Project 2061
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2061 *today*

Science Literacy for a Changing Future

Mathematics

Natural Sciences

Social Sciences

Technology

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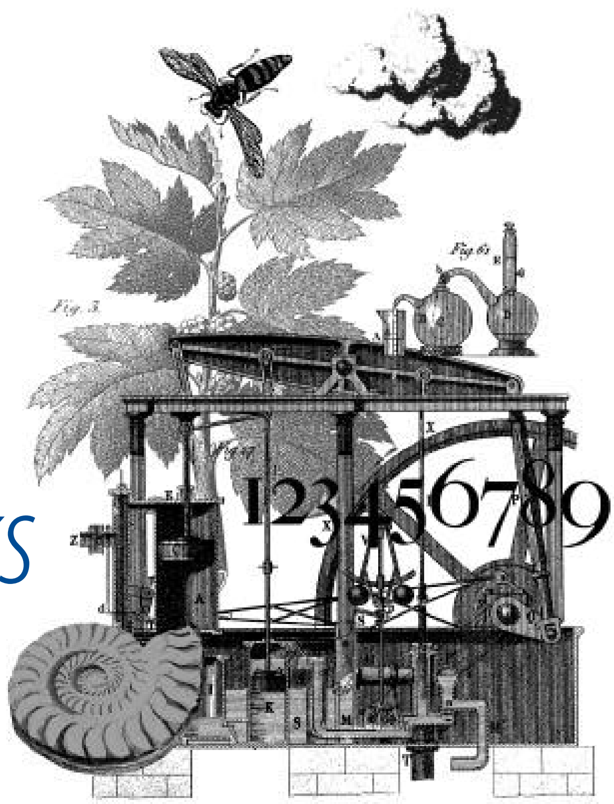
Putting *Benchmarks* to Work



Many states and school districts are modeling their frameworks and developing their content standards based on Project 2061's *Science for All Americans*, *Benchmarks for Science Literacy* and on the national standards recently released by the National Research Council. Educators are searching for curriculum materials to help students achieve the goals in these documents. Materials developers and publishers are attempting to convince educators that their materials will do the job.

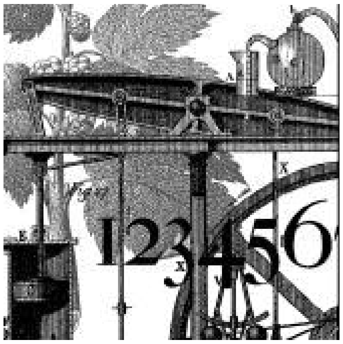
As it turns out, these are not simple tasks. But by listening closely to the concerns of the teachers, teacher educators, and materials developers who have attended Project 2061's workshops over the past two years, we have learned some important lessons about reforming the curriculum around specific learning goals. Summarized below, these lessons should be helpful to anyone planning to use *Science for All Americans* and *Benchmarks for Science Literacy*, *National Science Education Standards*, or another set of specific learning goals.

Study the learning goals themselves. Although Project 2061 put its benchmarks into clear language that reflects the level of sophistication actually expected from students, people naturally interpret them in terms of their own understanding of science and in the context of their own experience. Often, they read extra meanings into benchmarks. Consider, for example, the K-2 benchmark,

> Water left in an open container disappears, but water in a closed container does not disappear.

"Many of our workshop participants initially see this as an expectation for students to understand

continued on page 2



Benchmarks *continued*

the mechanism of evaporation, including molecules, invisible vapor, and the term 'evaporation' itself—when, in fact, the benchmark merely describes an observable phenomenon. "Benchmarks for later grades develop the notion of evaporation," explains Project 2061 Curriculum Director Jo Ellen Roseman, who helped to develop the Project's workshops.

On the other hand, people often *under*estimate what a benchmark requires. For example, a grade 3-5 benchmark on the scientific enterprise states

> Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.

"Our workshop participants often see this, initially, as a benchmark about the nature of *communication*, rather than a benchmark about the *essential role of communication in science*," says Roseman.

Such an interpretation may seem close enough at first glance, but it can cause real problems when it becomes the basis for decisions about the curriculum. For example, teachers might conclude that activities where students discuss their work in cooperative groups would satisfy this benchmark. More to the point, Roseman suggests, would be an activity in which students conduct a group investigation and then reflect on how sharing information helped the work along.

Use all the Project 2061 tools to clarify the meaning of a learning goal. In the technique used most successfully in Project 2061 workshops, participants first focus on a single benchmark and discuss with one another its meaning. They then examine other relevant parts of *Benchmarks* and *Science for All Americans* that can shed light on its meaning.

Consider again the K-2 benchmark on the water cycle, "Water left in an open container disappears, but water in a closed container does not disappear." By consulting the corresponding section of *Science for All Americans* and the growth-of-understanding map from *Benchmarks on Disk*, educators see this benchmark as an early step toward learning about climatic patterns. By examining other K-12 benchmarks from the same section, and discovering that *Benchmarks* delays until grades 3-5 the idea of liquid water turning into a gas (vapor), educators are less likely to read overly-sophisticated ideas into the K-2 benchmark. And from the *Benchmarks* essays and its research chapter, they learn that evaporation is difficult to understand even for upper elementary students and should not be expected of all students until middle-school. By comparing their initial reading of the benchmark with their later, more informed one, educators see the importance of such study.

Study learning goals within the context of how they will actually be used. Most educators have little time to study learning goals for their intrinsic interest only. Instead, they want to know how to use the goals for specific, often urgent jobs. As one teacher put it after spending three hours mapping sequences of benchmarks in one of the Project's trial workshops, "This is all quite interesting, but next time call me when you have a curriculum."

Project 2061 has developed workshops that address the immediate concerns of educators, helping them not only to analyze and understand particu-

continued on page 4

Using benchmarks or standards

The general enthusiasm for *Benchmarks* and *National Science Education Standards (NSES)* can help to guide thinking and resources in a productive direction. Or it can lead to hasty implementation of learning goals based on superficial interpretation of them. These three tips may be useful:

Do make use of the entire coherent set of learning goals. Sometimes educators pick and choose among the learning goals in *Benchmarks*, the *NSES*, or another set of learning goals, rather than adopt the whole, coherent set. In doing so, they not only lose important interconnections within or across topics, but also may lose the K-12 continuity that helps students to gradually build understanding of difficult concepts.

Dont' use *Benchmarks* as a "checklist" to validate an existing curriculum. *Benchmarks* and *NSES* were carefully written to specify exactly what is most important to learn about a particular topic. Interpreting them loosely to justify portions of the existing curriculum defeats their purpose. For example, *Benchmarks'* recommendation that students acquire a general understanding of the functions of the cell does not justify introducing dozens of specialized terms for the components of a living cell.

Don't simply add learning goals to the curriculum. Perhaps the most common misuse of *Benchmarks* and *NSES* is to *add* their recommended learning goals to an already unwieldy curriculum. Both documents are designed to help educators focus on *fewer*, important ideas so that students can learn them well.

Meet Donald Langenberg

As chancellor of the University of Maryland System, Dr. Donald Langenberg oversees the nation's twelfth-largest public university system, serving 128,000 students with 600 academic programs. In November 1995 Dr. Langenberg agreed to chair the National Council on Science and Technology Education, which provides advice and guidance to Project 2061. To find out more about Dr. Langenberg and his perspective on science and technology education, Mary Koppal of the Project 2061 staff interviewed Dr. Langenberg in his offices in Adelphi, Maryland.

MK: What can you remember about your first experience with science in school?

DL: I don't think I encountered any science until probably about 8th grade. The first science course I remember was physics, and it inspired me to become a physicist.

MK: Because of the teacher?

DL: Yes. An interesting teacher who knew absolutely nothing about physics. He himself had never taken a course in physics at any level and had simply been dragged into teaching this course. He was, among other things, a coach and probably was thought to have time on his hands. He discovered physics the same way we students did—along the way. It was an absolute revelation to him and he conveyed that sense of wonder to us. He had an old Model A coupe with which he had various difficulties. As we worked our way along through the physics text from mechanics to electromagnetism, somehow the difficulties of his Model A seemed to progress from mechanical to electrical too.

MK: You've spent most of your career in higher education. What do you think would happen if science literacy became a reality for the nation's high school graduates? What would colleges and universities have to do differently?

DL: In Maryland, we are already preparing for some of those changes. We have established a K-16 partnership and our first objective builds on the Maryland State Department of Education's development of standards and assessment tools. We are moving towards a situation where, perhaps, students' academic progression and even graduation from high school will be based on what they know rather than how long they have sat in the classroom. So one of the first things we'll have to do is throw out our current college admissions requirements and establish new ones based on student performance.

We're also working with the Maryland business community and have come to the conclusion that there is no reason why the tools used to establish eligibility for graduation from high school, admission to college, or employment at the worksite should be different. There should be a common standard for all three and for all students. Once change is in place, there is some possibility of eliminating entirely the notion of a single event called high school graduation. Why can't a student graduate from high school at age 15 in math and maybe not until 22 in English?

Now what would happen if kids arrived on campus already science literate? First, many of them would have far more choices than they do now. For example, not being mathematically literate simply bars a whole set of options at the college level.

MK: So science literacy for all students would enlarge the pool of potential scientists, mathematicians and engineers?

DL: Yes, but it would also enlarge the pool of people who have some sense of how the world works. And that's important for its own sake.

I have found in my own life, for example, that everything is connected to everything else. Nobody is smart enough to predict what job skills will be needed. I've always had an interest in history, but it was of limited use to me when I was a practicing experimental physicist. But now, later in my life, that interest is essential.

MK: One of the things that Project 2061 and others call for is more integration of the disciplines in ways that reflect connections in the real world. It seems that in higher education the disciplinary boundaries are very strong. Do you think this is something that is likely to change?

DL: Perhaps. But I would not spend a lot of time on a crusade to eliminate academic departments in colleges and universities. Life is too short, and they're too strong. But, as many others have noted, nature is not organized like a university. The problems that we all face are increasingly interdisciplinary.

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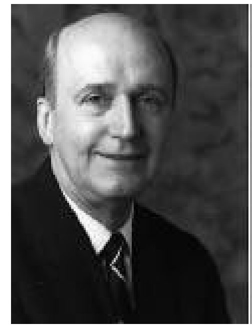

Donald Langenberg

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Marking Up *Benchmarks*

With nearly 100,000 copies in print, *Benchmarks for Science Literacy* would seem to be a finished product. But, according to Dr. Andrew Ahlgren, Project 2061's Associate Director, it is still evolving. "*Benchmarks* had extensive review during its development, but we wanted continued feedback as more educators used the book for different purposes and in different settings," he reports. So each copy of *Benchmarks*—from the first printing in 1993 through its fourth in 1995—includes an invitation for reader's comments and suggestions. Reader suggestions have already led to changes. For example, Deborah Smith, a science education professor at Michigan State University, suggested upgrading "following" to "writing" directions for a grade 3-5 benchmark in the Nature of Science chapter. Leon Henkin, a mathematics professor at the University of California, prompted us to insert a critical "always" in a grade 6-8 benchmark on logic in The Mathematical World chapter. Be sure to visit the Project 2061 Web site (http://www.aaas.org) within the next month or two for a listing of substantive changes to *Benchmarks* and keep the cards and letters coming.

Benchmarks *continued*

lar learning goals, but also to use this understanding to select and adapt curriculum materials, improve lesson design, consider assessments of student learning, gauge how well curriculum frameworks address science literacy, and more. For example, when analyzing and improving curriculum material, workshop participants:

- study the benchmarks themselves in the larger context of *Science for All Americans*;
- check how well the content of the material addresses the benchmarks, and at what grade level;
- reflect on the likelihood that students will *actually* learn benchmark ideas from the prescribed activities; and
- consider how to revise the activities to increase their potential to help students attain the learning goals.

The process is time-consuming, but educators who examine materials in this careful way report that they are able to make much better decisions about curriculum resources. They also find that they've gained some valuable insights on the meaning of goals-based education reform.

Spreading the Word

So that more educators can benefit from these experiences, Project 2061 will soon release *Resources for Science Literacy: Professional Development*, a new CD-ROM/print tool that will make available the Project's *Workshop Guide.* It will provide a variety of presentations, materials, and guidance on planning and developing a Project 2061 workshop, as well as other resources to help teachers understand and make effective use of learning goals for science literacy.

Langenberg *continued*

MK: Many educators see teacher preparation as the key to meaningful reform. The University of Maryland System educates a large percentage of the state's teachers. What kinds of changes are taking place in teacher education programs?

DL: The University of Maryland System has about half a dozen schools of education. Each is different. One or two are moving toward the five-year teaching degree. There is a stronger emphasis on content mastery. And educators are working quite closely with their K-12 peers on things like standards and assessment tools. It's become a good working relationship and suggests that there is really not such a great divide between high school and college.

MK: What about Project 2061? When did you first become aware of its work?

DL: I was a member of the AAAS Board when Project 2061 was originally launched in 1985. I've been a fan ever since.

MK: We've talked about science education and reform in a general sense. What do you think Project 2061 can contribute that is unique?

DL: Two things come to mind. The first is Project 2061's insistence that scientists, engineers, and other science-based professionals work as partners with educators to reform science education. This partnership has been essential in forging a consensus on science literacy. The other notable quality of Project 2061 is its consistency and persistence. It was absolutely astounding when Jim Rutherford proposed the notion that AAAS should begin a project that would last 20 or 30 years. In this country the long-term future is six months away. But persistence is vitally important, especially in education.

MK: Project 2061 marked its 10th anniversary in 1995. How would you evaluate its efforts so far? What do you think the Project should focus on next?

DL: Project 2061 has already been a success, but it hasn't yet reached it's ultimate goal. All of us who are concerned about education reform must hang in there until that goal is reached.

One of the fortunate events in the history of Project 2061 is its rough coincidence with the most important technological revolution of the past 500 years. I mean, obviously, the information technology revolution which is in the process of totally transforming all enterprises that depend upon information. Certainly there is no enterprise as information-dependent as education. I think we will need a decade or two of very careful attention to what that technology can do to help us achieve true literacy of all kinds.

Are College Grads Science Literate?

Harvard graduates—still in their caps and gowns—explain to an interviewer why the seasons change. Their confident, yet incorrect, explanations betray how little they really understand about the phenomenon.

This is the opening scene of *A Private Universe*, the now-classic videotape prepared by the Harvard-Smithsonian Center for Astrophysics, which documents that even after years of the "best education that money can buy," many students have faulty and inconsistent ideas about basic science.

Although Project 2061 focuses its efforts on the reform of K-12 education, it has long recognized that higher education—and not just teacher education—is critical to lasting and meaningful change. To find out more about the relationship between K-12 and higher education, Project 2061 has commissioned representatives from the American Association for Higher Education to examine the current status and suggest changes that would help support K-12 reform. Their Higher Education Blueprint is being summarized and will be distributed for extensive review over the next few months.

To gain other insights into higher education, Project 2061 invited arts and sciences faculty from colleges and universities to analyze their course syllabi for strong links to ideas in *Science for All Americans*, using an analytical framework developed by Project 2061. The 15 courses that were analyzed share a commitment to promoting science literacy, but approach the task quite differently. Consider, for example, the following three college courses:

"Foundations of Science"

Unlike the typical, overstuffed survey courses for non-science majors, Ezra Shahn's course at Hunter College focuses on three major themes that are fundamental to science: the Heliocentric Theory and the Study of Motion, the Nature and Properties of Matter, and the History of Earth and Life. The primary goal of the course, according to Shahn, is to lead students to an understanding of "how we know what we know" and "why we believe what we believe." Laboratories help students to understand how nature can be observed, measured, analyzed, and tested.

"Engineering—Intermediate Technology."

At Brown University Chris Bull and Barrett Hazeltine invite students to examine the applications of technology, particularly small-scale approaches to real-world problems, and evaluate alternative approaches in terms of social impact, cost, environmental effects, and so on. The course draws on pertinent physics and chemistry ideas, and offers some historical context, including a field trip to an 18th century textile mill. Students design their own technological systems.

photograph by
John Forasté/Brown University

"Evolution—Zoology/Botany"

Aware that most evolution courses require little more than rote memorization from students, Mark Hafner of Louisiana State University and Sherry Southerland of the University of Utah have developed a course that draws on both animal and plant examples to help students understand the basic concepts in evolution and how these concepts fit together in a coherent theory of evolution. Laboratories give students a chance to reinforce their understanding of abstract concepts by applying them to biological situations. The laboratories also directly address student misunderstandings documented in cognitive research literature.

Professors Southerland, Shahn, and Hazeltine brought some of the issues related to developing college courses for science literacy to the attention of a wider audience at the AAAS Annual Meeting in Baltimore. All 15 of the analyzed courses have been gathered into a database that will be included on Project 2061's forthcoming CD-ROM tool *Resources for Science Literacy: Professional Development*, available from Oxford University Press this fall.

About Project 2061

Project 2061 of the American Association for the Advancement of Science is a long-term initiative to reform K-12 education nationwide so that all high-school graduates are science literate. Its first report, *Science for All Americans*, outlined what all high-school graduates should know and be able to do in science, mathematics, and technology. Project 2061 is now creating a coordinated set of reform tools to help educators meet those goals in their own districts. Working with six school-district teams of teachers and administrators, Project 2061 has developed *Benchmarks for Science Literacy*, a curriculum design tool that translates the literacy goals of *Science for All Americans* into learning goals for the ends of grades 2, 5, 8, and 12.

Science for All Americans and *Benchmarks* will soon be joined by *Resources for Science Literacy*, a computer-based tool to help educators improve their own understanding of science literacy and identify and evaluate instructional materials to help students make progress towards it; *Designs for Science Literacy*, a guide to help educators take a systematic design approach to planning a K-12 curriculum; and *Blueprints for Reform*, recommendations for how various aspects of the K-12 education system must change to accommodate necessary curriculum reforms. Eventually, all of these tools will be pulled together by a computer-based, interactive, multimedia curriculum-design and resource system.

Project 2061 is supported by grants from the National Science Foundation, the Carnegie Corporation of New York, the John D. and Catherine T. MacArthur Foundation, the Andrew W. Mellon Foundation, and The Pew Charitable Trusts.

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Project 2061's print and electronic products are available from Oxford University Press. For ordering information, please call 1-800-451-7556.

Educating Tomorrow's Teachers

Too many elementary and secondary school teachers have not been adequately prepared to teach science, math, and technology. With a new grant from the MacArthur Foundation, Project 2061 is turning its attention to the professional development of the next generation of teachers.

The Problem

The nationwide movement to improve K-12 education so that high-school graduates are science literate has yet to change the way colleges and universities prepare and support new teachers. But to promote science literacy among their students, teachers will have to be science literate themselves. They must also be able to use science literacy goals to make sound decisions about curriculum and instruction. Clearly, changes are needed in teacher preparation—including the mathematics and science courses available to prospective teachers—and in the support teachers receive during their first years in the classroom.

The Project

With funding from the John D. and Catherine T. MacArthur Foundation, Project 2061 has launched a new teacher education project to address these needs. "Our goal is to improve the preparation and early induction experiences of teachers so that they are better able to teach to high content standards in science, mathematics, and technology," explains Project 2061 Associate Program Director, Pat O'Connell Ross. "Most teachers need a better understanding of these three areas and how they interconnect, of course, but that's just the beginning. They also need to know how student understanding of particular concepts builds across the grades. And they need to be familiar with research findings on student ideas in science."

Teachers will need new skills, too, according to O'Connell Ross: "Teachers will have to be able to select resources and plan activities to address specific learning goals. They will have to be able to choose appropriate assessment tools that get at student understandings—and misunderstandings—of the learning goals. And finally, they will have to be able to reflect on their teaching practices, and to discuss teaching and learning with their colleagues."

To address the manifold needs of new teachers, O'Connell Ross and Project 2061's Curriculum Director Jo Ellen Roseman will be working closely with two sites—in Maryland and in Colorado—to develop model programs for preparing teachers and supporting them during their first years in the classroom. Both states recently received U.S. Department of Education grants to reform teacher preparation statewide and already have several major initiatives focused on science literacy. The sites will allow for collaboration among one or more teacher preparation institutions, one or more K-12 schools or school districts, and state policy makers. The teams at each site will work together over the next three years to accomplish the following:

- revise existing and develop new college science courses around ideas from *Science for All Americans*;
- incorporate the study of *Benchmarks for Science Literacy* and its practical uses (for analyzing curriculum materials and assessment and designing instruction) into science methods courses;
- support the professional development of a cadre of experienced K-12 teachers to serve as mentors to new teachers; and
- help align state credentialling and professional development policies and practices with reform for science literacy.

Depending on local needs, the teams at each site may choose to focus on some of these goals more intensely than others.

The Possibilities

The MacArthur project draws on recommendations from a Teacher Education Blueprint prepared for Project 2061 under the leadership of faculty at Michigan State University. The opportunity to put into practice Blueprint recommendations, which happen to agree with recommendations of both the *National Science Education Standards* and the *National Board for Professional Teaching Standards*, will no doubt yield valuable insights into education reform, predicts O'Connell Ross.

These insights and the models for teacher preparation developed by the two sites will be shared through a final report on the project and related conferences for higher education faculty.

Director's Notes

Wait Time

Since the late 1960's, education research has suggested that lengthening the time teachers pause after they speak—wait time—elicits more numerous and more thoughtful responses from their students. Perhaps there is a lesson here for all of us who grow impatient with the pace of reform in the nation's schools. For example, consider the ambitious goal of developing "world-class standards by the year 2000." Given the nature of our change-resistant education system, it seems clear that more wait time is in order.

Looking for Results

But it is not easy to make precise time estimates. In the research on wait time most teachers were not able to estimate accurately how long they should pause to allow students to respond. Reports issuing out of the latest Education Summit seem to reflect a similar inability to estimate how long it takes to make changes that we all agree are needed.

We want results and we want them now. Such impatience can be motivating, but it can also be debilitating when we fail to live up to our expectations, however naive they may be. This may cause us to give up on today's reform effort and adopt a new one, or simply give up altogether. But it might temper our impatience somewhat to realize that important milestones have, indeed, been reached. The development of national science education standards is a case in point.

Standards in the Making

In 1985, when AAAS launched Project 2061, there was no national dialogue on standards, no general sense that they were needed. We estimated then that achieving nationwide science literacy would be a 20- to 30-year undertaking.

We believed that the first step toward science literacy was agreement *in detail* on what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school. This premise led to *Science for All Americans,* the project's 1989 report which offers a credible definition of adult science literacy.

That same year, the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics* (the first use of the "standards" designation), and President Bush and the nation's governors met to establish national performance goals. Four years later, in 1993, Project 2061 released *Benchmarks for Science Literacy*, and in 1996 the National Research Council of The National Academy of Sciences released *National Science Education Standards*.

What Matters Most

This has been a productive ten years. But it might not have been so if the many professional associations, scientific societies, and individual teachers and scientists who were involved had not reached agreement on what learning counts most. The overlap between *Benchmarks* and the math and science standards is remarkable, and I urge you to examine the detailed comparison of them that can be found on Project 2061's forthcoming *Resources for Science Literacy: Professional Development* CD-ROM.

In reaching a consensus on learning goals, the participants also came to agree on the guiding principles of reform in science education. These appear in a joint statement issued earlier this year by AAAS, the National Academy of Sciences, and the National Science Teachers Association. These principles (shown at right) suggest that it has been well worth a decade of effort to now be in accord on where reform in science and mathematics education is headed. Hopefully, adequate wait time will now elicit more numerous and thoughtful reform efforts from us all.

F. James Rutherford
Director

Guiding Principles of Reform

The first priority of science education is basic science literacy for **all** students, including those in groups that have traditionally been served poorly by science education, so that as adults they can participate fully in a world that is increasingly being shaped by science and technology.

Education for universal science literacy will, in addition to enriching everyone's life, create a larger and more diverse pool of students who are able to pursue further education in scientific fields and are motivated to do so.

Science literacy consists of knowledge of certain important scientific facts, concepts, and theories, the exercise of scientific habits of mind, and an understanding of the nature of science, its connections to mathematics and technology, its impact on individuals, and its role in society.

For students to have the time needed to acquire essential knowledge and skills of science literacy, the sheer amount of material that today's science curriculum tries to cover must be significantly reduced.

Effective education for science literacy requires that every student be frequently and actively involved in exploring nature in ways that resemble how scientists themselves go about their work.

FYI

SRI Evaluates Project 2061

SRI International, a well-known applied research firm that is studying systemic reform nationwide, is conducting an in-depth evaluation of Project 2061's impact on science education. In addition to carrying out case studies in Colorado, New York, New Jersey, and Georgia, SRI is now collecting information from prominent science education reformers and workshop participants across the country through telephone and mail surveys and personal interviews. The final report, due this fall, will indicate how and to what extent Project 2061 has shaped reform efforts at the national, state, and local levels.

Introducing. . .

Project 2061 welcomes two new staff members. Program Director **Dr. Gerald Kulm**, a mathematics educator who was an evaluator for NSF's Systemic Teacher Excellence Program in Bozeman, Montana, is developing *Blueprints for Reform*, a set of commissioned papers that examine different aspects of the education system and recommend needed changes. **Natalie Nielsen**, formerly a researcher at the Smithsonian Institution's Museum of Natural History, joins Project 2061's Communications Department as a writer.

New National Council Members

The National Council on Science and Technology Education, Project 2061's advisory board, welcomes seven new members: **Bernard Farges**, a math teacher in the San Francisco Unified School District; **Fred Johnson**, assistant superintendent for instructional services of Shelby County Schools, Tennessee; **Sue Matthews**, a middle school science teacher in Elbert County, Georgia; **George "Pinky" Nelson**, associate vice provost for research at the University of Washington and a former NASA astronaut; **James Oglesby**, a teacher educator at the University of Missouri-Columbia and former dissemination director for Project 2061; **Benjamin Shen**, Reese W. Flower professor of astronomy and astrophysics at the University of Pennsylvania; and **Terry Wyatt**, a high school physics and chemistry teacher in Toledo, Ohio.

Museums Using *Benchmarks*

Museums and science centers across the country are beginning to adopt Project 2061's guidelines for science literacy in their exhibits and educational programs. Earlier this year, Dr. F. James Rutherford, Director of Project 2061, attended the opening of *Science Alive!*, an interactive science center at Grand Valley State University in Grand Rapids, Michigan. The center is laid out according to sections in *Benchmarks* and its exhibits are closely tied with the objectives in both *SFAA* and *Benchmarks*. Also in Michigan, Project 2061's Associate Director Dr. Andrew Ahlgren has been consulting on the expansion of the Cranbrook Institute of Science in Bloomfield Hills which is proposing new exhibits and educational programs that will employ themes similar to those set out in *Benchmarks*. The Museum of Science, in Boston, Massachusetts, recently opened *Investigate!*, the second of six new permanent exhibits scheduled to open over the next decade. *Investigate!* is designed to improve the visitor's scientific thinking skills and emphasizes critical elements of *SFAA*.

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