of Greenland and Antarctica, which are needed to predict large melting events that can lead to sharp rises in sea level.

New advances in computing and informatics, in many cases driven by questions asked by earth system scientists, are allowing detailed modeling and rapid analysis of earth events. For example, major studies of the seismology of the 2004 Indian Ocean earthquake and the meteorology of Hurricane Katrina were conducted within months of these events. The same new technology, informatics, and visualization that allow researchers to understand earth events within days, sometimes even hours, of their occurrence also enable exciting, authentic, active learning based on real-time data. Within days of the Indian Ocean quake and Katrina, faculty were integrating data from both events into courses throughout the curriculum.

Earth system science research is increasingly focused on forecast models that are fundamental to policy making and political decision making. For example, general circulation models of the climate (GCMs) can be applied to simulate the effect of rising carbon dioxide levels on surface temperatures and precipitation patterns, allowing researchers to understand the likely impact on agriculture and weather in specific areas.
Importantly, the models also allow researchers to explore the validity of their results. The recent IPCC report on climate change shows that the confidence of prediction of temperature increase is significantly greater than that of sea level rise; models can predict warming as a result of carbon dioxide increase with far more certainty than they can forecast how fast glaciers will melt.

Like data, models are easily accessed in teaching environments. Earth system science teaching frequently takes advantage of online research models—for example, GCMs that simulate future climate scenarios are available on the National Center for Atmospheric Research Web site—as well as modeling tools that allow students to create and explore their own models. There are few teachable moments that can compare to allowing students to explore a flooding model for New Orleans in the aftermath of Katrina and discuss not only its scientific basis but the policy and societal implications as well.

Earth system science and the curriculum
How do we teach earth system science? This is a field that is inherently interdisciplinary. The core fields—earth science, ecology, atmospheric science, and marine science—bring together biology, chemistry, math, computer science, and physics with observations of the earth to address complex real-world problems. As a result, it is possible to find earth system science being taught in many places on campus. Courses addressing earth system science have long been essential parts of the general education curriculum, where they stand next to Astronomy 101 as among the most popular choices for students seeking to fulfill distribution requirements.

The traditional curricula that forced generations of general education students into “rocks for jocks,” where they memorized dozens of fossils and minerals, are a dying breed, however. New earth science curricula stress problem solving and active learning, taking advantage of the opportunities presented by real-time data on our planet. In recent decades, the traditional Geology 101 has often been supplemented or replaced with topical courses capturing attention with titles such as “Energy Wars,” “Forensic Geology,” and “Natural Disasters: Hollywood versus Reality.” Introductory geoscience instructors nationwide use such topics to introduce students to scientific thinking, the complex behavior of natural systems, and problem solving, preparing them to make the individual and collective decisions that affect our environment.

Given the increasing societal importance of earth system research and the growing need for scientists to tackle environmental issues that have complex legal, policy, and ethical ramifications, earth system science education must be interfaced with programs and courses in policy, law, and ethics. Such interdisciplinary programs already exist at the graduate level, but a compelling case can be made for undergraduate curricula that provide a solid basis of earth system science allied with internships in law and public policy. Moreover, this shift will affect programs in oceanography and ecology that typically only offer degrees at the graduate level and that must increasingly focus on undergraduates, targeting students who are interested in the intersection of science, policy, and law.

Earth system science holds the keys to pressing issues that will increasingly control the ability of humans to maintain current ways of life. Education about the earth must begin at the K–12 level, and we advocate increased emphasis and higher standards, especially in middle and high schools. However, colleges and universities must lead the charge toward increasing earth science literacy. The day of “rocks for jocks” is past; everyone needs to understand more deeply the environmental crises that face the earth. It is time to reexamine the status of earth system science in your institution.

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In mid-November, the National Association of State Universities and Land-Grant Colleges (NASULGC) announced its official approval of the Voluntary System of Accountability (VSA). For those of us who have been hiding under rocks during the past few years (not such an odd place to find academics, whose interests often run more to details of Shakespearean tragedy or, indeed, rocks, than to higher education policy), here’s why that matters.

Background
The VSA is an indirect outgrowth of the work of the Spellings Commission, a group that served at the behest of Secretary of Education Margaret Spellings and that was charged with examining problems in higher education. Accountability was one of those problems. After extensive research and debate, the Spellings Commission, under the leadership of chair Charles Miller, former regent for the University of Texas system (and the same person who led development of a K–12 accountability system that eventually served as a model for No Child Left Behind), issued a series of recommendations.

At an early stage in the drafting of those recommendations, Miller lobbied hard to mandate standardized value-added testing of general education skills, using a measure like the Collegiate Learning Assessment (CLA), as a basis for accountability and comparability among institutions. In response to push-back from higher education, the mandate was dropped from the final version—but only after the commission received assurances from organizations like NASULGC and the American Association of State Colleges and Universities (AASCU) that they themselves would take the lead in developing a rigorous system of assessment and accountability. NASULGC and AASCU appointed a committee to develop such a system, which they promised would fulfill both the letter and spirit of the Spellings Commission’s intent.

The result of this committee’s work is the VSA. Unfortunately, the VSA seems predicated on the assumption that the Spellings Commission approach is inevitable. Therefore, the VSA proposes mechanisms to control implementation of value-added testing (for example, via a phase-in, with decision points for campuses along the way), while failing to challenge the premise that standardized testing of purposefully generic (and thus theoretically broadly applicable) general education outcomes is the best means of encouraging and measuring institutional quality.

Further, the VSA, like institutional accreditation itself, is described as “voluntary.” But the intent, clearly, is that participation in something like the VSA will quickly become expected and, de facto, an essential practice for legitimate institutions of higher education.

What’s wrong with general education skills as the unit of comparability?
Those of us who take general education seriously might at first imagine the potential benefits of this nationwide focus on general
education outcomes. There would be satisfaction in seeing general education, often completed in the first year or two of college and described disparagingly to students as something to be “gotten out of the way,” more publicly valued. But however important general education should be to institutions, it is a poor measure of institutional effectiveness and a poor basis for institutional comparability. Here’s why.

First and most important, there’s the issue of student mobility. While courses in the major usually are taken primarily at the degree-granting institution, many students (and at some colleges and universities, most students) take some or all of their general education curricula at other schools. Given the political and pragmatic pressures for convenient portability of credits, especially general education credits, it is very difficult for an institution to control that portion of a graduate’s curriculum. Comparing institutional outcomes on skills primarily taught in the general education curriculum is therefore likely to tell us very little about the graduating institution.

Even if we argue that a degree-granting institution must accept responsibility for the effectiveness of courses and curricula students have completed elsewhere, it is important to note that the last half of a student’s curriculum is typically taken within a major. Near the time of graduation, it is the major with which students likely identify. Learning that occurs within the major courses can therefore be expected to strongly influence student performance on tests administered shortly before graduation. Although at first blush, general education skills like critical thinking and written communication may appear generic, the fact is that these skills, as enacted within the disciplines, can be surprisingly variable. As almost-graduates, both English majors and engineering majors may be highly experienced critical thinkers, but the generic skills learned in general education courses will have been largely retooled to reflect the thinking and reasoning processes most valued in each student’s own discipline.

Measuring critical thinking on a standardized national test requires ignoring these disciplinary differences. If the test-makers’ definition of critical thinking aligns well with skills valued within an institution’s most popular majors, scores will likely be good. But if not, well, someone within the university will be searching for a different test. Little information of value—to the public or to the institution itself—will have been gained.

Standardized tests of general education outcomes among senior students are therefore of questionable value as measures of institutional quality (although administration of a carefully selected test that aligns well with institutionally valued outcomes may be another matter). As the primary measure of comparability and accountability, such tests must be deeply suspect.

### Standardized testing for comparability and accountability

Flaws in existing tests and testing methodologies make matters worse. The Collegiate Learning Assessment (CLA), often described as one of the best of a new generation of standardized assessments of general education outcomes, demonstrates just one of the problems with such tests. The CLA attempts to measure value-added gains in skills like critical thinking,
written communication, analytical thinking, and problem solving, a process that requires testing both freshmen and seniors. Getting freshmen to take such a test seriously (despite the 180-minute testing period required for a longitudinal administration, 90 minutes for cross-sectional) is challenging but usually manageable. Getting similarly committed participation from savvy college seniors, for whom the test is unlikely to “count,” is often exceedingly difficult. And even if seniors can be persuaded to take the test, can they be counted on to take it seriously? If they are about to graduate as part of a class of five or twenty thousand, can they be expected to take the test as conscientiously as students graduating from a small private school where institutional loyalty has been carefully nurtured over four years? And, if not, will the scores be “comparable” in any meaningful way?

Other concerns about general education outcomes testing as well. Questions have been raised about what the tests actually measure, whether it is reasonable to assume “content neutrality” can or should be achieved in tests, whether what gets measured in a skills test is really the skill that universities intend to teach, whether it is theoretically possible to segment out performance on “generic” general education skills to the exclusion of years spent in a nongeneric major, etc. Each question represents a major issue regarding the value of the test and a reason for caution about widespread implementation for institutional comparability.

Other (better) options
Taken in concert, these questions must raise grave concerns about the standardized testing of general education outcomes for institutional comparability and accountability. Other approaches, including other testing options, would likely be more meaningful and more useful—and some of these other approaches are already available.

For example, a number of disciplines already use standardized testing for professional licensure or certification. At least one discipline within the traditional arts and sciences core (chemistry) has available a similarly well-regarded test of professional knowledge. For schools that offer majors where standardized exit testing already occurs and is well regarded, scores from such tests could be a useful comparability measure. If this approach were taken, additional discipline-specific tests might be developed, extending the reach of the measures, or relevant subject-area GRE
exams might be considered for use as a proxy. If “passing” such a test were a route to licensure or certification in the field, or if employers learned to ask students to report their exit test scores in the same way employers now ask about GPA, the problem of student compliance would be solved.

Of course, this still raises the question of what the public might learn from such scores that would be useful when comparing institutions. But the point is that there are many approaches to assessment of learning within an institution, and there are many purposes such assessment can serve. Once a particular system is implemented, even partially and voluntarily, it may rapidly become inevitable in the same way that No Child Left Behind (NCLB) now seems inevitable (or in the same way that ACT, SAT, and GRE tests became inevitable some years ago). However flawed the NCLB system, the question most often asked about it today is how Congress might tinker with it at the margins—not whether it has proven beneficial to student learning. Yet that remains a significant question.

I believe the current proposal to implement the VSA and its “College Portrait” scheme is too hasty. It’s like a book that’s been rushed to print to capitalize on the death of a celebrity—there just hasn’t been time to get it right.

For too long, colleges and universities have resisted pressures for greater accountability for student learning, taking a head-in-the-sand, “if we don’t acknowledge it, maybe it’ll go away” approach. That’s been a mistake. But I am equally suspect of knee-jerk reactions, and there is danger of that now, in the wake of the report from the Spellings Commission.

Furthermore, this may be the worst time, in some ways, to plunge into a testing approach to assessment. Implementing the VSA will focus institutional and national attention on assessment as a measure of institutional value rather than as a tool for improvement. Institutional resources for assessment will get poured into testing, which would be clearly beneficial to testing companies but less clearly beneficial to student learning. Students’ assessment participation will be largely spent on particular measures of still-questionable utility. Just as faculty are beginning to ask serious questions and generate useful answers about student learning, their energies will be diverted into outcomes testing—an approach that will simply reinforce suspicions that there was always a secret agenda behind talk about assessment. We’ll generate scores for convenient (if not necessarily meaningful) comparison. But will education be any better as a result?

Surely we can do better. We owe it to our students and our institutions to make the effort.
A CLASSIC COMING-OF-AGE ritual in Latin culture is the *quinceañera*, an elaborate fifteenth birthday celebration held to announce the arrival of a young woman. The *quinceañera* not only honors girls for having attained a certain level of maturity, but it also raises expectations for their further development and prosperous futures. Miami Dade College recently held a similar celebration for a set of youthful ideals that have, metaphorically, moved out of the faculty house. Spelled out in a new set of learning outcomes (see p. 32), these ideals are expected to raise levels of achievement and awareness throughout the college.

On October 19, 2007, students and faculty signed a covenant of engagement with ten outcomes that had been adopted the previous year. A wide range of interested parties gathered in Miami’s Freedom Tower to pledge their support, including the leadership of the college, the president and CEO of the Greater Miami Chamber of Commerce, and U.S. Under Secretary of Education Sara Martinez Tucker. Interestingly, we were surrounded by history and art. Listed on the National Register of Historic Places, the golden Freedom Tower is a beacon of hope well known for welcoming Cuban refugees in the 1960s—myself included—and at the time of our event, it was hosting a landmark exhibition of etchings by Francisco de Goya. Thus did the event itself evoke learning outcomes five and nine, which address diverse cultures and aesthetics, respectively.

Like the etchings on the walls, the Miami Dade College Learning Outcomes are becoming etched and framed in our collective mind. They are also taking root in every course. For
and Cultivating Assessments

How the Largest College Found Common Ground
example, students taking Biology and Environment with Professor Chris Migliaccio receive an extensive syllabus, a course study guide, and a chart of what he calls “Gen Ed Vitamins” that delineates how the ten learning outcomes align with the objectives and enriching activities of the course. “There is nothing in the outcomes that I don’t cover,” Migliaccio explains. “These are like survival skills, because our world is so interconnected. I didn’t have that paradigm when I was a student.” He is pleased when finishing students describe the course’s effect on them as a “paradigm shift.”

Although the integration of the outcomes into all of our two thousand courses will take some time, we still can celebrate our achievements thus far. Articulating and refining an ongoing discussion that has spanned decades, our very large and very diverse system has agreed—within the relatively short time frame of two years—on what we want graduating students to know. This agreement dovetails with our current effort to identify more authentic and effective methods of measuring what our graduating students have learned. Perhaps our example will inspire others: if the largest undergraduate institution in the nation can do it, then others can too—and on their own terms.

**Intentionality**

Our quest began with high expectations all around, for our staff as well as for our students. As a result of our open admissions policy, some of our students have a longer, more remedial educational journey than others. But still we expect all students to be truly educated and truly prepared to succeed by the time they graduate. The clear articulation of specific learning outcomes ensures that everyone knows exactly what we mean by a Miami Dade College education.

Although our college is uniquely large and diverse, our process for developing outcomes and assessments is not enigmatic. It has involved the keywords of collaboration, persistence, and democracy. A democratic process is paramount at a place with more than two hundred programs of study, eight campuses, and a majority of minority students and faculty; but democracy also works in smaller, more homogenous villages.

Just as visualizing success is a proven method for elite business leaders and athletes, intentionality is very important in education. Our process for developing outcomes and assessments is not enigmatic. It has involved the keywords of collaboration, persistence, and democracy. A democratic process is paramount at a place with more than two hundred programs of study, eight campuses, and a majority of minority students and faculty; but democracy also works in smaller, more homogenous villages.

Just as visualizing success is a proven method for elite business leaders and athletes, intentionality is very important in education. Our process for developing outcomes and assessments has been full of intention at each step, and this mentality mirrors the consciousness we want to see in the work of our faculty and students. The process itself models the outcomes.
When students and faculty work intentionally toward the same goals, we raise the consciousness of our entire system and move together toward what the Association of American Colleges and Universities (AAC&U) calls “an invigorated and practical liberal education” (2002, x–xi). Although expert consultants have proven very useful, we have not been looking to outsiders to tell us where to go; we are looking within. We believe in our faculty and in our ability to prepare students for personal and professional growth in the twenty-first century.

Miami Dade College has a large cohort of students with limited proficiency in English. Do we want these students to grow in areas other than language skills, and if so, how? In a remedial reading class taught by Isabel Rodriguez-Dehmer, cochair of the Learning Outcomes Coordinating Council, the students participate in a Habitat for Humanity project in an impoverished neighborhood. “This is something they normally wouldn’t do, but it really connected them to the college,” says Rodriguez-Dehmer, who collaborated on the project with the student services division. “We’ve hooked them to work harder and be part of our community.” This project follows from outcome six—“create strategies that can be used to fulfill

**Even courses with narrow and specific focuses can function on multiple levels**

Miami Dade College
personal, civic, and social responsibilities”—yet it also delves into other outcomes such as communication and ethical thinking. As this example demonstrates, even courses with narrow and specific focuses can function on multiple levels.

The process
Every good organization is guided by a mission statement, and our engagement with outcomes has been a college-wide attempt to further emphasize “the learner’s needs” identified in ours. We asked the business community and alumni as well as our community of teachers and learners, what should a student have gained by completing a course of study at Miami Dade College?

At the dawn of the millennium, even broader questions drove an expansion of our mission statement into a strategic plan for the years 2004–10. The plan challenges us to make progress in five major areas: access to the college, student achievement and success, serving the community, resource development and allocation, and employees and the college. The establishment of learning outcomes is among the priorities included under the second of these major areas. Moreover, the idea of assessment is articulated in this guiding document as a means “to continue to uncover meaningful methods of measuring student learning.” The will for reform was there. Our college had been grappling with these issues for years, but in 2005—just as state, regional, and federal commissions were questioning the level of accountability in higher education and the national dialogue was developing—a campuswide movement coalesced. When they returned from an AAC&U institute, the members of our general education team inspired the faculty with their conviction that our outcomes needed to be reformed, and they developed a purpose statement for “intentional learning experiences” that “foster effective citizenship and lifelong learning.” The statement makes it clear that, for us, learning is deliberate, goal-oriented, and continuous, and it laid the foundation for the list of outcomes that followed.

We did not preordain a “top ten” list. The list evolved from a community-wide dialogue that took place in workshops, committees, and the hallways of our campuses across the county. Local businesses and alumni as well as current students and staff took part in surveys and focus groups. Certainly other configurations of the outcomes may have been acceptable, but their wording is truly ours. The Miami Dade College Learning Outcomes help define what our institution stands for, and they demonstrate our commitment to the core values of a liberal education.

Assessment
In November and December 2006, just a month after the ten outcomes were formally adopted, a preliminary round of new assessments was administered. Instead of relying on standardized tests, we developed a series of scenario-based, authentic tasks that address multiple learning outcomes. For example, some students were challenged to write about a proposed offshore oil drilling operation. How well could they express their concerns? Among other outcomes, this task addressed environmental issues, ethics, and communication skills. Other tasks involved speaking in public, deciphering graphs, and appreciating art. In addition, one outcome was assessed using a commercial test of computer skills.

Before the process of creating these assessments began, a committee established the rules of engagement. The committee members agreed that the primary purpose was to establish a broad portrait of our graduating class that could be used for making year-to-year comparisons and for making decisions about the current curriculum. In essence, we developed a unique internal process based on the understanding that one test could not fit all purposes, and periodic review would be necessary to hone the tasks.

Results were grouped into four broad skill levels: emerging, developing, proficient, and exemplary. The results of the preliminary round of assessment were not particularly surprising—we know our students fairly well—and they reinforced reforms already underway. What we really learned is that our young and diverse institution is capable of reaching agreement, growing together, and uniting around our students. The process was team- and faculty-driven, and like a hybrid vehicle, it created its own energy.

Lessons learned
The assessment process has taught us at least four important lessons. First, consistent and open communication about the process is imperative
for gaining both faculty buy-in and administrative support, and faculty-led discussions are particularly effective in this regard. Second, students need more in-class opportunities to become familiar with performance-based assessments: tasks to assess various learning outcomes should be incorporated into each course. Third, external expert review and internal vigilance are both necessary in order to validate the process and to avoid grading bias and unreliability. Fourth, an exploration of the use of technology to streamline the entire process would benefit the college.

An unprecedented, college-wide effort is now underway to map the entire curriculum over the next two years. We are challenging all faculty and all disciplines to weave the learning outcomes and relevant assessments into their coursework. In the long run, every course in every discipline must demonstrate how it addresses the ten learning outcomes. Although our administration is also united in this vision, the effort is truly faculty-driven. Only the faculty can bring the outcomes to life.

On stage with me at the learning outcomes covenant signing event last October were several other presidents: the presidents of our campus student government associations, the president of the faculty union, and the president of the Greater Miami Chamber of Commerce. Each had—and retains—a place at the table. The representatives of this alliance pledged “to become intentional learners” and to “intentionally address the learning outcomes and actively engage students.” Although we can celebrate great strides in this direction, we recognize that our college, and society as a whole, still has a lot of work to do.

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REFERENCE
In recent years, the University of Michigan–Flint has undertaken more new initiatives than most institutions tackle over an entire generation. Since 2004, we have produced an ambitious five-year strategic plan, adopted a decentralized budget process, committed to increasing enrollment by 25 percent, reformed our general education program, and begun the transition from a commuter to a residential campus. Some of these initiatives were dictated by outside forces; others represent responses to growing internal calls for change.

Engaging in institution-wide change requires examining institutional culture—defined by the set of shared attitudes, values, goals, and practices that characterize the institution (Trice and Beyer 1984)—and, when necessary, engaging in cultural change. Colleges and universities are historically slow to make changes to institutional culture, however. They tend to seek extensive deliberation and study, which too often result in resistance to change.

Engaging in institution-wide change requires examining institutional culture—and, when necessary, engaging in cultural change. The types of change needed to meet demands for a twenty-first-century education require us to rethink not only who is involved, but also how decision making and implementation occur. As R. Eugene Rice (2006) has observed, institutional change requires serious consideration, buy-in, and support from all stakeholders. While faculty are central to the success of almost any institutional change effort, it is also essential that staff, students, administrators, governing boards, and the community at large be given real opportunities for involvement in decision-making processes.

Like other higher education institutions, our university has certainly struggled with its share of failed attempts at change. At times, it has seemed as though we have abandoned nearly as many initiatives as we have begun. But for a relatively brief moment during the 2005–6 academic year, our whole campus was moving together, at the same time, and in the same direction. Something was different this time.

Fostering campus engagement

In reforming our general education program, one of our major initiatives, we consciously chose to alter the way we address campuswide issues. Instead of our traditional approach—appointing a committee and charging it to bring back to the campus a fully realized plan or solution—we separated the content of the project from the processes for addressing it.

At an Association of American Colleges and Universities (AAC&U) Institute on General Education, former AAC&U Vice President Andrea Leskes informed a team of our faculty that an astounding 95 percent of general education reform failures are directly linked to failures in process. Heeding Leskes’s advice that we carefully consider matters of process as a part of our larger reform effort, we gave control of the process to the committee; decisions about the content of the project were left to the rest of the university. In other words, we empowered the campus community as a whole to make decisions about the curriculum, rather than relying on an appointed committee to make those decisions on their
behalf. In the end, this process-oriented approach enabled us to achieve much more than the reform of a single program; we changed the culture of the campus.

Early in the general education reform process, the steering committee sifted through the responses to a campuswide survey of opinions on what was wrong with the old general education model and what a new program should look like. After grouping and categorizing the responses, a picture began to emerge that astonished us. Of course, the surveys yielded predictable complaints associated with the program itself, including its inadequacy to meet the needs of students and faculty. But what also emerged was a broader set of complaints that transcended the programmatic issues and gave the committee its first look at the underlying problems that had contributed to years of collective failure: a culture of secrecy and suspicion, a lack of communication at almost every level, a fierce sense of territoriality, and a strong sense of disenfranchisement.

The committee had inadvertently uncovered a historical roadmap to our own failure, and we realized that we had been charged with much more than managing a process for producing a new general education plan. If we were to have any chance of success in reforming general education, we would have to find a way to transform the culture of self-defeat and failure into a culture characterized at every level by transparency, collaboration, and inclusiveness.

Using an analysis of the cultural problems on our campus as a starting point, the steering committee made a strategic decision to address directly the very problems that had for so long impeded institution-wide success. The first challenge was to engage our constituents in the conversation of reform. Disengagement and apathy had grown over the years to the point where they eventually had embedded themselves in our cultural identity. To address this problem, the steering committee created tasks and timelines. But the real work of the committee was to guide the how of reform and leave the what to the rest of the campus. Our mantra became, “the role of the steering committee is to manage the process, not determine the content.” Although it seemed foreign to many of our colleagues, this process-first concept gave them an upfront invitation, maybe even a challenge, to become involved in solving the problem.

Previously, faculty had complained bitterly that top-down leadership decisions had rendered
their involvement meaningless. And so the steering committee took a calculated risk. We bet that by ceding decision-making authority to the faculty, administration, and staff—that is, by creating an equal playing field—we could empower our colleagues to take collective ownership of the plan that would eventually emerge. The risk paid off. Nearly a third of our colleagues attended the campuswide kickoff workshop at the beginning of the 2005–6 academic year. Attendance at the myriad events that shaped the yearlong initiative remained uncharacteristically high, and by the last meeting of the year, when we debated and voted on the final plan, 73 percent of our voting faculty were in attendance. True to our strategy, we had made institutional change by addressing a cultural problem.

**Changing communication patterns**
The profound lack of communication revealed by our survey was a second problem that had embedded itself in our campus identity. While it certainly rose to the top of our list as a cultural problem that had become an impediment to progress on institution-wide initiatives, the communication void also revealed something else. Over the years, by driving a wedge between faculty and administrators, breakdowns in communication had created a subculture of suspicion and secrecy. Rice (2006, 12) frames this dangerous dichotomy as a tension between two established internal cultures—the “collegial culture” (faculty) and the “managerial culture” (administration)—each “driven by an economy that exerts an enormous amount of power.” If left unchecked, these economies of power can create serious impediments to vital internal communication.

For our campus, a pathway to identifying and embracing our own tensions and power struggles emerged through the careful development of a communication structure the likes of which the University of Michigan–Flint had never before seen. For the steering committee, which had already committed itself to engaging all of our constituents in the reform process, building an effective communication system became a catalyst for achieving the level of engagement we sought. In addition to posting everything related to the reform effort on a Blackboard community and issuing biweekly updates on our progress, we hosted fifteen brown-bag discussions, published a monthly newsletter, and scheduled major workshops with nationally known experts. Our weekly steering committee meetings were open to all to attend, and we encouraged feedback at every step of the way. At no time during the reform process was the campus ever left in the dark about the committee’s work.

Power struggles between competing subcultures were not eliminated, but they were minimized to an extent that allowed collective movement forward. By adopting a neutral posture within a conversation fraught with highly charged opinions and deeply held beliefs—that is, by managing the process and not the content—the committee was able to stave off failure while influencing noticeable shifts in the campus culture.

**Broadening our perspective**
It was relatively unsurprising that our insularity would present itself as another cultural problem impeding institutional progress. In some ways, we had lost touch with the rest of the academic world, with national trends and best practices. And to make matters worse, we had fallen into a pattern of certain failure in attempting to solve campuswide problems. Faculty committees were selected by senior administrators...
to solve long-standing institution-wide problems. These committees were routinely sequestered for as long as a full academic year, given nearly impossible charges, and asked to produce comprehensive plans of action. Later, they would be paraded in front of the governing faculty to present their plans. The faculty, in turn, would soundly defeat the initiatives, one by one, on the grounds that vision, faculty input, and loyalty to the existing programs were lacking.

Out of frustration, and as a last resort, we contacted AAC&U President Carol Geary Schneider for advice. She suggested that we apply to send a team from our university to the AAC&U Institute on General Education. Our chancellor, a reform-minded leader, approved and supported the idea. Upon returning to campus after five intense days of workshops, plenary sessions, and consultations with as many as a dozen experts on general education reform, team members were energized and committed to educating the campus about some of the national trends driving successful reform movements. We knew that in order to get our colleagues to support a new approach to change, we would have to address the underlying cultural problem that stood in the way.

The insularity that so often stymies creativity and progress can easily be overcome by inserting broader perspectives into local conversations. We began our reform process by inviting nationally recognized experts to conduct workshops on our campus. These outside experts shared theories, practices, and specific success stories associated with reform. The attendance at these workshops—drawn from across the campus—was unprecedentedly large, and the broad participation created a new energy that expedited the engagement the committee was so desperately seeking. For the remainder of the academic year, we continued to bring outside perspectives into the conversation, and we did it while addressing some of the other cultural problems simultaneously. After all, cultural problems, and the solutions to them, are interconnected and interdependent. It seemed intuitive to tap into our emerging communication structure as a way to address the insularity problem, and in doing so, we steadily increased the level of campus engagement.

The challenge of faculty governance
Faculty governance presents both challenges and opportunities for institutional reform. Our university has four academic units, and each maintains autonomy over its own curriculum—a power granted by the Board of Regents. While all of the units had shared a single general education program from the beginning, the future seemed less certain. Moreover, among the faculty, there was deep distrust of any interference with governance processes. For the committee, this meant taking a crash course in institutional policies regarding governance issues.

At times, faculty governance created unexpected problems for the steering committee.
But we discovered that establishing a clear and transparent timeline of events, including those that relied on faculty votes, helped ease the suspicion and mistrust that sometimes threatened to bring the whole reform movement to a screeching halt. A well-structured timeline does not carry the same institutional importance as realizing and addressing cultural problems, but it certainly helped us address the cultural problems with less fear and trepidation. The committee communicated its intentions from the very beginning with a mantra that we repeated over and over again, and the timeline helped reinforce the message: “we don’t know what a new plan will look like, but we know how we’ll get there.” By the end of the 2005–6 academic year, however, we did know what a new plan looked like—three-quarters of our governing faculty cast their votes for one. Anyone involved in a major institution-wide reform effort would do well to brush up on faculty governance structures and processes, as well as the cultural histories attached to them.

**Conclusion**

So how did such sweeping cultural change occur on our campus in such a short period of time? Like many historical phenomena, it happened in revolutionary ways. The steering committee went public—making all of its work and documentation available to the campus community, and sharing the view that our best hopes for success depended upon collective action. The committee used existing faculty governance structures to define the process—but not the curricular content—that would result from a foray into uncharted territory. We inundated the campus with national news about general education reform, we invited participation from campus members who had felt silenced or “silo-ed,” and we refused to accept the status quo as an option. We placed the needs of our students squarely at the center of the discussion and unrelentingly communicated with all constituents to help them see roles for themselves in the initiative. Silos were dismantled, barriers were crossed, and the culture of secrecy and suspicion that pervaded the campus was transformed into one of openness, inclusiveness, collaboration, and engagement. We learned, in short, that cultural change enables institutional change.

How successfully we resolve the remaining and yet-to-emerge cultural challenges that threaten our movement toward a more collaborative culture at the University of Michigan–Flint may depend upon how well we heed Rice’s (2006) call for a transformative view of faculty work—from an individualistic approach (“my work”) to a more collaborative approach (“our work”). We have yet to see how our process-oriented approach to change and its subsequent cultural changes will play out over time, but we will have plenty of opportunities to address new issues on campus from such a perspective. Assessment and reaccreditation, the establishment of an early/middle college, and efforts to internationalize the campus loom large on the horizon. We hope that the lessons we have learned from our willingness to examine and, where necessary, change existing cultural practices and to place student learning squarely at the forefront of our thinking will help us find broader success in these campuswide initiatives. As faculty move toward collaborative change with a clear focus on the commitment to student learning, and as they move under the direction of persuasive and exemplary leaders and committees, we are extremely hopeful that the cultural changes will indeed prove lasting.

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REMEMBER THE CULTURE WARS? The term has lost currency but the thing it labeled, a deep division in the American polity, is definitely still with us. And the phenomenon is now global: world economic integration has brought increased contact and conflict between national and supranational cultures. Fundamental conflicts over values and vision—culture wars—are very much with us today.

One of the first salvos in our domestic culture war was fired by Lynne Cheney, the former head of the National Endowment for the Humanities. In a 1994 op-ed piece in the Wall Street Journal entitled “The End of History,” Cheney launched a preemptive attack on a set of as-yet-unpublished advisory standards for the teaching of American history in our schools. That the battle was joined over the teaching of history is no accident: the story of who we have been is necessarily the story of who we are and what we value. Turks and Armenians, Kurds and Iraqis, Palestinians and Israelis all see the common events of their histories through dramatically different lenses, and such disparate visions make compromise and accommodation more difficult. A common ground on which cultural conflict over history could be resolved thus promises to be a useful thing.

Under the advisory standards that Cheney criticized, students were to be challenged with historical questions (“Was the atomic bomb used to shorten the war? Or was it done for political reasons?”) and given arguments and primary documents from both sides, thus encouraging them to make up their own minds. Such an approach nurtures critical thinking, evaluation of sources, tentative conclusions, and a host of other worthy educational goals, while requiring students to become producers, rather than passive consumers, of their historical understanding.

But for Cheney and neoconservative commentators like Rush Limbaugh, this approach promised a dangerous, nation-threatening loss. As they saw it, history is the nursemaid to citizenship. If American citizens were not to be taught a particular and laudatory metanarrative about their history—the story of American exceptionalism with its heroic sweep of ambition, statesmanship, and accomplishment—much mischief would ensue. For conservatives, the traditional narrative is a necessary foundation of American political life.

But had the standards writers ignored the contributions of ethnic, minority, and revisionist historians, they would have been guilty of professional malfeasance. And their pedagogic goal was worthy: they wanted students to understand that history is a lively conversation, one to which the present always brings its own concerns, obsessions, assumptions, and values. History is not simply “what happens” (as Limbaugh insisted); it is what historians do. There are standards of excellence that can be learned, and the national standards sought to codify them.

Ultimately the controversy was resolved, as political struggles often are, through compromise. Since the conservative position was styled as a moral rather than political position—Cheney et al. wanted complete purity in the return to a monocultural history teaching
of yore—the compromise looked like a victory for the multiculturalists. “At all levels of education,” said Todd Gitlin (1998), “the traditional story of steady progress in American history has been shattered by stories of the battles fought by women, Native Americans, and members of other disadvantaged groups. Non-Western history has a more-honored place alongside Western civilization.”

But what if the conservatives had a point? What if, in the absence of any other strong unifying force (shared fealty to a king, faith in a common God), by default national history becomes the crucible of national identity? If we fragment our history into a set of competing and contradictory histories based on ethnic, class, gender, religious, and racial categories, we risk undercutting the core of shared vision and values that is necessary to the functioning of our, or any, system.

At bottom, this argument is blind to the true foundation of American exceptionalism. It fails to accept the beautiful, bold, noble premise that underlies our founding. What holds the American polity together is not a language or an ethnic identity or a common history, but rather a shared commitment to the abstraction of process, to the meta-objectivity of political forms explicitly designed on the understanding that a free and diverse people will worship and think and behave—and even interpret their own history—in ways that confound any expectation of permanent consensus. Thus we have the epistemological ecumenicism behind our Constitution and its Bill of Rights. No single worldview or point of view is given pride of place there, and it does not try to define civic Truth. Instead, it defines the processes by which that truth is found—and changes.

Unfortunately, appreciation of the value of this boot-strapping out of particular subjectivities and into the meta-objectivity of process is demonstrably weak, not merely among neoconservatives but among the American populace in general. Americans seem willing to trade away civil liberties if doing so would provide safety from whomever the government tells us is a threat. A few decades of historical education under the new standards might begin to rectify this, for then a system that depends on civil liberties and participatory processes would no longer have a citizenry trained up under a history that is both authoritarian and monocultural. But the conservatives do have another point: complex matters are best learned and retained through assimilation to overarching cognitive structures—theories or narratives.
Multicultural history runs the risk of being retained as a simple metanarrative about the perpetration of injustice—what Cheney characterized as a "gloom and doom" vision of America.

So, we are led to a conclusion that seems to support the conservative position: If our divisive, interest-group-competing constitutional system requires a shared consensual mythos to hold it together against the divisive forces of religion, regionalism, ethnic diversity, competitive self-interest, and difference of moral opinion; if an Enlightenment-era commitment to shared processes is too abstract to serve as that consensual mythos; and if students will take the disparate, multivoiced materials of multicultural history and turn them into a single-voiced narrative anyway; then perhaps we do need a single, world-ordering narrative to serve as the foundation of our polity.

The problem is that, after what Gitlin calls "the great compromise of 1996," there is no single, authoritative interpretation of American history embedded in the national standards as issued. And, says Gitlin, "we are likely to live without a new, overarching narrative for quite some time to come" (1998).

But there is a candidate for a shared, overarching narrative that would fill the bill satisfactorily, and the time for recognizing it has long since arrived.

Environmental history as meta-metanarrative

Every day, more than fifteen million tons of carbon are exhausted into the atmosphere, adding to the burden that causes current and future global warming. Every day, one hundred and fifteen square miles of rainforest are destroyed, with consequent effects on local and global weather patterns. Every day, seventy-two square miles of desert are created, with similarly dire results. Every day, forty to one hundred species disappear and two hundred and fifty thousand humans are born. These are matters of incontrovertible fact (Orr 1992).

Clearly these rates cannot be sustained indefinitely. We are changing planetary systems on a grand scale in a one-off experiment in seeing if nature can adapt to injury as rapidly as we can give it injury to which it must adapt. If the experiment fails—which seems increasingly likely, if we credit reports from scientists in the field—the changes we are wreaking now will destroy the ability of the planet to support human civilization at anything like a level that we would find commodious, comfortable, even recognizable.

The first step in developing the understanding we need is to see nature historically. We can no longer justify the eighteenth- and nineteenth-century assumption that nature stands outside history, aloof, infinite, and unchanging. Nature has a history. It has always had a history, and over the past century that history has increasingly become a tale shaped by humans. We can accurately assess the implications of human acts only if we take the measure of our changes across human lifetimes. How are we to know if greenhouse gases are producing global warming? We study history. How are we to know what the consequences of cutting down the rain forest will be? We look for clues in history—in the change of ecosystems over time in response to changes humans have instigated.

As I have argued elsewhere (Zencey 1997), because nature’s rhythms move on a time scale that far surpasses our own, historical understanding is the fundamental precondition for ecological understanding.

An appreciation of environmental history shows us that our current experience of “now”—the brief threescore-and-ten span of our lives as we live them today—is not normal but is instead a remarkable aberration in the history of the planet. Everyone alive today was born into the Age of Oil, an era that may yet prove to have been a brief, century-and-a-half-long efflorescence of frantic human economic activity fueled by an unrepeatable drawdown of the planet’s natural capital (See Costanza et al. 1997). It is within our power to define the age differently. It could be remembered as an intermediate step toward an ecologically sustainable industrial culture, a culture created through wise use of antique sunlight to build an infrastructure that operates solely on current solar income.

Ironically, among the ways in which the Age of Oil is unprecedented is that it has seen the intrusion into human life spans of ecological changes that have heretofore been noticeable only in geologic time. Such is the power of oil that it united the human and geologic
scales. Key moments in environmental history are now reported in the daily paper.

As a meta-metanarrative organizing our thinking about American (and world) history, the story of human culture’s relationship to nature has some distinct advantages. First, it is objective; there is no gainsaying its insights, no credible argument holding that the facts of our ecological abuse are simply a matter of opinion that could be changed by adopting a different interpretive lens. Glaciers are measurably retreating, the oceans are measurably warming, soil fertility has been measurably diminished. The truths of environmental history can be discounted only at the cost of discounting most of the edifice of science itself. It takes quite a bit of logical legerdemain to maintain a position that says science is true and right and good when it is coupled to an economic system that brings us wealth, but it is not credible when it warns us of the dangers of destroying planetary ecosystems.

Second, environmental history is transcultural and transnational. Civilizations can clash all they want over whether Abraham or Adam Smith is a better guide to the regulation of our common life, but if we fail to cap carbon emissions and limit fish catches—if, more generally, we fail to learn and apply the lessons that environmental history offers us about the wise use of natural capital—succeeding generations will view that sort of controversy as a tragically pathetic distraction of no greater lasting import than the debates among medieval Scholastics over how many angels can dance on the head of a pin.

Third, as an organizing narrative the story of the mutual interaction of culture and nature has a scope and reach unsurpassed by any other metanarrative. Those schemes—God’s Righteousness Redeemed, The Progress of Enlightenment, Our Manifest Destiny, Marxist Class War, or the (Right) Hegelian End of History tale currently beloved of neoconservatives—are limited in comparison. It may be true, as Thomas Kuhn (1962) said, that the comparison of such alternative visions is more a matter of aesthetic vision and practical utility than logical proof, but one sure guide to utility in practice can be found in two criteria that have themselves proven to be undeniably valid in practice: breadth of application and degree of assimilation of detail (Pepper 1948). These—scope and reach—are relatively easy to compare. Scope:
every civilization has a necessary root in nature, and stands or falls on how well it hedges that root. Reach: the lessons of environmental history apply to matters of large national policy (what’s the best way to promote development of a sustainable energy infrastructure?) and petty individual choice (walk or ride?).

Environmental history as meta-metanarrative has one, paramount, additional virtue: by understanding the history of how humanity has related to the planet, we will have available to us the information and perspectives we need to ensure that the project of human civilization has a good chance of continuing beyond the next few generations or so.

The lessons of environmental history
From the perspective of environmental history, the notion that America’s greatness as a nation depends solely on some quality of the American character, or on that quality of character in combination with the exceptional quality of its economic and political institutions, is a naive conceit that can flourish only in ignorance of thermodynamics and ecology. Europeans set forth on this continent a new nation—one that happened to have lucked into history’s largest-ever stock of unexploited scarce low entropy: valuable matter and energy in the form of deep soil fertility, standing timber and easily extractable minerals, including especially fossil fuels (see Georgescu-Roegen 1971; Farley and Daly 2003). It is a lucky accident that cannot be repeated, not on this planet, ever. From the continent’s gift of natural capital we extracted an unsustainable flow of income that was easily turned into wealth, which for several centuries we have used to purchase comfort, distance from want, distance from nature, distance from compulsion of nearly every kind. To some extent, we have been able to export this bargain—low entropy in, wealth and freedom out—to other nations, but the global pursuit of it is sustained only by the world’s ever-increasing drawdown of natural capital, particularly fossil fuel. When the capital runs out, the bargain is done. And unless we are careful, the freedoms we purchased will be done away with, as well.

The unavoidable conclusion is that a dramatic change is required in the relationship of industrial culture to nature. That change is inevitable; an unsustainable relationship must, by definition, come to an end. The only question is, how intelligently will we face and prepare for that end? That is, how much natural capital will we reserve from current consumption? Our answer will determine how many humans the earth will support a generation from now. It will also determine both the standard of living and the standard of liberty those humans will enjoy.

We can, if we choose, use the lessons of environmental history to ease our global transition to a post-cheap-energy, post-rapacious economy, a world in which democratic freedoms and a decent standard of living are no longer purchased by cheap energy and the destruction of natural capital. A general appreciation among the American populace of the truths of environmental history is not anything like the sum total of the intelligence we will need to make that transition. But such an appreciation would make rational anticipation of inevitable change a good deal more likely. And in rationally, purposefully planning our move to a sustainable society lies the best (and perhaps our only) hope for continuing to enjoy an advanced civilization of any sort—our own exceptional, noble, constitutional democracy included.

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REFERENCES


ON A DAY when I was supposed to be in Innsbruck, Austria, for a conference, I found myself quite unexpectedly back on my own campus in eastern North Carolina as the sun was coming up. Flight delays had forced me to cancel the trip the day before. Disappointment still clung to me; I had not been able to shake it with a good night’s sleep in my own bed at home, surely a more restful night than I would have endured on the transatlantic flight with its usual inconveniences. My mind, which for days had been anticipating the rhythms of travel and preparing for a temporary sojourn in an unfamiliar land, was still in a state of forward motion, as if programmed to complete the intercontinental mission even as I remained grounded.

The trip to Innsbruck was one I had looked forward to. I had mentally rehearsed not just the paper I would deliver but the postpresentation activities I might enjoy; I imagined that I would emerge triumphantly into the bright sunlight and crisp air of a glorious alpine day, adrenaline still surging from the presentation, and make out for the nearest beer garden with newfound friends. After heartily consuming schnitzels and a few rounds of the local brew, we might all meander along hiking trails or walk aimlessly on the cobblestone streets of the city center with our hands clasped behind our backs and our heads inclined toward one another, talking easily about conference topics and making plans for sightseeing excursions to historic castles and churches.

That’s how I envisioned my day, far from home. I certainly didn’t intend to be on familiar terra firma, at the same campus I stride across nearly every day. But here I was, having awakened in the predawn darkness and needing a good brisk walk in the fragrant morning to clear my head.

As I lit out toward the quad from my office building, I could feel myself gradually returning to my senses, my mind coming in for a landing. But I was still a bit disoriented; I had the strange sensation that I was not in an entirely familiar place after all, that somehow (as E. M. Forster wrote in *Howards End*) “the unseen had impacted on the seen” and enchanted everything slightly. Having expected to take in the panorama of my

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overseas destination by this time on my body clock, it was as if I was apprehending the university through Innsbruck-seeing eyes—fresh and new. The campus was beckoning me to pay closer attention, to be more awake and alert and alive to my environment.

This is what international travel does, after all. In a foreign land, with unfamiliar surroundings and customs and language, one is often in this state of heightened awareness and agitation. It’s partly a matter of survival, partly a fervent desire not to miss anything. At home, by contrast, the routines of daily life immunize us against much of deep noticing; we are conditioned to go about our business as usual until we are wrenched into consciousness by a sudden jolt or disturbance, and then we are inevitably surprised to detect a feature of the landscape that has been in front of us all along. “Hmm,” we marvel, “I never knew that was there.”

**Seeing the extraordinary in the ordinary**

How often do we—or might we—have such a moment of revelation on our own campuses, an encounter that causes us to see the extraordinary in the ordinary? The fact of the matter is that we often don’t know our own universities as well as we should. We busy ourselves with the customary multitude of tasks, or we consciously choose not to commit to a place because we’re convinced that the stay will be temporary, or we consider ourselves more “cosmopolitan” (citizens of the world) than “local” (stewards of region), as the popular distinction goes. Some of us have drawn the old invidious comparisons to other places and found our home institutions lacking in certain respects, and instead of appreciating them on their own terms, we decide that their shortcomings give us permission to check out. We travel the same well-worn path from the car to the office, literally and figuratively, so that we miss a good deal of the rest of the campus. These are among the same explanations we all use, assuming we even give much thought to it. More likely, we treat the campus as a vast backdrop that we rarely even regard as we play out our individual parts. At some point, it’s worth asking what we might be missing when we do this.

The study I was to present in Innsbruck was one that took me to twelve institutions over a fifteen-month period. As part of that study, I spent several days on each campus, often eating my heart out at the splendor of these venerable old colleges and universities, details of which I dutifully recorded in my field notes. What I was trying to do was capture a bit of the reverence and awe that might be inspired in a rising high school senior coming to the campus for the first time as part of a summer enrichment program that was the focus of my research. I reckoned that students must show up and be completely taken by the gorges of Cornell, the Mission-style architecture of Stanford, Jefferson’s “academical village” at Virginia, and the majestic beauty of every school I visited. The physicality, of course, is a portal into even deeper and richer recesses, but buildings and spaces are more than mere ornamentation. They tell their own complex stories, and there’s no question that they have the capacity to make striking and lasting impressions.
We tend not to take these things for granted when we visit other campuses. On our own turf, however, we do it daily. Perhaps it took me twelve institutions and a canceled trip abroad to come to the realization of my own university’s aesthetic value. As I strolled across the grounds, I came to see my scuttled journey to Innsbruck as fated: Maybe I was meant to be shown how to make my own familiar surroundings delightfully strange, to see my campus as a repository of sights and sounds every bit as fascinating as the ones to be found far afield in exotic locations.

Campuses are, after all, ideal places for fostering such a spirit, for getting underneath layers and surfaces of all kinds. As if to present me with a metaphor for this, I capped off my walk by ascending the steps of our auditorium, something I’ve done many times over the years. This time, though, instead of filing into the building for an opening convocation or other ceremonial speech, I turned around to look out at the tableau before me—a quadrenge of lush green punctuated by patches of fresh mulch and assorted new plantings to herald the beginning of the academic year. It was then that I recognized the initials of the university cut subtly but unmistakably into a familiar shrub, easily missed, like Henry James’s figure in the carpet. I had just experienced one of those “Hmm, I never knew that” moments.

**Framing matters**

There are treasures for the uncovering—hidden in plain sight—if we but simply approach them from time to time with an archeologist’s mentality or the untutored eye of a visitor. We can resurrect something that dwells beneath the sedimentation of our own habitual way of regarding common objects in our midst. And what is the good of this? Making the familiar strange carries with it the potential to open up new interpretive possibilities that can be generative beyond measure. It can invigorate what has grown stale, causing us to be more generous in our assessment of the places we inhabit. It can remind us that we only ever have a partial and imperfect line of sight into the nature of things and the character of people—always a good lesson. And it can sharpen what has grown faint, like a slant of light that falls across a European fresco to illuminate a detail previously obscured.

Perhaps the most meaningful value to be extracted from this simple act, though, is the promise of an enlarged capacity to imagine our world—however we define its boundaries—differently. For all of these reasons, we might resolve to see and experience our campuses like freshmen or like tourists visiting for the first time, full of wide-eyed wonder and bewilderment, roaming and exploring, and occasionally suspending perpetual motion long enough to take in new vistas. By doing so, we will begin to notice formerly unseen filigreed buildings bathed in the golden hues of late afternoon, and we will stop dead in our tracks at such sights and understand that their existence stands for all sorts of other possibilities. In other words, we will become architects of strangeness, transforming the places where we work and live.

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