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**BAKER  
FORUM**  
PROCEEDINGS





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PROCEEDINGS

**APRIL 2-3, 2004**

**EXPANDING THE  
PATHWAYS TO  
SCIENCE AND  
ENGINEERING CAREERS**

# 2004 BAKER FORUM

## MISSION STATEMENT

**T**he Baker Forum was established by the Cal Poly President's Cabinet\* on the occasion of two decades of service to Cal Poly by President Warren J. Baker and his wife, Carly, to further the dialogue on critical public policy issues facing the nation and higher education. The Forum gives particular attention to the special social and economic roles and responsibilities of polytechnic and science and technology universities.

The health, prosperity and survival of humanity in the 21st century depend upon our ability to sustain and increase the pace of scientific and technical innovation. Polytechnic and science and technology universities must lead the way to ensure that these innovations are applied broadly to serve the interests of society and to prepare new generations of innovators and problem solvers.

Envisioned as a biennial event, the Baker Forum provides an opportunity for polytechnic and science and technology university presidents and industry leaders to come together in an issue-focused, highly interactive setting designed to promote international dialogue, highlight issues of critical importance and stimulate creative responses.

Funding support from the President's Cabinet, friends of the University and John Wiley & Sons, Inc., is gratefully acknowledged.

\*The President's Cabinet is a 45-member senior advisory group of state and national leaders in business, industry, government and the community.



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With the creation of the Baker Forum, John Wiley & Sons, Inc., generously established the Wiley Lifetime Achievement Award. This award, bestowed at the Baker Forum, recognizes extraordinary leadership and lasting contributions to American higher education and public life. William C. Harris, director general, Science Foundation Ireland, is the recipient of the 2004 Wiley Lifetime Achievement Award. Harris joins Walter E. Massey, president of Morehouse College, recipient of the first Wiley Lifetime Achievement Award in 2002.



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Every two years, the Cal Poly President's Cabinet takes great pride in convening U.S. and international leaders from the education, government and industry sectors for important discussions about the roles of polytechnic and science and technology universities in today's world. At the second Baker Forum, held in April 2004, a distinguished group of leaders considered the overall theme "Expanding the Pathways to Science and Engineering Careers: Exploring the multiple roles that industry and higher education can play in support of P-12 science and mathematics education."

On behalf of the Cal Poly President's Cabinet, I am pleased to share these proceedings as a record of the 2004 Baker Forum and its findings and recommendations regarding a topic of enormous importance to the future of California and the nation.

As background, participants in the 2004 Baker Forum were energized by awareness of global trends that, if left unchecked, will place the United States at growing risk:

- As its economic competitors, particularly emerging giants like India and China, embark on impressive programs of economic growth, the United States is experiencing increasing trade imbalances, outsourcing of jobs at higher technical levels, and growing competition in scientific and technological discovery and innovation.
- Instability arising out of the collapse of the former Soviet Union, social and cultural ferment in the Islamic states, persistent underdevelopment in Africa, and overpopulation and underdevelopment in many of the world's other regions are contributing to an escalating climate of danger and uncertainty around the globe. Resurgent global terrorism and threats to public health such as AIDS and SARS are both aspects of this heightened state of risk. America's defense and public health science and engineering work force is a key bulwark against these spiraling threats.
- The production of science and engineering baccalaureate and graduate degrees in the United States has declined in key fields and is lagging behind leading competitor nations that are investing significant resources in the development of science and engineering education and research. Our nation's ability to sustain scientific and technological innovation and respond to public health and security threats is jeopardized by these trends.
- The educational strategies that have been used to address the profound change in the demographic makeup of the United States have not produced adequate results. In particular, the performance of African-American and Hispanic students in K-12 and higher education continues to lag behind that of white and Asian-American students.

The Inaugural Baker Forum in 2002 concluded that a leading cause of lagging participation by U.S. university students in science and technology fields is to be found in the relatively poor performance of U.S. pre-college students in science and mathematics when compared to that of students in other nations.

Against the background of these troubling trends and this key finding of the Inaugural Baker Forum, the 2004 Baker Forum took up for discussion a very timely Business-Higher Education Forum (BHEF) draft report<sup>1</sup> on pre-school through college (P-16) science and mathematics education and Cal Poly's own initiative to support and strengthen teaching and learning in these key disciplines, the University

<sup>1</sup> The Business-Higher Education Forum report was subsequently published in February 2005 titled "A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education." We are indeed grateful to the Business-Higher Education Forum for permission to review and comment on the BHEF draft report at the 2004 Baker Forum.



Center for Excellence in Science and Mathematics Education.

A powerful Friday evening keynote address by Science Foundation Ireland Director General William C. Harris, "Learn or Lose: U.S. Education Threatens Economic Prosperity," set the stage for highly engaged Saturday panel and breakout group discussions of the BHEF report's analysis of causes and solutions for the lagging performance of U.S. students in science, mathematics and technology disciplines.

As summarized in these proceedings, 2004 Baker Forum participants embraced Dr. Harris' call for a greater sense of urgency in reforming U.S. P-12 science and mathematics education. Forum participants also endorsed the BHEF report's call for a sustained effort by the P-12 education system, supported by business and higher education, to raise substantially the performance of *all* U.S. students in science and mathematics.

Following up on the 2004 Baker Forum, Cal Poly is embarking upon a new initiative to increase the number of science and mathematics teachers it educates and to strengthen its support for California science and mathematics teachers already in the classroom. This is just one example of the types of measures at the local, state and national level that are needed to achieve improvements in the performance of U.S. students, and to ensure that the nation is able to preserve its competitiveness and security in the years to come.

We are indeed pleased to share with you these proceedings of the 2004 Baker Forum and would like to invite your comments, observations and suggestions for this biennial public policy dialogue.



# KEYNOTE ADDRESS



LEARN OR LOSE:  
U.S. EDUCATION THREATENS ECONOMIC  
PROSPERITY



**WILLIAM C. HARRIS**  
DIRECTOR GENERAL  
SCIENCE FOUNDATION IRELAND



◆  
Unless we change  
our approach to  
education, we will  
leave too many  
of our citizens  
out of the future  
of America, and  
innovation in  
America—in fact,  
the nation as a  
whole—will suffer.  
◆

**T**hank you very much for inviting me here this evening. Thank you, Warren. I am truly honored to be here and to receive the Wiley Lifetime Achievement Award.

I am especially honored to be considered worthy of an award Walter Massey has received and to receive this award at an event named in honor of another one of my heroes, Warren Baker. Warren's leadership of Cal Poly and public service to California and the country have been extraordinary. Instead of cloning dinosaurs (as in "Jurassic Park"), we need to clone leaders like Warren Baker.

I hope that the remarks I offer tonight will do nothing to besmirch Warren's good name.

On this night before what will surely be a Saturday of thoughtful deliberations on related topics, I want to offer a few radical ideas on issues requiring urgent attention. If you can't get away with some radical thinking on a Friday night in California, then you can't get away with it at all. And this topic needs radical thinking.

I will paint a stark picture of the divide between success and failure in American education and research. I want to draw sharp lines and get past qualifications that could take the edge off the sense of urgency I believe we need. There are lessons in history we can't afford to forget. And I will offer some ideas for how we might again begin to apply them.

This year the Business-Higher Education Forum produced a draft report on science and mathematics education. I will refer to it as the BHEF report. (This report follows in the wake of another important BHEF report, "Building a Nation of Learners," published last June.) The new BHEF report focuses on the critical challenges facing K-12 science and mathematics education in our country.

These words are so well known—"challenges in K-12 education"—that some of our eyes glaze over when we hear them. But I would urge all of us to recognize the direct connection between doing something about these challenges and our ability as a nation to maintain prosperity.

The BHEF report vividly presents issues we, the university community, cannot afford to ignore. To the contrary, we must immediately confront them. So I have titled these remarks "Learn or Lose: U.S. Education Threatens Economic Prosperity."

Unless we change our approach to education, we will leave too many of our citizens out of the future of America. And if we do, innovation in America—in fact, the nation as a whole—will suffer. We could see economic growth grind down. Once we lost our place as the world's greatest innovator, decline would follow.

In this country, we lack neither the means nor the talent for continuing development built on new ideas and discoveries. Recently, in the *New York Times*, Thomas Friedman said it quite well in a column titled "The Secret of Our Sauce." He wrote:



“America is the greatest engine of innovation that has ever existed, and it can’t be duplicated anytime soon, because it is the product of a multitude of factors: extreme freedom of thought, an emphasis on independent thinking, a steady immigration of new minds, a risk-taking culture with no stigma attached to trying and failing, a noncorrupt bureaucracy, and financial markets and a venture capital system that are unrivaled at taking new ideas and turning them into global products.”<sup>2</sup>

So that’s what’s right about us, and it’s plenty. It’s not news, and it pleases us all to be part of it. But if we are satisfied with the status quo and the university’s role today in our culture of innovation, we are mistaken. In fact, our greatest challenge may be overcoming the belief that our education system, with the university at the pinnacle, serves us just fine. Our greatest challenge may be overcoming the misplaced assurance that our system still works.

For at least the last 25 years, from every podium, from every state, from every corner of the country, from the local to the national stage, from the classroom to the boardroom, we have heard the statement or said it ourselves: “American higher education is the best in the world.”

Can this be true if the school system from which the university draws students is in many ways intellectually insolvent? Can American higher education be the best in the world if study after study proves that our K-12 students grow less intellectually adept the longer they are in our classrooms?

Can it be true if test after test shows that a large percentage of our college-going students cannot solve a simple

quadratic equation, answer fundamental questions about geometry, chemistry or physics, or, in many cases, even write a coherent paragraph?

Our system of education, let alone of science and mathematics education, is troubled.

Consider just a few data from the BHEF report:

- One: More than 80 percent of four-year public institutions now offer remedial courses.
- Two: Almost one-third of first-time freshmen now enroll in at least one remedial reading, writing or mathematics course.
- Three: U.S. students begin on top of the world in mathematics and science in elementary school, but by the 12th grade overall U.S. student performance has sunk to near the bottom in international comparisons.
- And finally: Most of our students are not even mastering the necessary skills and knowledge for work or lifelong learning.

We may reassure ourselves that a few years in higher education can continue to correct what 12 years of earlier education might have failed to do. But must higher education only provide academic triage and try to remediate what schools have not done?

As it is, students who take a remedial course are 20 percent less likely to graduate from college than those who take none.<sup>3</sup> Can we be so comforted when education is vital to success, including for the nation?

Or, more likely, should universities help the schools accomplish their service to

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<sup>2</sup> Thomas L. Friedman, “The Secret of Our Sauce,” *New York Times*, March 7, 2004

<sup>3</sup> Cliff Adelman, in *Crosstalk* (Vol. 6, No. 3), Summer 1998



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the U.S. after World  
War II.

◆

students before the students reach us? Should universities help schools address the struggles they face teaching students in an ever more complex, diverse, fast-paced and competitive society? We might all say, “Absolutely, yes!” But if so, then our universities are failing.

We have known for too long from nearly every barometer of student achievement that our children, in large numbers, in massive percentages, are not being prepared for their full participation in society.

It is not enough to continue waiting for millions of students to arrive unprepared at our doorsteps, age 18 and ready for a massive game of catch-up. We must think radically and implement a strategy for overhauling a system that has not adapted to meet the new challenges.

Recent wake-up calls indicate the need to dispute old or tired ideas as well as newly threatening ones even as they begin to form. For example, many prominent voices are saying we face a threat from outsourcing and from Indian and Chinese economic growth.

But an immediate problem is even more pressing—our sudden refusal to benefit from the talented students around the world. Before we look long term to other solutions to our education challenges, we must remain competitive in the short term.

Two weeks ago, I met with China’s minister for science and technology in Beijing. In a very polite conversation, he said the U.S. seems to be closing up. He noted that more Chinese graduate students are now going to Europe or staying in China.

He is right. For the first time since World War II, the number of foreign

students applying to graduate and doctoral programs in science at American universities has now declined, and declined broadly.

As only one example, the Council of Graduate Schools reported last month that 90 percent of American colleges and universities saw a drop in applications from international graduate students last fall.

The U.S. is making a huge mistake if this approach continues. We are the most multicultural society the world has ever known. Our R&D enterprise competes with the world, and depends upon the world for talent too. More than that, we do not right now have a sufficient base of science and engineering talent within the U.S.

We should have learned well enough already that we win with our hard work, but also with our national openness. Thirty-three million people now living in the United States were born outside it. Our immigration influx is a resource of ability and growth the rest of the world wishes it could enjoy. Let’s leave the Great Walls to China.

We should learn instead what the competition is reminding us about the place of education in transforming competitiveness. I am referring to the dramatically improving education systems in other countries.

Higher education in India and China is growing at a pace comparable to what we experienced in the U.S. after World War II. A journalist recently wrote quite poetically:

“The Indians and Chinese have three or four millennia of civilization embedded in the minds and souls of their huge populations. Now they also have well-functioning states highly



respected throughout the world. It's not coincidental that Indian and Chinese youngsters do well in many areas of education. They are all immersed in stories about great heroes and heroines that mold their minds and give their souls direction. Their most powerful direction is education."<sup>4</sup>

The threat from China and India is not outsourcing, but education. It is not even population. Yes, today China's population is nearly four times as large as America's. But trends indicate that by the middle of this century America's population could be half the size of China's, rather than a quarter.

The question is not how many people does a country have, but how well educated will the rising work force be? What level of innovation will they have relative to the world's?

We should also be hearing these remedial lessons from Europe. Many European countries and the E.U. as a whole are determined to reverse the brain drain and finally compete with U.S. research and development. This fiscal year, in Ireland alone—in a country no larger than South Carolina—Science Foundation Ireland, or SFI, received a 62 percent boost in funding.

Ireland has about 1/100th the population of America, but Ireland has had a pretty good run lately. By early 2004, SFI had awarded funding commitments amounting to almost \$420 million over the next five years for more than 150 projects comprising more than 750 individuals, research teams, centers and visiting researchers. These award recipients include outstanding researchers from Ireland, Australia, Belgium, Canada, England, Germany, Japan, Russia, Scotland, Slovakia, South Africa, Switzerland and the U.S.A.

More than that, Ireland is acting aggressively, proactively and with passion to build on their already superb education system by introducing a new level of science and mathematics preparation.

This sense of the power of R&D and modern education is strong across Europe. In Central and Eastern Europe, dramatic experiments are under way to revamp their education systems, which already are strong and serve students extremely hungry for success.

Our population size cannot give us assurance. Nor can our education system as we now know it. Nor should we be assured by the fact that in overall totals, expenditures in the United States far outweigh the resources of anyone else.

World history proves that our size and our wealth must not be our comfort. In his recent book, *As the Future Catches You*, Juan Enriquez of Harvard University bluntly reminds us, "The future belongs to populations who build empires of the mind."<sup>5</sup>

In 1840, China and India accounted for 40 percent of world trade. They produced commodities prized around the world, such as silk, jewels and jade. About the same time, in 1800, Cubans and Argentineans were richer than Americans.<sup>6</sup>

But none of those previously economically rich countries moved fast enough during the Industrial Revolution. China, India, Cuba and Argentina all fell far behind their competitors in almost every aspect of national wealth and prosperity.

Fifty years ago, Taiwan was a corrupt, poverty-stricken, technologically deprived nation. "Someone living in Mexico produced, on average, twice that of someone living in Taiwan."<sup>7</sup>

◆

The future belongs  
to populations who  
build empires of  
the mind.

JUAN ENRIQUEZ  
*Harvard University*

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<sup>4</sup> Franz Schurmann, "Return of the Old Empires: India and China," *Pacific News Service*, November 26, 2003

<sup>5</sup> Juan Enriquez, *As the Future Catches You*, p. 56

<sup>6</sup> *Ibid.*, pp. 21-22

<sup>7</sup> *Ibid.*, p. 26



◆

The next major advancement is now needed. We must link the best part of our school system—that is, our universities—with the schools that serve most of our population: our K-12 schools. Our system is in need of change for a population competing with the world.

◆

By 1974, though, Taiwan had imposed some of the toughest university entrance exams anywhere and had begun emphasizing scientific literacy. Its industrial plant grew, and so did its exports and competitiveness. By the 1990s, “Taiwan had become one of the world leaders in personal computer and chip manufacturing. And a Taiwanese was producing four times more wealth than a Mexican.”<sup>8</sup>

Mexico enjoyed a proximity to the wealthiest country on earth. It had massive coastlines where exports could have passed inexpensively. It had a strong family tradition and a homogenous culture. But it didn’t set the conditions for modern education, technological development, scientific literacy or entrepreneurship.

If the education system as a whole does not work together, eventually the bottom will fall out. How can it not—the ideas and talents of students are the only real force for perpetual ingenuity.

The BHEF report put it well: “All of the world’s great civilizations . . . rose on innovation, the spread of ideas and technology, and the cultivation of learning to fuel the creativity and productivity of their citizens. These societies ultimately failed not by being outflanked by stronger economies or military forces but from complacency.”

As it is, we may already have depended too long on the current system. A few cherished notions deserve our doubts. As examples, let me quickly name three.

First, foreign graduate students have long been a wonderful boon to America. Yet this advantage has also allowed us to dodge the issue of why we can’t convince American students to pursue careers in science, engineering or technology.

Second, our vaunted productivity may also be a result of working harder rather than wiser. In 1982, Europeans and Americans worked roughly the same number of hours per year. Now, Americans work 300 hours more per year—that’s a 46-hour week instead of a 40-hour week, every week.<sup>9</sup> Is a blind work ethic allowing us to avoid the real action required to educate and work smarter?

Third, and last, maybe we have been using our billions of dollars to prop up an education system that surely suffers from the divide that separates universities and schools.

In the last 50 years, American higher education has enjoyed remarkable expansion. Fifty years ago, we didn’t have a world-leading research university. Then came the National Science Foundation and the GI Bill, DARPA, the infusion of funds after Sputnik and the emergence of the national academies.

Meanwhile, innovations made higher education accessible across society, thanks to community colleges, standardized testing, affirmative action and financial aid. Today, for-profit higher education is creating new competition, and technology is altering the concept of college learning. The vision that California’s Clark Kerr had of a form of college education to suit every student’s needs has largely come true.

The next major advancement is now needed. I would like to conclude my remarks with a few thoughts on what this advancement might be. We must link the best of our school system—that is, our universities—with the schools that serve most of our population: our K-12 schools. Our system is in need of change for a population competing with the world.

<sup>8</sup> Ibid

<sup>9</sup> “From Sea to Shining Sea,” *The Economist*, November 6, 2003

What can be done? The Business-Higher Education Forum report gives us an excellent course to chart. I would like to add two specific suggestions and a third broader one. These ideas arise from the premise that our universities are uniquely able to bring about change in K-12 schools. These two parts of our system are mutually dependent for improving the quality of education our students receive.

First, we must tackle the isolation of teachers within the university culture. Too often, it seems like the education of teachers is distinct from the education of other students. Then the education of teachers concludes, and they move into schools only to become even more separate from every other profession. My point is simple: First-rate teachers are the key to inspiring learning.

It takes special skill to teach, and special training and commitment to do so—and, I would argue, especially in the science and math disciplines. Isolating teachers as students and then as professionals does not serve them well or educate the university in how to help them. We should integrate the training of teachers more fully within our science and liberal arts curricula. Then we should develop programs that support them in their efforts to remain abreast of developments in their fields, including giving them opportunities to work along with our science, math and engineering faculty as peers. Such efforts will help them in their work with students and bridge the gap between higher education and K-12 schools.

I've introduced a related concept in Ireland. At the science foundation, we now have what we call our STAR program to support teachers willing to work in the labs of our best researchers during the summers.<sup>10</sup> The teachers and researchers have embraced it wholeheartedly. The

same would occur here.

Second, universities should form deep bonds with the schools nearest them, bonds that make matriculating easier and more successful, whether at the local university or elsewhere.

These bonds should especially focus on schools serving low-income students and new immigrants. Sixty percent of students from high socioeconomic backgrounds earn bachelor's degrees by age 26. Only seven percent of young people from low socioeconomic backgrounds do so.<sup>11</sup> Racial differences only exacerbate the gap.

These are not only crises worthy of school administrators or governments. They are also crises requiring the focus of foundations and universities as a whole, as well as of businesses large and small.

The untenable educational attainment among those from low-income or non-white backgrounds creates not only disparity, but also distrust. It then becomes self-reinforcing as it reduces the personal capital available for change. It is also costing us the talents of immigrants, who historically have had such a part in our innovative culture. In the 1990s, the largest number of immigrants in our history moved to America. The efforts to meet these challenges must broaden, intensify and perpetuate themselves.

My third and final suggestion is less specific and complex. But it is also of greatest importance. We in the university must initiate holistic, fearless innovation within the system. We haven't done that since community colleges were born.

I quoted a statement earlier that noted a few of America's greatest strengths,

◆  
First, we must tackle  
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◆  
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◆  
Third, we in the  
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◆  
<sup>10</sup> STAR = Science Teacher Assistant Researchers

<sup>11</sup> National Center for Education Statistics Statistical Analysis Report, "Coming of Age in the 1990s: The Eighth-Grade Class of 1988 12 Years Later," U.S. Department of Education Office of Educational Research and Improvement (June 2002)



◆

I think we have to learn again the lesson we have taught the world—that innovation begins with education.

◆

including “extreme freedom of thought, an emphasis on independent thinking, a steady immigration of new minds, a risk-taking culture with no stigma attached to trying and failing.”

I am sorry to say that I no longer think that description applies to the university world and especially its coordination with K-12 schools.

I think we have to learn again the lesson we have taught the world—that innovation begins with education. Re-learn that lesson, that is, or lose. Lose the capacity to renew our pool of talent and ideas. Lose the chance in our time to create change that will serve America for the next century. For American enterprise to be innovative, so must higher education.

America is relatively young in comparison to our chief competitors. But is it *still* hungry? And does the spirit of innovation that brought us here still persist within the university from which so much innovation emerges? Innovation, that is, not simply for single departments or individual faculty, but innovation in how the university organizes itself and defines its mission, including as part of the education system from which its talent comes?

The world is determined as never before to compete with American ingenuity and its research and development enterprise—which means, at its core, competing with our education enterprise.

Today, we fail millions of students in our own communities, in the schools that surround the very universities of which we are so proud. I don’t know why this is so. Perhaps the diagnoses of others are true. Perhaps we do bore our students. Perhaps we do fill our classrooms with too many poorly

trained teachers. Perhaps we do overwhelm teachers with expectations far beyond their roles as educators. Perhaps the unions do have too strong a grip on the profession. Perhaps we do test students into submission. Perhaps we do operate the school calendar as if we were still an agrarian society. And perhaps we in higher education should re-think the very nature of what we do and do not do to help.

Finding the answers and solving the problems should be part of the job of the university. If the universities cannot do so, who can?

It might be said, of course, that higher education has enough to handle. That departments have enough to manage trying to put together a strong curriculum for their majors. That deans have enough to manage trying to keep this superb faculty member or attract that young star. That provosts have enough to manage trying to find space for that new laboratory for a pressing sub-specialization. And that presidents have enough to manage trying to convince the legislature or alumni that this time the money is really needed.

But one fact, finally, defines the university’s role. One profession educates all the others. It is the professor. And the university is the one institution that can shape the system of education and innovation, of learning and of discovery, which begins when our students first start to learn.

In 2000, the Carnegie Corporation raised some of these issues when it released a report titled “Liberal Arts Education for a Global Society.” The report grew out of a conference of educators not unlike this group. The Carnegie group examined undergraduate education and offered telling observations that included these three:



- - One: Professional and liberal arts education exist worlds apart, rather than as complementary parts of an integrated curriculum.
- - Two: With the first two years of undergraduate study most often in disarray, higher education does not provide leadership for the secondary school curriculum.
- - Three: The kind of searching self-assessment necessary to a renewed mission is a rarity in higher education.

The BHEF report is a searching self-assessment that should guide us in the same straightforward way. Yet searching self-assessment is hardly common to the university anymore, as it should be—and must be—in the 21st century.

We cannot count on the habits of the 20th century anymore. We cannot count on the trajectory of these last 50 years to continue.

What new systems can be proposed? How can we build an education path that offers opportunity at every level and is seamless across levels? How can we make the passage of students through our education system an advancement, not a reduction, in their opportunities and abilities?

We must peel back the old comforts and assurances and re-think the very model of how we do business, allocate our resources, allocate our talent, and work as part of the system of national education needs, and whether we truly serve the nation as we must. The time has come to ask hard questions.

Innovation creates leadership. And education spawns innovation. We claim to be the genesis of innovation in America. It is time at last that we become innovative again too.

An extraordinary group of leaders is gathered here. Because of your prominence and capability, I believe you have a strong leadership role in expanding the university's value to the full education enterprise. And for fostering a new age of university attention to the great challenges before our society, beginning with the system by which we educate our people. America requires it.

My favorite "philosopher," Yogi Berra, once quipped, "When you come to a fork in the road, take it."

I believe we have come to a fork in the road. Wishful thinking and the status quo will not and cannot help us. It is time to get on with the hardheaded work of innovation that America and its universities taught the world.

This work, I know, will be part of our focus tomorrow. I look forward to this dialogue and the energy and ideas that will begin here. I cannot think of a more appropriate topic for the second Baker Forum, or of a more appropriate institution than Cal Poly to catalyze the actions that have become imperative for California and the nation.

Let us agree tonight that we intend to leave tomorrow with a shared commitment to building a nation of learning and learners, for learning is the path to success and economic prosperity, for individuals and a nation. We owe the achievement of this goal to our children and grandchildren. Our schools and universities exist for them. They cannot dare to fail. We must help them succeed.

Thank you for the privilege of joining you on this mission. May our work go well. Indeed, it must. Thank you.

◆  
 Let us agree tonight  
 that we intend to  
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 ◆



## WILEY LIFETIME ACHIEVEMENT AWARD

William C. Harris



### THE WILEY LIFETIME ACHIEVEMENT AWARD

With the creation of the Baker Forum, John Wiley & Sons, Inc., generously established the Wiley Lifetime Achievement Award. This award, bestowed at the Baker Forum, recognizes extraordinary leadership and lasting contributions to American higher education and public life. Science Foundation Ireland Director General William C. Harris, the 2004 Baker Forum keynote speaker, was the second recipient of this award.



William C. Harris was named founding director general of Science Foundation Ireland in July 2001. Dr. Harris' career includes service at the National Science Foundation (NSF), Columbia University and the University of South Carolina (USC). Most recently, he was vice president for research at USC, overseeing research activities throughout the USC system, several interdisciplinary centers and institutes, the USC Research Foundation, and sponsored research programs.

Harris had previously served as founding president and executive director of Columbia's Biosphere 2 Center (B2C) in Arizona. In December 1999, the trustees unanimously endorsed a proposal he put forward to build Columbia "West" over the next decade.

Harris served at the U.S. National Science Foundation from 1977 to 1996, including director for the mathematical and physical sciences division (1991-96), where he was responsible for a federal grants appropriation of \$750 million per year. At the NSF, he also established 25 science and technology centers to support investigative, interdisciplinary research by multi-university consortia.

Harris has authored more than 50 research papers and review articles in spectroscopy, and in 1977 became a fellow of the American Association for the Advancement of Science. He earned his undergraduate degree at the College of William and Mary and his Ph.D. in chemistry at the University of South Carolina.



# PANEL DISCUSSION AND BREAKOUT SESSIONS



EXPANDING THE PATHWAYS  
TO SCIENCE AND ENGINEERING CAREERS



## PANEL DISCUSSION AND BREAKOUT SESSIONS



n the second day of the 2004 Baker Forum, a panel discussion and breakout sessions took up four important discussion topics related to the overall Forum theme:

- An emerging Business-Higher Education Forum (BHEF) proposal for a professional national outreach program to promote science and mathematics education
- Emerging BHEF proposals regarding how business can strengthen its support for P-16 science and mathematics education's efforts to achieve systemic change
- Emerging BHEF proposals regarding how higher education can strengthen its support for P-12 science and mathematics education's efforts to achieve systemic change
- Cal Poly's new University Center for Excellence in Science and Mathematics Education (UCESME) and strategies for engaging industry in its work

## PANEL DISCUSSION

In an opening discussion of the 2004 Baker Forum theme, Robert C. Detweiler, Cal Poly's interim provost and vice president for academic affairs, was joined by six distinguished panelists:

Julian Crocker, superintendent, San Luis Obispo County Schools, commented on ways to strengthen the partnership between K-12 schools and both business and higher education. First, he urged that business get past the habit of assigning blame to K-12 education for the ills of the work force and society. He suggested that many effective programs, such as the AVID Program, are already in place to support science and mathematics education (and teachers), and recommended that we should strengthen support for those programs rather than create new ones. He noted that teachers lack sufficient free time to engage in professional development. Crocker recommended further that universities adopt admissions standards based upon the standards used by the K-12 system to measure student performance.

Sally Goetz Shuler, executive director, National Science Resources Center, emphasized that the nature of science learning today needs to take into account how students' lives have dramatically changed during the past century. In the past, more children were exposed to practical examples of natural and mechanical processes and principles as a part of everyday life outside of the classroom. Today, with modern technology prevalent throughout the country, students' learning is more symbolic, with little or no direct engagement with the natural world. To affect this change, the strategic engagement of business and industry is needed to provide all students with hands-on, inquiry-centered science programs that are based on research and are externally evaluated.

William C. Harris, director general, Science Foundation Ireland, endorsed the idea of a concerted public information effort to increase awareness and interest among K-12 students in science and mathematics. He suggested that both higher



education and business bear special responsibility for anticipating and planning for society's educational and workforce needs in this era of heightened national security concerns. Harris noted that it is critical that we de-politicize education and make a long-term commitment to reforms that transcend both electoral politics and the business cycle. He observed that remedying the crisis in science and mathematics education will require a national commitment equivalent in scope to the Morrill Act, which created our land grant colleges and universities. Harris foresees a national initiative that would connect academic institutions more effectively to the society that supports them.

Tom Kelly, vice president, Internet Learning Solutions Group, Cisco Systems Inc., described Cisco's global initiative to provide hands-on instruction in networking technology in schools and colleges around the world. Kelly encouraged close study of the Cisco initiative as an example of successful partnership between industry and education. He noted that the company's network academies address the concern Sally Goetz Shuler raised about the distancing of children from the physical world, giving young people an opportunity to learn first-hand how things work in the information age while at the same time offering them skills that are marketable in today's economy. The Cisco program also leverages existing corporate and educational capital and human resources to enable efficient and cost-effective delivery of education to students.

Barbara Ross, manager of strategic relations, California Education, Apple Computer Inc., observed that Apple is very interested in understanding better the factors that impede or facilitate student progress to diploma and degree

completion. She observed that to the extent that business understands these causal factors it will be better positioned to contribute to education in effective ways. She noted that we have knowledge of the strategies that work, but need to scale them up. She went on to suggest that the liberal arts be redefined to encompass not just broad cultural competence, but also an understanding of how to live in a technologically grounded, rapidly changing society.

James M. Rosser, president, California State University Los Angeles, discussed the achievement gap that persists between majority students and underrepresented minority students, particularly in scientific, engineering and technical disciplines and fields. He noted that this gap has been exacerbated by the high incidence of underqualified teachers, especially in math and science, in schools that serve high concentrations of low-income and minority students. Rosser had three specific suggestions to address this problem: (1) assign at least two credentialed master teachers who hold degrees in math and science, respectively, to every pre-K-8 school; (2) provide differential compensation and retention support for teachers of math and science in low-income and minority schools who are competent in math and science; and (3) ensure that university faculty who contribute to effective pre-K-12 reform receive credit toward retention, tenure and promotion. He noted that Defense Department schools are very effective in preparing diverse students for college and work. The schools have high standards for all and a common curriculum delivered by teachers with strong academic qualifications at multiple locations around the world.



◆

The strategic engagement of business and industry is needed to provide all students with hands-on, inquiry-centered science programs.

SALLY GOETZ SHULER  
*National Science  
Resources Center*



## BREAKOUT SESSION #1

*Evaluating the emerging Business-Higher Education Forum (BHEF) proposal for a professional national outreach program to promote science and mathematics education*

◆  
A national  
outreach campaign  
should appeal to  
Americans' sense of  
national pride,  
ambition and  
aspiration.  
◆

### SESSION CONVENER

Keith Fox  
Founder and CEO  
Brandsoft Inc.

### SESSION CO-CONVENER

Bill Boldt  
Vice President for University Advancement  
California Polytechnic State University

Breakout group participants suggested that any campaign should appeal to Americans' sense of national pride, ambition and aspiration. It should make clear that effective, widespread education in science, mathematics and technology is a critical precondition for technological innovation, the emergence of new businesses, the creation of jobs, and the promotion of economic growth and development. Government, business and education each have a role to play in advancing this message and realizing its vision in practice.

Looking beyond the scope of the information program to broader issues of educational reform, the breakout group went on to suggest that universities take the lead in implementing a national initiative for reform in science and mathematics education equivalent in scope to the Morrill Act, a land grant to universities in the late 19th century that supported renewal of the nation's agrarian economy. This initiative should include the following elements:

- The K-12 system should provide world-class curricula and opportunities for teacher development.
- Higher education should embrace K-12 teachers through mentoring programs and cooperative efforts with industry to provide teachers with applied science and mathematics experiences.
- Businesses should provide opportunities for student teachers and teaching professionals to see how science and mathematics are applied in industry settings by providing employment opportunities.



*Evaluating the BHEF proposals regarding how business can strengthen its support for P-16 (pre-kindergarten through university) science and mathematics education’s efforts to achieve systemic change*

SESSION CONVENER

Frank J. Elliott  
Retired Vice President  
Storage Systems Group  
IBM Corporation

SESSION CO-CONVENERS

Warren J. Baker  
President  
California Polytechnic State University

Julian Crocker  
Superintendent  
San Luis Obispo County Schools

Breakout session participants confirmed that U.S. business is committed to sustaining America’s scientific and technological preeminence by supporting an effective P-16 educational system. They emphasized, however, that a clear statement of the case for investing in science and mathematics education needs to be made available to business—making the problem tangible, conveying the benefit to industry and communicating what business can do to help.

Addressing potential roles for business, breakout session participants observed the following:

- Business can and should play a lead role in state P-16 councils to help educators advance the cause of science and mathematics educational reform and improvement.
- Science and mathematics educational reform and improvement should be given a place of prominence as part of business’ lobbying agenda.
- Business should also consider participating in regional councils, bringing together business, higher education and P-12 education.
- Business should also share with educational institutions its expertise in management systems.

- At present, local efforts by business to support schools are not clearly tied or effectively linked to an overall strategy for educational improvement. A high-level sponsor may be required to assume leadership to achieve a well-coordinated strategy.
- Already extant groups, such as the Business Roundtable, might be tapped to provide leadership and coordination. CEOs should be engaged directly as well.

As business considers expanding its engagement in science and mathematics educational reform and improvement, several policy issues might be given priority:

- Implementing high academic standards and expectations for all P-12 students, regardless of whether they are entering the work force or college upon graduation from high school. Particular emphasis should be given to reaching those students who are not currently exposed to the best programs and achieving at high levels.
- Improving the quality and standing of the teaching profession, reforming teacher compensation policies and enhancing professional development for teachers
- Encouraging business to help “sell” to parents and students the value of preparation in science and mathematics by communicating how such studies can help students achieve the American dream

While business programs developed to support education at the local level are helpful, business may have a greater impact on educational reform and improvement by helping to shape and influence educational policy at the national and state levels.

◆

**U.S. business is committed to sustaining America’s scientific and technological preeminence by supporting an effective P-16 educational system.**

◆



## BREAKOUT SESSION #3

*Evaluating the BHEF proposals regarding how higher education can strengthen its support for P-12 science and mathematics education's efforts to achieve systemic change*

### SESSION CONVENER

Richard F. Hartung  
Sonoma Consulting Group

### SESSION CO-CONVENER

Robert Detweiler  
Interim Provost and Vice President for Academic Affairs  
California Polytechnic State University

Session participants agreed that the challenge of reforming and improving science and mathematics education is a systemic issue of enormous complexity, equivalent to the Sputnik crisis. They asked, "How do we galvanize the public and its leaders?"

As a starting point, session participants argued that improving science and mathematics education should be approached as a matter of high national urgency and priority, with appropriate resources committed to addressing it.

At the state level, they contended that we need political leadership by governors to help ensure that science and mathematics education is made a high priority in state and local educational policy.

And higher education has an important role to play. Session participants maintained, in fact, that higher education should support making improvements in P-16 education in science, mathematics, engineering and other technical disciplines a national and state priority similar to the priority that was given to support for agriculture by the Morrill Act (the federal act that supported establishment of the land grant universities).

Through their own programs, universities should emphasize the following priorities:

- Adopting common, stage-sequenced learning outcomes for science and mathematics teacher education students
- Fostering and supporting science and mathematics teacher performance evaluation systems calibrated with educational standards
- Reallocating limited resources to give priority to high-need teaching fields such as science and mathematics
- Producing not just majors in science and mathematics, but graduates who are "education specialists" in science and mathematics
- Working with P-12 teachers to identify and disseminate innovative best practices in science and mathematics education, particularly promoting "inquiry-based" approaches to teaching and learning
- Ensuring that teacher preparation programs incorporate pedagogies that are sensitive to cultural issues



- Providing professional development opportunities for science and mathematics teachers. This might include using distance education to disseminate teaching innovations. It might also include site-based research refresher courses as part of in-service professional development for teachers. (This might require additional investments in schools' science infrastructure.)
- Giving special attention to the early learning experience of young children, including developing guidelines for exposure of children to science and mathematics in the earliest years; creating strategies for helping young children overcome "math phobia"; and forming approaches to sustain children's curiosity in natural phenomena. Teachers should be encouraged to embrace partnerships with parents in motivating children and young people to achieve in science and mathematics.
- Reforming university general education to foster a wider and deeper science and mathematics literacy

◆

Higher education should support making improvements in P-16 education in science, mathematics, engineering and other technical disciplines a national and state priority similar to the priority given to support for agriculture by the Morrill Act.

◆



## BREAKOUT SESSION #4

*Establishing Cal Poly's University Center for Excellence in Science and Mathematics Education (UCESME):  
Strategies for engaging industry*

◆  
It is critical that K-12  
be involved broadly  
in development of  
the Center's strategic  
vision.  
◆

### SESSION CONVENER

Jaime Oaxaca  
Chairman  
The Oaxaca Group – Grupo Oaxaca

### SESSION CO-CONVENERS

Philip S. Bailey  
Dean  
College of Science and Mathematics  
California Polytechnic State University

Bonnie Konopak  
Dean  
College of Education (formerly University Center for Teacher Education)  
California Polytechnic State University

Breakout session participants encouraged Cal Poly to develop a fully articulated strategic plan and business plan for its new University Center for Excellence in Science and Mathematics Education (UCESME).

They observed that the Center's priorities for industry engagement should address strategic as well as tactical measures.

Session participants recommended that a business plan be developed, incorporating:

- A strategic vision
- Dialogues with stakeholders (students, parents, teachers, etc.)
- An understanding of student needs and best practices for meeting those needs
- Long-term and short-term objectives
- Benchmarks for success (with clear metrics)

Mary Crebassa, co-chair, College of Liberal Arts Dean's Advisory Council, volunteered to facilitate a retreat to begin strategic planning for the Center.

In the discussion leading up to these recommendations, session participants commented that:

- It is critical that K-12 be involved broadly in development of the Center's strategic vision and plan and in any implementation efforts.
- Cal Poly should make sure that the Center is focused on the needs and expectations of children. The university should use focus groups to evaluate this effort.



- Cal Poly has a number of effective initiatives already under way (including collaborations with K-12) that can be inventoried and brought together through the work of the Center.
- To engage industry successfully, the University should present a cogent, compelling, concise case that includes a discussion of new reasons to invest in science and mathematics teaching; new ways to teach; new tools to help teachers teach; and strategies for engaging new students in the study of science and mathematics.
- Cal Poly should review and tap into existing models of industry involvement in teaching and learning (such as the “City Vision” initiative). To the extent it attempts to foster new industry engagement initiatives, Cal Poly (and its industry partners) should listen carefully to teachers about how to do this effectively. Teachers need to guide industry engagement to make sure it is integrated with the overall educational program.
- Support for teachers should include exploring ways to provide them with additional time for planning and learning, as well as additional educational resources.



◆  
Cal Poly should  
review and tap into  
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learning.  
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**T**he 2004 Baker Forum set out to explore roles that industry and higher education can play to strengthen U.S. pre-school through grade 12 science and mathematics education and thereby expand pathways to science and engineering careers. With a Business-Higher Education Forum (BHEF) draft report on science and mathematics education<sup>12</sup> as a key resource, we discovered considerable common ground among the participating leaders from industry, higher education and P-12 education regarding both challenges and solutions.

We agreed that improving the performance of U.S. students in science, mathematics, engineering and other technical fields is a matter of increasingly urgent importance for the United States. Our national security, global economic competitiveness and domestic standard of living all depend on our ability to continue to marshal a skilled and innovative science and engineering work force. The lagging education of U.S. graduates in key science and technology fields is putting the future strength of that work force at risk.

We determined that strengthening P-12 science and mathematics education is an important key to ensuring a continuing and adequate flow of well-prepared students into science and engineering careers. Moreover, as the BHEF draft report argued, the demands of the new century require that all students graduate from high school with strong preparation in these subjects, whether they go on to college or proceed directly into the work force.

Heeding research findings cited in the BHEF draft report and elsewhere, we concluded that the most effective way to strengthen science and mathematics education is to educate, support and retain competent, enthusiastic and engaged science and mathematics teachers. We should strive for teacher training, professional development, compensation and reward systems that raise the stature and standing of the teaching profession and permit us to attract additional talented, creative students into it. Teachers need additional time—and additional educational resources—to become familiar with and implement educational best practices. And teachers need tools—classroom and laboratory facilities and inquiry-based learning materials—to engage students in the excitement of scientific and mathematical discovery and understanding.

If we are to achieve the improvements needed in science and mathematics education, Forum participants concurred that we must engage business, higher education and P-12 education leaders in making this an urgent national and state priority. While recognizing that P-12 educators have already identified many of the steps that must be taken to ensure success, and that their lead roles should be honored and supported, Forum participants identified key roles for business and higher education as well.

Forum participants concurred with the BHEF draft report that business has important roles to play in strengthening science and mathematics education, including providing overall leadership for strengthening P-16 science and mathematics education (through the work of statewide and regional P-16 education policy councils); leading a national campaign to raise the public's awareness of the urgent need

◆  
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◆

<sup>12</sup>As noted earlier in these proceedings, the Business-Higher Education Forum report was published in February 2005 with the title "A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education."



◆

Teachers need assistance from business and industry to acquire the information and insight needed to convey to students how science and mathematics are connected to careers.

◆

to strengthen science and mathematics education; and seeking greater consistency between business efforts on behalf of education in local communities and national and state policy priorities. Teachers in particular need assistance from business and industry to gain access to industry-based opportunities for professional development; to acquire the laboratory and learning resources required to provide hands-on learning opportunities to students; and to acquire the information and insight needed to convey to students how science and mathematics are connected to careers and work critical to our nation.

Higher education also has a role to play in strengthening P-12 science and mathematics education. Forum participants suggested that there be a national initiative, with universities at the center, much like the Morrill Act, which supported development of the land grant universities. Through such a national initiative, and through local efforts, universities should facilitate and support preparation of qualified science and mathematics teachers; identify and disseminate innovative best practices in science and mathematics education (especially “inquiry-based” teaching and learning); provide ubiquitous and conveniently accessible professional development opportunities for teachers; give special attention to the early learning experiences of young children, to foster their interest in science and mathematics; and also reform university general education, to foster greater science and mathematics literacy.

Subsequent to the Baker Forum, a summary of these findings and recommendations was shared with BHEF staff to aid in further refinement of the BHEF report.

◆

As we concluded the 2004 Baker Forum, we also agreed that Cal Poly should start now to strengthen and expand its efforts to support science and mathematics education in California. Accordingly, through the new University Center for Excellence in Science and Mathematics Education, Cal Poly has launched a significant new effort to prepare and support science and mathematics teachers, particularly in underserved areas of the state. With support from Cabinet volunteers and a generous foundation gift from Cal Poly alumnus Joseph Cotchett and his wife, Victoria, this new Center is refining a strategic vision and putting into place an ambitious, results-oriented action plan. We are working hard to ensure that the Center will have an important long-term impact on California science and mathematics education.

In closing, I would like to express my sincere appreciation to the 2004 Baker Forum participants for assisting Cal Poly and the Business-Higher Education Forum in assessing the roles that industry and higher education can play, together with P-12 educators, in strengthening P-12 science and mathematics education. With the benefit of the 2004 Forum dialogue, I am more convinced than ever that we must make this a high priority if we are to ensure the continued security and prosperity of our state and nation. We hope these proceedings might also help others to recognize and understand the critical importance of raising the science and mathematics literacy of all young Americans.



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2004 BAKER FORUM PROCEEDINGS  
APRIL 2-3, 2004

CALIFORNIA POLYTECHNIC STATE UNIVERSITY