The 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. It 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 in ensuring that these innovations are applied broadly to serve the interests of society and in preparing 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.

*The President’s Cabinet is a 49-member senior advisory group of state and national leaders in business, industry, government and the community.
For over two decades, the President’s Cabinet, a dedicated and gifted group of volunteers from industry, has served California Polytechnic State University (Cal Poly). This distinguished panel of business leaders provides advice, counsel, and support to this outstanding university.

Three years ago, when President Warren Baker and his wife, Carly, completed their 20th year of service to the University, the members of the Cabinet sought a fitting way to recognize these two very special people and their superb contributions to Cal Poly and to higher education in America. Indeed, all of us who have followed Warren and Carly Baker’s untiring work realized that the Bakers’ exciting vision, high sense of purpose, and “can-do” spirit had lifted Cal Poly into the top rank of American universities.

To honor the Bakers’ distinguished and sustained efforts, the Cabinet decided to initiate a biennial public policy forum. The purpose of this forum is to bring together leaders from higher education, business, and government to consider the important role that polytechnic and science and technology universities play in our global society and find ways that this vital role might be maintained and strengthened. The Cabinet proposed that this gathering of minds be called “the Baker Forum,” not only to acknowledge the Bakers’ contributions but also to ensure that the forum draws to Cal Poly international leaders of the highest caliber for important dialogue.

With these purposes in mind, the inaugural Baker Forum was convened at Cal Poly in April 2002. Over 100 distinguished leaders from academe, government, and industry met to consider the future of polytechnic and science and technology universities in a discussion of several pressing and related issues:

- **Meeting the Ethical Challenge**: Defining the social and ethical responsibilities of polytechnic and science and technology universities.
- **Fueling the Pipeline**: Preparing a new, diverse generation of innovators, problem solvers, and leaders.
- **The Business and Industry Connection**: Seeking partnership strategies to support faculty and students, provide applied and contextual learning and research opportunities, and sustain economic growth and development.

The proceedings of the inaugural Baker Forum presented here provide a record of the participants’ important contributions to the discussion of these critical topics.

We are particularly indebted to Dr. Susan Hackwood, executive director of the California Council on Science and Technology (CCST), for her opening keynote address on CCST’s report, “Critical Path Analysis of California’s Science and Technology Education System,” and to Dr. Walter Massey, president, Morehouse College, and Mr. Gary Bloom, president, CEO, and chairman, Veritas Software, for their thoughtful commentaries on Dr. Hackwood’s timely and compelling presentation.

A special highlight of the first day of the inaugural Baker Forum was the conferral upon

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1 During the course of Forum conversations, it was agreed that a title that more accurately captures the full dimensions of this topic might be “Creating Pathways to Science and Engineering.” See for example, the panel comments of Joseph Bordogna and the later comments of Jaleh Daie.
Dr. Walter Massey—in recognition of Dr. Massey’s long and distinguished career in service to higher education and the nation—of the Wiley Lifetime Achievement Award, and, by Cal Poly and the California State University, of an honorary doctorate of science.

On the second day of the Forum, an outstanding panel provided opening remarks on the Forum’s three discussion themes, and, in ensuing “breakout sessions,” all Forum participants shared their valuable insights and observations.

The result of the first Baker Forum, as recorded in these proceedings, was a truly incisive, profound, and inspiring exchange, culminating in a set of recommendations directed to polytechnic and science and technology universities and their partners in government and industry.

Among the critical recommendations, the following merit special attention:

• Education, government and industry should work to foster greater awareness among parents and students of the opportunities available through study of mathematics, science and engineering.
• Business, industry and higher education should increase their support for improvement of K-12 education, particularly through outreach to students and parents, support for teacher education and retention, and encouragement of more effective approaches to math and science teaching and learning, with particular emphasis on connecting these fields to career settings and other real-world issues.
• States should provide increased support to community colleges, recognizing their critical role as gateways for underrepresented students and, in particular, their role as training grounds for math, science and engineering associate and baccalaureate degree students.
• Community colleges and universities should work to promote increased academic success among math, science and engineering students, by evaluating student attitudes and needs, setting high academic expectations, tracking student progress, providing mentoring and support, and targeting 100-percent degree completion.
• Education, government and industry should develop partnerships, based on clearly stated goals, resting upon viable and sustainable financial and organizational models and yielding clearly definable and measurable benefits for all parties.
• Universities and their industry supporters should join in collaborative efforts to expose students to real-world case studies, illustrating professional ethical challenges and responses to them.

I believe that these recommendations will lead to important and consequential progress, if acted upon by polytechnic and science and technology universities and their partners around the world.

Cal Poly, with support from the President’s Cabinet, is undertaking a number of initiatives related to these recommendations:

• Follow-up on the California Council on Science and Technology’s Critical Path Analysis continues. With Dr. Susan Hackwood’s continued leadership and support, CCST is considering undertaking a study of science and math teacher education and retention in California, to identify opportunities for improvement. Cal Poly is actively supporting this effort as well as a Business Higher Education Forum initiative to forge a partnership between U.S. industry and

2 John Wiley & Sons, Inc. has generously established the Wiley Lifetime Achievement Award that recognizes a national leader whose work exemplifies extraordinary leadership and lasting contributions to American higher education and public life.
government to strengthen math and science education nationwide.

- The Workforce Preparation/Business Linkages planning group of the new California Master Plan for Education completed a final report that, with significant Cal Poly input, advocated:
  - greater integration of K-16 academic/career preparation;
  - strengthened K-16 emphasis on hands-on, contextual learning;
  - strengthened focus on K-16 workforce outcomes; and
  - new approaches to address the higher costs of K-16 vocational, scientific and technical programs. The final Master Plan report has incorporated a number of key Workforce Preparation/Business Linkages recommendations.

- Cal Poly is undertaking a targeted “student success” initiative this year to identify and eliminate barriers to student progress to degree, recognizing that while Cal Poly’s degree completion rates lead the CSU System, they lag selected comparison universities (e.g. several of the University of California campuses and selective private universities).

- The newly inaugurated Cal Poly College Academic Fee Initiative and the ongoing Cal Poly Plan are already starting to yield extraordinary dividends for academic quality and student success. Information about the Cal Poly Plan is available on the Web, at: http://www.calpoly.edu/~inststdy/cp_plan/index.html. Information about the historic College Academic Fee Initiative can be found on the Cal Poly Home Page: http://www.calpoly.edu/.

Cal Poly continues to work vigorously, across a number of fronts, to forge expanded partnerships with business and industry. Among these initiatives is an ongoing effort to develop a campus-sited Technology Park.

The Cabinet is involved in a number of important ways in supporting these critical initiatives.

- Over the past several years, the Baker Forum has attracted numerous donors. Generous contributions have come from members of the President’s Cabinet, from John Wiley & Sons Inc., and from other friends and supporters of the Forum, including Mr. Clifford Chapman and Mr. Gene Shidler, who gave a very important sustaining gift. I would like to express sincere thanks to all those who have contributed to the Baker Forum.

It has been a high privilege to help launch this biennial gathering, whose inception was the result of heartfelt respect, affection, and gratitude for all that Warren and Carly Baker have given to Cal Poly and to American higher education. I am pleased that the publication of these proceedings will allow us to share with a wider audience the important results of the inaugural Baker Forum.
PRESIDENT’S CABINET
Cal Poly is grateful to the President’s Cabinet for their support and vision in creating the Baker Forum.

WILEY LIFETIME ACHIEVEMENT AWARD
John Wiley & Sons, Inc. have generously established the Wiley Lifetime Achievement Award which recognizes a national leader whose work exemplifies extraordinary leadership and lasting contributions to American higher education and public life.

BAKER FORUM PATRONS
We gratefully acknowledge this generous cornerstone gift providing sustaining support for the Baker Forum.

Clifford W. Chapman & Gene A. Shidler

INAUGURAL BAKER FORUM BENEFACCTORS
We would like to thank the following individuals for their support of the inaugural gathering of The Baker Forum.

M. Richard & Joyce Andrews
Everett & Arlene Chandler
Donald & Jeannette Fowler

James & Joan Sargen
Wesley & Thelma Witten
Conrad & Christine Young

BAKER FORUM ENDOWMENT FOUNDERS
The following individuals are founding members of the Baker Forum Endowment which supports this biennial assembly of leaders in education, science, and industry.

Alfred & Rose Amaral
M. Richard & Joyce Andrews
Robin & Barbara Baggett
Philip & Christina Bailey
Warren & Carly Baker
Michael & Linda Bandler
William & Genene Boldt
William & Rose Marie Bowles
Everett & Arlene Chandler
College of Agriculture
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Thomas & Linda Dalton
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Wesley & Thelma Witten
Paul Zingg & Candace Slater
We Gratefully Acknowledge John Wiley & Sons, Inc.
for its sponsorship of the Baker Forum

The Wiley Lifetime Achievement Award

With the creation of the Baker Forum, John Wiley & Sons, Inc. has generously established the Wiley Lifetime Achievement Award. This award, to be bestowed at the Baker Forum, recognizes extraordinary leadership and lasting contributions to American higher education and public life. Morehouse College President Walter E. Massey, former Director of the National Science Foundation, is the first recipient of this award.

About John Wiley and Sons, Inc.

John Wiley & Sons, Inc. was founded in 1807, during the Jefferson presidency. In the early years, Wiley was best known for the works of Washington Irving, Edgar Allan Poe, Herman Melville, and other 19th century American literary giants. By the turn of the century, Wiley was established as a leading publisher of scientific and technical information.

Wiley is a global publisher of print and electronic products, specializing in scientific, technical, and medical books and journals; professional and consumer books and subscription services; and textbooks and other educational materials for undergraduate and graduate students as well as lifelong learners. Wiley has approximately 15,000 active titles and about 400 journals, and publishes more than 1,500 new titles in a variety of print and electronic formats each year.

With about 2,700 employees worldwide, Wiley has operations in the United States, Europe (England and Germany), Canada, Asia, and Australia. The Company has U.S. publishing, marketing, and distribution centers in New York, Colorado, Maryland, New Jersey, and Illinois. Wiley’s worldwide headquarters are currently located in New York City. In mid-2002, the company plans to relocate its headquarters to a waterfront location in Hoboken, New Jersey.
These proceedings of the Inaugural Baker Forum are dedicated to the memory of two distinguished leaders in the fields of science and engineering: Keith Uncapher, a member of the President’s Cabinet who participated as a panel member at the Baker Forum and Stephen Jay Gould, who was to give the keynote address at the forum, but was prevented by illness from participating. We are saddened by the loss of these visionary individuals who have made remarkable contributions to American science and technology.

Keith W. Uncapher, 1922-2002

Keith Uncapher was a key figure in the emergence of the Internet. For nearly a half century, he made groundbreaking contributions, including lead roles in the development of packet-switching technology and the now ubiquitous “domain names” (“.com,” “.net,” “.edu,” etc.). During the last decade of his life, he was a national advocate for U.S. leadership in Micro Electro Mechanical Systems (MEMS), and for the extension of MEMS to nano and molecular scale devices and applications.

Uncapher was co-founder and senior vice president of the Corporation for National Research Initiatives (CNRI) from 1986 until his death in October 2002. In the 1950s, Uncapher directed the computer systems center at the RAND Corp., Santa Monica, California. In 1972, he founded the USC Information Science Institute and was founding executive director until 1986. In 1974, he became an Associate Dean for Information Sciences at the University of Southern California, as well as Professor of Computer Sciences. Uncapher was a member of the National Academy of Engineering and former president of IEEE Computer Society and the American Federation of Information Processing Societies. Uncapher was a 1950 graduate of Cal Poly, with a bachelor degree in mathematics and minor in Electrical Engineering, and was a member of the Cal Poly President’s Cabinet.

Stephen Jay Gould, 1941-2002

Stephen Jay Gould, a paleontologist and historian of science, was among the best known and widely read scientists of our present generation. He earned his A.B. from Antioch College in 1963 and his Ph.D. from Columbia University in 1967. He held the positions of Alexander Agassiz Professor of Zoology and Professor of Geology at Harvard University, Curator for Invertebrate Paleontology at Harvard’s Museum of Comparative Zoology and Vincent Astor Visiting Research Professor of Biology at New York University. Gould was a recent President and Chairman of the American Association for the Advancement of Science.
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This inaugural Baker Forum is both a culminating event and a starting point. Let me explain why.

This first Forum is a culmination because it is the capstone of Cal Poly’s yearlong Centennial Celebration:

• The Celebration began on March 8th, 2001, with a History Day program that featured the release of the University’s centennial history, Cal Poly: The First Hundred Years, and an exhibit of historical Cal Poly photographs. An important part of the ceremonies was a panel discussion focusing on the presidencies of Julian McPhee, Robert Kennedy, and Warren Baker, whose combined tenures cover a period of nearly eight decades.

• Our History Day was followed in April by the formal opening of the University’s Centennial Comprehensive Campaign, at which NBC News anchor Tom Brokaw gave the keynote address. Now, almost a year later, the University is well on its way to meeting its announced campaign goal of $225 million.

• The academic year 2001 began in September with Cal Poly’s Founders Celebration, featuring a Centennial Colloquium and Convocation, at which Cal Poly awarded honorary doctorates to David Baltimore, Nobel Laureate and president of the California Institute of Technology, and to Rita Colwell, National Science Foundation director. The Founders Celebration took place only two weeks after the terrible events of September 11th, and was a poignant and powerful occasion reminding us of the high expectations and heavy responsibilities shouldered by American higher education whenever the nation is in crisis.

• On History Day 2002, the University presented its second History Day program. Amory Lovins, founder and director of the Rocky Mountain Institute, delivered a memorable presentation on natural resource stewardship and sustainability, issues of special concern to us as we consider the care and use of the University’s nearly 10,000 acres as Cal Poly’s second hundred years begin.

And this Baker Forum is also a beginning.

As we reflect on our past and consider our future, we are mindful of several unifying themes that have defined and shaped us:

• Our academic community is focused on our polytechnic mission, our applied-learning educational philosophy, and our emphasis on student learning as the principal measurement of our success.

• We are a community that fosters certain values that include reason and respect, community engagement and environmental awareness, and social responsibility and civic duty-values that are reflected in the performance of the University and in the character and conduct of our graduates.

• We are a community of service in which a marriage of intellectual and utilitarian concerns addresses the very meaning and tradition of the American academy. At
INTRODUCTION

Cal Poly, the nature and quality of the services we perform underscore the central purposes of the institution itself, while the boundaries of the University in the liberal arts, in applied sciences, and in research are coterminous with the boundaries of our region, state, and nation.

Indeed, higher education, through its commitment to community, character, and service, is inextricably connected to the larger purposes and needs of American society. Universities that succeed in fulfilling their social mission are those that recognize that public service is not only a legitimate role but also a privileged endeavor.

At Cal Poly, the educational opportunities provided by a faculty who teach classes relevant to the needs and challenges faced by California and the nation allow our graduates to address American society’s complex and challenging problems. We are particularly mindful of the character and content of our institutional identity and of the responsibilities that stem from it. We recognize that others look to us for leadership and for results.

The Baker Forum is an expression of how the University’s intellectual and social responsibilities are addressed by identifying a problem, articulating its nature, forging partnerships, and providing leadership. The pressing issues discussed at this Forum, which include the ethical challenges confronting our future leaders, the need for a well-educated and diverse workforce, and the importance of creating effective partnerships, not only have critical implications for the economic future of California and its citizens but also for the entire nation’s prosperity and security.

We at Cal Poly know that action without understanding has no meaning, just as understanding without action has no consequence. We are pleased, in this centennial year that the inaugural Baker Forum focuses on such important issues that require our deepest understanding and compel our wisest and most energetic actions. The Forum’s processes of applied and problem-based learning are captured in Cal Poly’s central tenet, “learn by doing,” the heart of our institutional identity.

The pressing issues discussed at this Forum, which include the ethical challenges confronting our future leaders, the need for a well-educated and diverse workforce, and the importance of creating effective partnerships, not only have critical implications for the economic future of California and its citizens but also for the entire nation’s prosperity and security.

Paul Zingg
Provost and Vice President for Academic Affairs, California Polytechnic State University
KEYNOTE ADDRESS

California at Risk:
The Imperative for Science and Technology Educational Reform
Susan Hackwood

BAKER FORUM HONOREE
Walter E. Massey
INTRODUCTION

It is a pleasure to be joined this afternoon by Walter Massey, who was the chair of the California Council on Science and Technology (CCST) before I became executive director.

The California Council on Science and Technology was established by state legislation and has been in existence for some time. At the state level, the Council’s functions are very similar to those of the National Academy of Sciences and the National Research Council.

The California Council includes 147 individuals who have been recognized for their contributions to the state’s science and technology sectors. The Council is composed of a 13-person board of directors, of which President Baker is a member; 30 stellar individuals who are leaders in industry and academia; and 104 fellows committed to public service.

Because our studies and final reports undergo a rigorous review process, the Council has a high degree of confidence that our recommendations will produce the necessary and desired changes when implemented.

CRITICAL PATH ANALYSIS OF CALIFORNIA’S SCIENCE AND TECHNOLOGY EDUCATION SYSTEM


Our new “Critical Path Analysis” establishes agreed-upon baseline measures for student flow through the entire California educational system, identifies the system’s strengths, weaknesses, and bottlenecks, and makes policy recommendations to increase the number of well-prepared students ready to join the science and technology (S & T) workforce.

WORKFORCE SHORTFALL AND CALIFORNIA’S EDUCATION SYSTEM

Let’s first define the problem, which our report analyzes.

The high-tech industry is crucial to California’s economy: If this industry were removed, the gross state product would resemble that of a Third World country. And yet California is not producing sufficient numbers of S & T workers, as evidenced by the high-tech industry’s increased reliance on imported labor. Nor is California training enough women and minorities to fill the shortfall in white male employees. Relying on workers from other states and countries is a poor business model and not a long-term solution for building a competent and necessarily diverse workforce in California.
The following chart (fig. 1) identifies the growth industries in California. (Our Council contends that the recent dot-com failures are only a temporary blip, that the U.S. economy as a whole was already undergoing change, and that these growth trends in California industry still hold true and will continue.) The chart indicates that state educational institutions will not produce enough graduates with baccalaureate degrees in a science or an engineering field to fill jobs projected between 1998 and 2008 in the different workforce sectors.

California’s workforce shortage is part of a wider national problem. Competing industrial countries are doing a better job in educating their populations, as indicated by the ratio of their 24-year-olds that hold science or engineering degrees (fig. 2). The United Kingdom, South Korea, Germany, Japan, and Taiwan lead the United States, which has not attained similar proportionate increases in degrees awarded to its own age-group population.

As the foundation of our report, our Council commissioned a series of studies by economists, public policy analysts, and social scientists, asking that they intensively analyze each component of California’s workforce and education sectors (fig. 3). These studies measured the demand for S & T workers; assessed the competence and effectiveness of K-12 teaching in science and math; examined the role of the universities and colleges; evaluated alternative paths to competency, such as continuing education; and investigated the problem of a digital divide.

The Council insisted on examining the shortfall between workforce needs and well-prepared graduates as a systems problem, realizing that the whole education system needs to be looked at in its entirety, both quantitatively and qualitatively, and that changing something at one point in the flow changes something somewhere else. We divided up the educational process into segments, to find out how students progress through the system to earn higher degrees, obtain continuing education, or enter the workforce. The report notes the number and achievement-level of the students, and the cause and effect of their movement through the system’s different pathways (fig. 4).

**K-12 SYSTEM**

In California, there are currently 6 million students in the K-12 system. The fastest growing ethnic group is Latino, which makes up 50 percent of kindergarten enrollment and 43 percent of high school enrollment. California’s spending per pupil has been among the lowest in the 50 states, and although that ranking has improved in the last year and half, California still suffers from a decade of under-spending on K-12 education. Science and math scores are among the lowest in the country, and California’s teachers are less well educated than are those in other states. Forty thousand California teachers have emergency credentials only, and an enormous number of teachers in science and math do not have degrees or preparation to teach in these areas.

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**PROJECTED GROWTH IN HIGH-TECH INDUSTRIES**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Additional Undergrads, 17,000/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Scientists</td>
<td></td>
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<tr>
<td>Computer Support Specialists</td>
<td></td>
</tr>
<tr>
<td>Computer Engineers</td>
<td></td>
</tr>
<tr>
<td>Data Base Administrators</td>
<td></td>
</tr>
<tr>
<td>Biological Scientists</td>
<td></td>
</tr>
<tr>
<td>Biotech &amp; Electronic Engineers</td>
<td></td>
</tr>
<tr>
<td>Data Processing Equipment Repairers</td>
<td></td>
</tr>
<tr>
<td>Math Scientists</td>
<td></td>
</tr>
<tr>
<td>Computer Systems Analysts</td>
<td></td>
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<tr>
<td>Air Enginner Specialists</td>
<td></td>
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<tr>
<td>Electronic Engineering Technicians</td>
<td></td>
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<tr>
<td>Aircraft Mechanics</td>
<td></td>
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<tr>
<td>Biological Agri. Food Tech</td>
<td></td>
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<tr>
<td>Computer Programmers</td>
<td></td>
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<tr>
<td>Data Entry Keyers/Ex Composing</td>
<td></td>
</tr>
<tr>
<td>Aeronautical Engineers</td>
<td></td>
</tr>
<tr>
<td>Computer Programmer Aides</td>
<td></td>
</tr>
<tr>
<td>Aircraft Assemblers, Precision</td>
<td></td>
</tr>
</tbody>
</table>

Source: State of California, EDD

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**RATIO OF S&E DEGREES TO THE 24-YEAR OLD POPULATION, BY COUNTRY**

<table>
<thead>
<tr>
<th>Country</th>
<th>1975</th>
<th>1997</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Germany</td>
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<td></td>
</tr>
<tr>
<td>Japan</td>
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<tr>
<td>Taiwan</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
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<td></td>
</tr>
<tr>
<td>China</td>
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</tr>
</tbody>
</table>

Source: National Science Board, Science and Engineering Indicators-2000

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**PROJECTS CONDUCTED:**

1. The Science and Technology Sector’s Demand for Workers
   Cecilia A. Conrad, Pomona College

2. A Critical Path Analysis of California’s K-12 Sector
   Julian Betts, UCSD

3. The Role of Universities and Colleges in California
   Lynne Zucker and Michael Darby, UCLA

4. Issues Impacting Baccalaureate Degrees in S&E
   CCST researchers with assistance from UC, CSU, and AICCU

5. Alternative Paths to Competency:
   Continuing Education and Lifelong Learning
   Mary Walshok and Carolyn Lee, UCSD

6. The Digital Divide
   Edited by Roger G. Noll, Stanford University
Our Council believes that improving K-12 education would vastly increase the flow of successful students through four-year institutions and into the science and technology workforce. Presently, the California Department of Education estimates the K-12 student attrition rate at 30 percent, while our own analysis puts the rate at 35 percent. For Latino students, K-12 attrition is nearer to 40 to 45 percent. California is losing enormous numbers of students between elementary and high school, and between entry to and graduation from high school. Students who do graduate are poorly prepared for college, and Latino students fare well below the norm: Only five percent of Latino 9th graders are able to start college without remediation.

A major aspect of California’s unsatisfactory K-12 education is the critical, acute shortage of qualified teachers in a system that doesn’t allow for the equal distribution of good teachers. Master teachers are not teaching in the schools where they’re most needed, and are not teaching those subjects students need most. In addition, the present system does not reward teachers: Teachers’ salaries are not competitive with those of equivalent-ly trained workers in other professions, and science and math teachers receive no more money than teachers in other subjects.

**Attitudinal Trends Among K-12 Students**
Beyond the obvious deficiencies in the K-12 system lurk troubling sociological trends that help account for too few students pursuing education and employment in the fields of science and engineering. Many contemporary students are not interested in science or engineering and among these students two discrete groups can be distinguished:

One group of students never considers careers in the fields of science or engineering. These careers are not an aspiration of their lower- or middle-income families and students do not understand why higher education is important or why they should pursue studies in S & E. Students are not aware that a high-tech career pays twice as much as a non-high-tech career, that in California the average yearly salary for those who have a baccalaureate in science and engineering is $70,000, while graduates in other disciplines earn an average of $30,000.

The other group of students uninterested in the fields of science and engineering are from wealthy families. These students reject a career in S & E because they imagine these disciplines to be boring and that the students who pursue S & E studies are out of touch with the mainstream of modern youth culture. A recent study of Silicon Valley students showed that students think their parents work too hard and have an unappealing lifestyle. That survey suggests that in California we are not doing a good job of marketing careers for students in science, engineering and technology.

We believe that parents in California need to be better educated about available opportunities in S & E studies and have a clearer understanding of how students prepare themselves for S & E careers. Many parents are not receiving the necessary information to advise their children about becoming members of the science and technology workforce.

**COMMUNITY COLLEGES**
There are currently 1.6 million students in the California community college system, but only a relatively small number
graduate with associate or certificate degrees, and of those, only 6,000 graduates in science or engineering. Each year, about 55,000 students transfer from community colleges to four-year institutions, although only about 10,000 major in science and engineering degree programs.

The community college system, which is misunderstood and often overlooked, has enormous potential to increase the number of well-prepared graduates for the workforce. The vast majority of faculty members at community colleges have at least a master’s degree and the quality of teaching is much higher than in California high schools. Community college transfer students do as well academically as other university students. Their grade-point averages are equal to or slightly better than those of students who begin four-year colleges as freshmen. And because most community college students are first-time students who attend part time, the community colleges provide an important gateway to educational opportunity for first-generation students.

Even though the number of community college students transferring to four-year schools is too low, as are the numbers of those students receiving S & E degrees, we believe that community colleges, by reaching a diverse population and by providing needed remediation, can be an important bridge between high school and four-year institutions.

Of special interest are programs like the Middle College Program, in which at-risk high school students attend 11th- and 12th-grade programs in community colleges, where they receive good instruction and can be groomed for transfer to four-year institutions. However, these special programs are limited by classroom capacity and laboratory space.

The important role of community colleges in preparing students for the workforce is hampered by woefully inadequate and under-funded counseling services that do not provide accurate and timely information about transfer to four-year institutions. In addition, community college faculty salaries are not competitive enough with those of other professions, and, as in K-12, teachers in science or other technical disciplines receive no higher salary than teachers in other areas.

**BACCALAUREATE SYSTEM**

The California baccalaureate system numbers almost 600,000 students. Each year about 19,000 students receive S & E degrees, 82 percent of them graduating from public institutions and the remainder from private colleges and universities. Although in many ways California leads the nation in science and technology, the state ranks only 9th in the number of science and engineering degrees produced per capita. California’s population is increasing, as is the total number of baccalaureates, but the number of students earning engineering degrees has decreased by about 13 percent over the last decade.

**University of California**

Our study takes note of the trend in baccalaureate degrees in biology, computer science, engineering, math, and the physical sciences at the University of California from 1990 to 2000 (fig. 5). While the number of baccalaureates increased during this period, the...
increase was concentrated in biology. Degrees in engineering did not rise but remained constant. Enrollments at UC were up, but graduation rates had not yet reflected the greater number of students. In the UC system the attrition rate for S & E majors is 20 percent. A positive fact that bears attention is that higher salaries for teachers in S & E have greatly increased the UC system’s ability to attract and retain top-quality faculty in the last few decades.

California State University
In the California State University System too there has been an increase in biology degrees, but the number of engineering degrees continues to decline (fig. 6). Only a few decades ago, the CSU was the primary producer of science and engineering graduates in California, but has now fallen behind UC. Attrition rates among S & E majors now average 66 percent and are even higher on some Cal State campuses. Engineering degrees granted by CSU fell 25 percent between 1900 and 2000. It is worth noting that CSU faculty, unlike teachers at the University of California, do not receive higher salaries for teaching S & E disciplines.

A LONGITUDINAL STUDY: 9TH GRADE THROUGH BACCALAUREATE
Our longitudinal study indicates how many 1990 9th-grade students ultimately received a baccalaureate degree in science and engineering (fig. 7). In 1990, there were about 380,000 9th graders in California, and in 1994 about 255,000 of these students graduated, a decrease of 30 percent in the size of the 1990 entering class. Of the 1994 graduates, only 43,000 enrolled in the UC and CSU systems (although 88,900 students met UC and CSU entrance requirements). Of the 43,000 UC and CSU students from the high school class of 1994, 13,600 enrolled in science and engineering degree programs, but only 8,300 graduated in those disciplines.

This longitudinal analysis identifies additional striking facts about California’s post-K-12 system, its attrition rates, and the source and numbers of its graduates ready to join the workforce.

The number of CSU students enrolled in science, engineering, and technology programs declined significantly. For example, of the 6,600 CSU freshmen enrolled in those disciplines in 1994, only 2,000 eventually graduated.
Of the 88,300 students who entered the community college system in 1994, only about 54,000 transferred to four-year institutions. However, our study estimates that about 10,000 of these transfer students majored in science and engineering degree programs at colleges and universities and that 7,700 of them obtained degrees in those disciplines. From these statistics, it is clear that community colleges are providing about half of the total number of California students who receive degrees in S & E.

Significantly, only about 4.4 per cent of 1990 9th graders ultimately graduated with baccalaureate degrees in science and engineering. Even more troubling, only about 1.5 percent of Latino students (a total of 1,600) received baccalaureates in S & E (fig. 8).

It is evident that demographic shifts in California’s population have placed new demands on our educational institutions to adequately prepare students to enter the S & T workforce. Between 1990 to 2000, the percentage of white students in high schools decreased (as it did in community colleges and universities); while at the same time the number of white high school students who graduated increased. Although the Latino population in high schools and community colleges rose after 1990, the number of Latino students who eventually attained a baccalaureate degree continued to decline (fig. 9).

Key Factors in S & E Baccalaureate Enrollment and Degree Trends

The stagnating or declining trends in S & E degrees in many fields can be explained by a number of different but related factors: We think that you need to educate the parents about available opportunities and what students need to do to get through the system. Many parents just don’t have the knowledge to advise their children properly.

Again, an inadequate K-12 system with too few teachers in math and science, especially in low-income schools, is a significant factor. K-12 counseling and library services are insufficient for students’ needs. Poor preparation in high school remains a major barrier: Students enrolling at CSU do not have the necessary math and science skills to succeed in their first few years of courses.

Too few students are transferring from community colleges. Increasing the rate of transfer of community college students is really worth exploring.

Improving college and university retention and graduation rates is an important objective. And importantly, university funding and budget formulas need to be revised to better reflect the higher cost of science and engineering degree programs. In addition, there is not sufficient targeted planning for S & E degree programs in our colleges and universities.
ADVANCED DEGREES

Master’s

In 2002 graduate schools in California awarded approximately 6,100 master’s degrees in science and engineering. Forty-five percent of these degrees were granted by private institutions. For many years, master’s degree recipients were compared unfavorably with their Ph.D. counterparts, but now in most areas of technology the master’s is the preferred degree and it continues to increase in importance.

While Ph.D.’s are vital in stimulating economic growth by pursuing research and development, graduates with master’s degrees are in greater demand in the industry workforce.

Unfortunately, fewer California students are earning master’s degrees, while non-resident aliens make up 35 percent of each year’s master’s recipients. (Indeed, this is the entry point into the education system for large numbers of non-resident aliens.)

Ph.D.’s

California is doing well in producing Ph.D.’s. Excellent schools graduate innovative professionals, and California has 12 top-ranked institutions with doctoral programs. While there is a current oversupply of Ph.D.’s in biology and physics, engineering doctorates and postdoctoral students enjoy a very low unemployment rate.

CONTINUING EDUCATION

The last component of our study is continuing education. There are twice as many California students in continuing education as there are in regular degree programs at UC, CSU, and private four-year institutions.

Our study found that people don’t enter continuing education in order to make drastic career changes: Californians don’t leave aerospace engineering to become multimedia technologists. Instead, students in continuing education are pursuing studies that are integral to their present jobs.

California doesn’t track the courses continuing education students take, and we believe that our workforce development programs are not correctly targeted to address continuing education in a fast-moving field like technology. The demand for continuing education provides a good measure of the requirements for regional industry growth and is a crucial indicator of economic development. California may not be sufficiently funding the right programs in this important sector of the education system.

REPORT SUMMARY

California is not graduating enough university students in S & E to meet workforce needs; the community colleges are not graduating sufficient numbers of S & E students who will transfer to four-year institutions and complete S & E degrees; and students from the K-12 system who do enter baccalaureate S & E programs require substantial remediation.

California must ensure that all K-12 students receive instruction from teachers qualified in the subjects that they teach. It is critically important to increase the number of community college students who transfer to four-year institutions.
Improving retention and graduation rates at UC and especially at CSU should be special objectives.

In addition, university funding and budget formulas need to be revised to better reflect the higher cost of science and engineering degree programs. Even if the K-12 and community college systems were immediately improved and the number of eligible S & E students increased, most California university campuses would not be prepared to handle the sudden influx of students. Building programs take years to set in motion and there is not presently the infrastructure to support future higher enrollments.

CONCLUSION

Let me end by announcing that our Council plans to use this report to develop policy recommendations that can be embraced by our political leadership and by our California education system. It is an established fact that California’s educational system is failing to adequately prepare students for science, engineering, and technological professions (fig. 10). Outstanding jobs in these fields are going to university graduates from other states and other countries, and California’s dependence on imported skills will confront the state with manifold disadvantages in the future.

RECOMMENDED GOALS
1. Increase student participation and achievement at each of the critical junctures throughout the California education system by (fig. 11)
   • Identifying what we can do at each juncture to increase participation.
   • Expanding student awareness of science and technology.
   • Hiring qualified teachers and adopting pedagogical methods that excite students and enable them to learn.

2. Target increases in bachelor’s, master’s, and Ph.D. programs at California’s universities (fig. 12).

3. Address resource adequacy problems related to the maintenance of our public educational programs.

4. Meet the challenge of continuing education by targeting programs more effectively.

Finally, we must remember that California’s education system is very complex and that we need to apply a systems engineering analysis in order to solve it’s many problems (fig. 13). All of us are just beginning to understand the interrelated problems that demand integral solutions.

The education system is a complex coupled process and should be compared to a product development process.

WE NEED A SYSTEMS APPROACH
Programs cannot be effectively reformed piecemeal.
Dr. Hackwood’s critical path analysis can provide a model for use on the national level to address what has become a nagging problem: Insufficient numbers of Americans are pursuing careers in science and technology. America’s scarcity of professionals in these fields seems to occur in cycles. Sputnik in 1956 was the first national awakening to the fact that too few Americans were being educated in science and technology and that the nation faced a serious lack of trained professionals in those technical disciplines. Dr. Hackwood’s presentation indicates that the scientific community has become more sophisticated in addressing America’s need for more scientists and engineers, but that there remain real problems to be solved.

I will comment briefly on three aspects of Dr. Hackwood’s presentation.

My first point concerns the importance of early childhood education. My very close friend, Leon Letterman, a Nobel Prize-winning physicist, likes to say, “All children are born scientists but they have it taught out of them.” By that he means that all children are born curious; they’re born with a desire to understand how the world works. But somehow, about the 4th or 5th grade, they begin to lose interest in subjects and ways of thinking that we would classify as “naturally” scientific.

Last year I served on a commission chaired by Senator John Glenn which did a comprehensive study of the barriers to improving children’s science and math education. Not surprisingly, the commission found that the greatest problem was a lack of high-quality teachers, a point Dr. Hackwood emphasized in her address. Teachers are not adequately trained in science and mathematics to confidently teach these subjects in ways that are exciting and interesting to students. Moreover, even well trained, committed teachers are unable to keep pace with current advances in science and math because there is no systematic approach to continuing education for teachers in K-12.

Senator Glenn’s commission further found a troubling lack of professionalism in America’s system of science and math education. Teachers do not have the support systems, the recognition, the compensation, and all of the other things that foster a sense of self-esteem and well being and that make teaching engineering or physics an attractive profession. The commission consequently recommended focusing on ways to retain in the profession those numbers of excellent teachers that we already have.

My second point concerns the universities’ responsibility for educating Americans in science and engineering. We in higher education have traditionally placed the blame for America’s insufficient number of scientists and engineers on our K-12 education system. Dr. Hackwood’s figures indicate that not all of the blame can be laid there. As Dr. Hackwood points out, each year we enroll in our universities about twice as many students interested in science and technology as we graduate in those fields. In the California State University system, the attrition rate in science and technology studies is over 60 percent. If we in the universities concentrate on finding ways to make sure that more entering students interested in those fields succeed in their studies, then we can increase the number of professionals in the sciences and engineering.

I’ve been impressed by a recent study by Elaine Seymour and Nancy Hewitt titled *Talking About Leaving: Why Undergraduates Leave the Sciences*. Seymour and Hewitt surveyed students who left science and technology after entrance to college. They
found certain common reasons for leaving among women and minorities, and that some of the reasons women and minorities remained in or left science and engineering degree programs were different from those of their white male counterparts. But Seymour and Hewitt’s most important conclusion is that the best way to attract and retain women and ethnic minorities is to address issues and conditions that dissuade all students of all racial and ethnic backgrounds from pursuing degrees in science and engineering.

The students that Seymour and Hewitt interviewed complained that they had been “weeded out.” These students perceived a widespread attitude among science faculty that only a few students are capable of succeeding in science and engineering degree programs, and believed that the faculty designed courses to weed out the majority while retaining the few.

I’ve heard this complaint from the time that I first entered higher education. I believe we haven’t adequately recognized that students learn in different ways and at different rates and that we must design courses to fit students’ differing learning requirements. We are now using technology to design courses that compensate for, or adjust to, the differences in the ways students learn, and this may be one promising method in solving some aspects of the “weeding out” problem.

Finally, I would like to comment briefly on the problem of diversity. We need to attract individuals from groups that have not been represented adequately. The reasons are pressing and practical, beyond America’s cherished creed of fairness and social diversity. The number of white American males entering science and technology studies, especially at the graduate level, is not increasing, but decreasing. As Dr. Hackwood pointed out, it is women who have entered the life sciences who account for the increased numbers of professionals in those fields. Indeed, women and members of minority groups account for practically all of the increase in the number of graduate-level science and engineering professionals, although increases in those professions have been very small over the last 10 years.

But I have yet another reason for arguing for diversity in science and technology. In addition to America’s human resource needs and America’s belief in equity and social justice, diversity is important for the health and vitality of science and technology themselves. Science and technology are inherently multicultural endeavors-scientific and technical interest, ability, and genius are not confined to particular racial, ethnic, or cultural groups. Historical evidence shows that individuals from a wide range of cultural and ethnic backgrounds have made invaluable breakthroughs in science. In my field of physics, for example, over the past 30 years Nobel Prizes have been awarded to scientists who are French, Japanese, Dutch, Russian, Pakistani, Indian, Italian, German, Swiss, Chinese, British, and American (which of course includes all of the above national and ethnic groups, and others). And the same pattern of diversity and excellence exists in other scientific fields.

Cultural and ethnic inclusiveness in science, engineering, and applied fields enriches the practice of science. Each individual brings a different viewpoint and perceives physical phenomena through a different lens of sensibility, thereby enriching and broadening the way that together we interpret and understand the physical universe.

In conclusion, let me repeat that I think the critical path analysis as outlined by

We need to attract individuals from groups that have not been represented adequately... Science and technology are inherently multicultural endeavors-scientific and technical interest, ability, and genius are not confined to particular racial, ethnic, or cultural groups. Historical evidence shows that individuals from a wide range of cultural and ethnic backgrounds have made invaluable breakthroughs in science.

Walter E. Massey
President, Morehouse College

[518x750]COMMENTARY
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**Walter E. Massey**  
*President, Morehouse College*

Dr. Hackwood is an exceedingly important study, one that will be useful not only for California but for the rest of the United States. You might say that once again California leads the way.
As a CEO whose business depends on an available pool of well-trained professionals, I don’t believe that the current economic downturn and the bursting of the dot-com bubble, or any of the other changes in the tech market, decrease America’s need for more university graduates in science and technology. I don’t believe that the present cyclic downturn in the economy and the temporary decline in high-tech jobs solve the shortage of trained professionals. However, there is a growing possibility that present economic conditions will deter many students from entering technology fields.

When I spoke at Stanford University three years ago, the discussion was concerned with how to start a company, how to invent the newest technology, and how to instantly become a CEO. When I spoke again there recently, the discussion was about how to get jobs.

I am concerned that the economic downturn and the resulting high unemployment in Silicon Valley will cause some students to delay or refrain from entering science and engineering study, and that the supply of future well-trained professionals will be limited.

Dr. Hackwood raised a few points in her keynote address that deserve comment. My comments reflect two perspectives: first, as a CEO of a high-tech company, an industry perspective; and, second, as a father with two young children in public schools, a concerned parent’s perspective.

Dr. Hackwood indicated that California needs to produce 17,000 more graduates a year to fill jobs in science and engineering fields that are either unfilled or held by foreign workers. As a leader of one of the top ten software companies in the world, I face the problem of a shrinking workforce. Indeed, the core concerns in our day-to-day strategy at Veritas are how to hire, train, and retain the best talent in the industry. The pool of college graduates in computer science from which we hire software engineers has noticeably decreased in size. How to increase the number of qualified graduates is a problem all of us must solve and a special challenge for CEOs who want their companies to grow.

As Dr. Hackwood’s research showed, America’s workforce gap in science and technology has its roots in the K-12 system. As a concerned parent, I am aware that there is a shortage of qualified teachers. It’s a strange anomaly that even in the heart of Silicon Valley we don’t have enough technically literate instructors. I believe that the necessary technology is available, but that the educational environment is not conducive to successfully making it available to students.

Part of the problem in training and maintaining sufficient numbers of qualified teachers in science and technology is that teachers’ salaries are not competitive with those in other fields. Indeed, many competent teachers look for better-paying jobs outside of teaching. The cost of living, rather than a lack of interest in teaching science and technology, is driving many good instructors out of our schools.

The report that Dr. Hackwood commissioned also showed that 40 percent of California teachers hold a master’s or more advanced degree. However, I don’t know...
Industry needs to help. Industry must be alert and forward-looking in making investments in education. It must take into account the pace of technological advance, national and worldwide economic trends, and the overall competitive landscape. The role of industry has to be defined with a clear engagement model and a clear understanding of what our schools and universities need.


Gary Bloom
Chairman, President and CEO, Veritas Software and Member, Cal Poly President’s Cabinet

of any teacher in my son's school who has a master's degree. I believe that our schools need to attract more graduates in science and technology to teaching and that more of our teachers should have advanced degrees.

The community college system also has difficulty in attracting well-trained teachers, and lacks a differential salary scale for science and engineering instructors. Another area of concern, as Dr. Hackwood’s report showed, is the inadequate funding for the expansion of UC and CSU science and engineering degree programs.

I have to conclude, without sarcasm, “it's all about money.”

In the high-tech industry, what do we do when we need talent and can't find it? We raise salaries. We increase the money we spend on attracting talent. At Veritas, we don't produce more and better software by spending less, but by hiring more people and spending more money. As in business, in education everything has its cost. California has to allocate greater funds or raise tuition fees so that the universities can spend more in attracting and training our future scientists and engineers and teachers. If we need more science and engineering degree programs in the universities and especially in our K-12 programs, we must spend more, realizing that money plays a critical role in improving science and technology instruction.

Industry needs to help. Industry must be alert and forward-looking in making investments in education. It must take into account the pace of technological advance, national and worldwide economic trends, and the overall competitive landscape. The role of industry has to be defined with a clear engagement model and a clear understanding of what our schools and universities need.

Indeed, in business the lack of a business plan - the lack of a strategy - almost always leads to failure, as evidenced by the recent dot-com collapse. Very few dot-com companies had business plans or well-thought-out business strategies. Business must be very disciplined and far-sighted on entering into a partnership with our public education system to increase America's science and technology workforce.

Future rewards are dependent on the investments we make today. Partnerships between industry and education are the key to increasing the quantity and quality of science and engineering graduates. The term "partnership" in the high-tech field is an overused and misused term and too often is a euphemism for marketing "fluff" or "feel-good relationships" that ultimately accomplish little. Industry and university partnerships must be grounded in agreed-upon, tangible goals that lead to collaborative working relationships aimed at increasing the professional workforce. These partnerships can take many forms, including joint research projects, cooperative studies, guest lectureships, exchange programs, and technology round tables.

Industry must be visible in the universities, and the universities must be visible in industry. Industry can support universities by loaning staff, by hiring university faculty and students as project consultants, and by supporting academic advisory boards like President Baker’s Cabinet. Industry representation on curriculum committees will ensure that the universities know the kind of training a successful workforce needs. Business leaders also need to expand their relationships with students, increase their participation in career centers, and advise and assist university administra-
tors. Industry must have multiple touch points in the university system.

The Baker Forum is a good start in encouraging the partnership between industry and the universities to improve and increase training in sciences and technology in our school systems and to produce America’s future technical professionals. Indeed, open and honest dialogue is often the basis for inspired ideas and new approaches. Sustaining this dialogue is essential during this period of economic downturn and international conflict. As a Cal Poly graduate, I’m especially honored this evening to have been able to deliver these comments at the Baker Forum. I was a student here 20 years ago, when Dr. Baker and his wife, Carly, first arrived at Cal Poly. I hope that in some small way my comments will lead to better industry-university cooperation to improve our children’s education and to make the investments today that will ensure a thriving science and technology industry in the future.

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Gary Bloom
Chairman, President and CEO,
Veritas Software and Member,
Cal Poly President’s Cabinet
In the occasion of the 2002 Inaugural Baker Forum, Cal Poly was pleased to join with the California State University and John Wiley & Sons, Inc. to honor Walter E. Massey’s distinguished leadership in science, his outstanding contributions to higher education and his continuous support and mentoring of minority students.

**Honorary Doctorate of Science**

Conferred by the California State University and California Polytechnic State University, in recognition of Walter E. Massey’s outstanding accomplishments as a scientist, educator, administrator and public advocate for science and engineering. The California State University was represented by Board of Trustees Chair, Laurence K. Gould, Jr. and by Trustees, Roberta Achtenberg and Harold Goldwhite. President Warren J. Baker represented Cal Poly.

**Wiley Lifetime Achievement Award**

John Wiley & Sons, Inc. has generously established the Wiley Lifetime Achievement Award, which recognizes a national leader whose work exemplifies extraordinary leadership and lasting contributions to American higher education and public life.

Walter E. Massey, ninth president of Morehouse College, is a nationally recognized scientist, educational leader, innovative administrator, and passionate advocate for mentoring students in science and math education.

Following receipt of the Ph.D. in physics from Washington University in St. Louis, Massey held a variety of academic and administrative positions, at the University of Illinois, the University of Chicago, Brown University and the University of California System, where he served as Provost and Senior Vice President for Academic Affairs. In his present role as President of Morehouse College, he leads the nation’s only historically black, all-male, four-year, liberal arts college, an institution with a long tradition of producing outstanding leaders.

Under former President George Bush, Massey served as Director of the National Science Foundation, the government’s lead agency for support of research and education in mathematics, science and engineering. At the National Science Foundation he promoted interdisciplinary collaboration and worked vigorously to improve scientific and technical education and increase the number of minorities and women in these critical fields. As he once observed, “we need to stress more that there is a joy in teaching, formally and informally in guiding, mentoring, watching others grow and knowing you have contributed to that growth and development . . .”
Massey has also served as President and Chairman of the American Association for the Advancement of Science, Vice President of the American Physical Society and a member of the National Science Board. He was recently appointed by President George W. Bush to serve on the President’s Council of Advisors on Science and Technology.

Massey has received numerous awards including the Outstanding Educator of America and the Distinguished Service Citation of the American Association of Physics Teachers, the Archie Lacey Award of the New York Academy of Sciences, the Golden Plate Award from the American Academy of Achievement and the Bennie Trailblazer Award from Morehouse College. He is also the recipient of over 20 honorary degrees from institutions such as Washington University, Amherst College and Yale University.
PANEL DISCUSSION

The Future of Polytechnic & Science and Technology Universities
Pictured previous page: Baker Forum Panel, left to right: Keith Uncapher, Gary Bloom, Diana Natalicio, Susan Hackwood, David Goodstein and Joseph Bordogna
Panel moderator, Paul Zingg began the discussion by suggesting to the panelists that a high-tech economy demands a workforce with skills like those of the riverboat pilot in Mark Twain’s *Life on the Mississippi*. A good pilot must know the capabilities of the boat, anticipate problems, and adapt to the changing conditions on the river.

Joseph Bordogna agreed that the riverboat captain is an apt metaphor to emphasize that students must acquire a systems perspective and learn to anticipate the social consequences of designs looming just beyond the bend:

You have to know where you’re going on the river. And you have to know what your business is, why the ship is going up and down the river. You have to know the intent of the whole system that you’re working in. We have to teach modern engineers to make excellent things, but also to have a sense of the right thing to do.

We need an educational system that educates students to think of the consequences of their designs before they start them. In particular, students need to think of the unintended consequences of their finished work.

Bordogna added that successful preparation for the science, engineering and technology workforce requires that students develop the ability to “face open-ended situations,” and that this demands an interdisciplinary understanding.

Students must constantly learn, from day one of their freshman year, how to handle open-ended issues and ambiguity, how to correlate chaos and put constraints around it, and to understand that uncertain, often changing problems and questions have always shaped the terrain of work in science and engineering. As we begin the 21st century, it is imperative that students are able to skillfully and ethically process complicated situations and that they realize that their work requires a knowledge of and sensitivity to those social, moral issues to which we all owe awareness and responsibility.

Gary Bloom responded to Zingg’s metaphor of the riverboat pilot, noting that the recent dot-com debacle showed that young executives possessed technical skills but lacked planning and analytical capability and foresight. Bloom pointed out that many young executives weren’t proficient in bringing products online and in correctly estimating the initial costs that the investment market would bear. They tended to be slow and inefficient in adapting to changing market conditions. Bloom observed that the best workforce would possess both excellent technical and analytical skills, but that unfortunately this desirable workforce hasn’t yet emerged.

It’s the workforce we don’t quite have yet. We haven’t had it in the dot-com era, and we don’t have it in traditional companies. A large number of executives at most large companies do not have the necessary anticipation or adaptability. They’re not adjusting to the changing times rapidly enough. Our problem lies in closing the workforce gap is not just a matter of closing the gap between Haves and Haves Not. It’s not just about social capital. It’s about perspective and lenses, and bringing to these conversations-bringing to our boardrooms, bringing to the places where decisions are made about the technologies that are chosen and applied—the benefit of diversity . . . .

**Paul Zingg**
Provost and Vice President For Academic Affairs, California Polytechnic State University
We need an educational system that educates students to think of the consequences of their designs before they start them. In particular, students need to think of the unintended consequences of their finished work.

Joseph Bordogna
Deputy Director and Chief Operating Officer, National Science Foundation

the difference between the workforce we have and the workforce we want.

In asking President Diana Natalicio and the other panelists to respond to Bloom’s description of the present workforce, Zingg underscored President Massey’s commentary on Susan Hackwood’s keynote address by stressing that closing the workforce gap is not just a matter of closing the gap between Haves and Haves Not. It’s not just about social capital. It’s about perspective and lenses, and bringing to these conversations—bringing to our boardrooms, bringing to the places where decisions are made about the technologies that are chosen and applied—the benefit of diversity.

Natalicio noted that the University of Texas at El Paso (UTEP), “like many institutions for many years,” had “defined itself in a way that was absolutely unrealistic for its setting, for its mission.” Natalicio realized, when she became president in 1988, that “we didn’t know who we were and, most importantly, we didn’t understand whom we were serving.” When UTEP analyzed its student population, it was discovered that 85 percent of students were from El Paso and were predominantly Latino. For a long time, UTEP had criticized the local schools for failing to prepare students for college-level work, until UTEP understood that it could improve student preparation by entering into a partnership with the school districts, the community college, chambers of commerce, and local government.

Natalicio described the essential features of the El Paso Collaborative for Academic Excellence, outlining the partnership’s aims and accomplishments:

What’s been most important has been raising the expectations of these young people, and of their parents, their teachers, and their counselors as to what these students can do and be. We have learned that many young people at a very early age are trapped into underachievement because we make negative assumptions about what they can do. This illusion that only certain select people can succeed in science and math has led to a tremendous squandering of young talent. We’re trying to turn that around, we’ve achieving a lot of success, but we’re not there yet—it’s a work in progress.

In outlining his thoughts on the special challenges in preparing students for the emerging workforce, David Goodstein challenged the appropriateness of the riverboat and pipeline metaphors as they applied to training in science, engineering, and technology.

Goodstein noted that the riverboat captain was unlikely to have had a formal education and would not have adapted easily to new transportation technologies such as trains and trucks. Goodstein contended that the pipeline metaphor is misleading because it implies “a very leaky pipeline that starts with a torrent of bright, eager young people—natural born scientists,” as Leon Letterman has described them—and winds up as a mere trickle of technically trained people.

Goodstein argued that the education and recruitment of scientists is more like an “active mining and sorting operation”:

Those of us who are technically trained sort through the human
debris which comes our way, looking for diamonds in the rough that can be cleaned and cut and polished into glittering gems just like ourselves.

Goodstein suggested that scientists themselves must take responsibility for the poor results of this winnowing process.

Bordogna then noted that the National Science Foundation recently substituted the word “pathway” for “pipeline”:

A pipeline is sort of a negative thing—it leaks, and yet the metaphor of a pathway to the future suggests that there may in fact be various pathways, each with many gates that have to be opened to allow entrance to a range of students with differing backgrounds, skills, and levels of preparation.

Zingg asked Keith Uncapher whether the events of September 11th and the resulting increased public awareness of the critical importance of a skilled S & T workforce paralleled earlier concerns about education and the workforce following the discovery of nuclear power and the successful Russian launch of Sputnik.

Uncapher concurred that Sputnik had shocked the Department of Defense, whose leaders then established the Defense Advanced Research Project Agency (DARPA) in the late 1950s. A visionary psychologist, J. C. R. Licklider, was appointed to head the Information Processing Techniques Directorate of DARPA. Licklider helped create several computer science departments in major universities. These departments channeled the energies of their faculty and graduate students into the development of new information technologies and communication systems for the Air Force. DARPA supported university contractors in the fabrication and testing of early chip and software designs that later became the basis for the Internet.

Uncapher cautioned that the current, post-September 11th environment poses a new challenge to the Department of Defense:

> What we lack today is a robust economy, one capable of sustaining a large investment in new military applications with civilian spin-offs.

Uncapher further noted:

History shows that the earlier work of DARPA was largely responsible for the technology that fueled our industrial economy. But before 9/11, we had not made a substantial research investment since 1986. From 1986, and until just recently, DARPA has failed to refurbish the supply of technology which is useful to private enterprise in this country.

Uncapher pointed to the development of nano-scale computers and micro-electrical mechanical systems (MEMS) as a promising area of new research. He predicted that these devices would begin a revolution in the methods of measurement in the microphysical world, a change comparable to the revolution in interpersonal communication made possible by the Internet.

Contending that scientific change cannot

![Keith Uncapher, Senior Vice President, CNRI](image-url)
The key issue is not the amount of money that’s put into innovation, but the amount of leverage that comes from those funds . . . . And to achieve leveraged outcomes from industry partnerships with education, what we need is a university-funded development office whose job is to foster such partnerships.

Gary Bloom  
Chairman, President and CEO Veritas Software

be separated easily from political change, Zingg asked Bordogna to respond to a provocative statement by Bill Joy, chief scientist of Sun Microsystems. Joy wrote:

Failing to understand the consequences of our inventions, while we are in the rapture of discovery and innovation, seems to be a common fault of scientists and technologists.

Bordogna acknowledged that at a recent workshop Bill Joy and he had taken opposite positions. Bordogna argued that one way to combat the “double-edged sword” of technological innovation and its social consequences is to make instruments of science “ubiquitously accessible to all meritorious proposals.” Bordogna singled out the terascale computing system that Uncapher mentioned, explaining that the National Science Foundation will make that technology “accessible to the Haves Not as well as the Haves, so all meritorious proposers will have the tools.”

Zingg recalled that Shirley Jackson, the President of Rensselaer Polytechnic Institute, had also spoken of a “double-edged sword,” but that her reference had been to the relationship between technological progress and the role of the marketplace.

Bloom responded that in bad economic times we often overlook the important relationship between the pace of and need for technological innovation and the rate of market application. Bloom pointed out that in Silicon Valley, at the height of the dot-com frenzy, many of the innovations funded by venture capitalists and investment bankers did not generate immediate returns. He stated that today the market has dramatically shifted and firms must show that they are innovative and profitable. Bloom recalled that firms were once rewarded for being ahead of their time, but that “today that’s almost a liability.” This short-run strategy, Bloom warned, has long-term repercussions:

If you don’t fund projects on the basis of their two- or three-year potential but focus on their present lack of revenues, I think the innovation curve is going to stall out on us. I think there is some stalling of that innovation curve right now. And that poses a very dramatic risk to our economy and the leadership position that we have in technology.

Zingg stated that a theory proposed by Paul Romer, a Stanford economist, had recently attracted much attention. Romer believes that providing financial incentives for universities will increase the supply of well-educated scientists and engineers and thereby help sustain the pace of industry innovation. Zingg added that Congress has appropriated $5 million for Tech Talent legislation sponsored by Representative Sherwood Boehlert and Senator Joseph Lieberman and based on Romer’s theory. In reference to Romer, Zingg asked the panelists if it is possible, feasible, and desirable for the federal government to “buy innovation or buy innovators.”

Bloom expressed his skepticism about purchasing “intellectual capital.” He insisted that adequate “incentives for innovation” were not at the “heart of the problem”: The key issue is not the amount of money that’s put into innovation, but the amount of leverage that comes from those funds . . . . And to achieve leveraged outcomes from
industry partnerships with education, what we need is a university-funded development office whose job is to foster such partnerships.

Bloom then stressed that educational institutions must take the lead in leveraging partnerships with business.

Goodstein shared Bloom’s reservations about Romer’s theory. Goodstein was recently asked by a reporter from the Chronicle of Higher Education to comment on a paper by Romer. The reporter informed Goodstein that Romer had observed that it was more expensive to train scientists and engineers than liberal arts majors, and that Romer claimed “administrators in colleges are siphoning people away from technical subjects into liberal arts, because liberal arts are less expensive.” The reporter noted that “Romer believes the solution to this problem is to give the schools incentives to train more scientists and engineers.”

To the reporter, Goodstein expressed reservations about Romer’s explanation for falling enrollment in technical studies. Goodstein argued that every department, including science departments, seeks to increase the number of its majors, and he denied that there is any mechanism by which students can be siphoned from one department into another.

Susan Hackwood concurred with Goodstein. She had circulated Romer’s article to members of the board of the California Council on Science and Technology, and “the response we got [to Romer’s theory] from just about everybody [on the CCST board] was basically the same thing: ‘Money is not going to solve the problem.’”

Returning to his earlier point, Uncapher stated that a more effective way for government to promote innovation is to create a national infrastructure that enables faculty and graduate students to create new designs that can be fabricated and distributed at low cost. This strategy has enabled inventors and designers to launch their own businesses, such as Sun Microsystems and Silicon Graphics. Uncapher predicted that the development and application of nano-scale technology and micro-electric measurement systems (MEMS) also would depend on government-supported infrastructure. He pointed out that polytechnic and science and technology universities will play an important role in the “melding” of various disciplines (e.g., chemistry, biology, and the social sciences) to encourage development of these new technologies.

Bordogna agreed with Uncapher that government should build an infrastructure that facilitates learning and promotes creativity. Bordogna indicated that this view was consistent with Bloom’s “generic” point about how to best use government money. Bordogna noted that the National Science Foundation is pursuing this strategy in a program called “Partnerships for Innovation,” which allows applicants to compete for funds if they are willing to form collaborative arrangements. He observed that the NSF has generated some “spectacular ideas” by enabling partnerships that are “infrastructure related.”

Bordogna’s comments prompted Bloom to further clarify his views about the strategic role of funding. Bloom acknowledged that once university-industry partnerships have been formed and programs are under way, funds are needed to sustain them:
The partnerships that we have to build must reflect a willingness to believe, and at a very basic level to change our attitudes about who can do science, who can do engineering, who can do math. I believe that there is talent everywhere, that it crosses gender and ethnic and geographic and socioeconomic boundaries, and that what we’re doing is squandering talent.

Diana Natalicio
President, University of Texas, El Paso

There are going to have to be more professors; professors are going to have to be paid well enough so that they remain at their posts; there are going to have to be more laboratories and the physical infrastructure costs are going up.

Bloom then added a caveat:

There is a money equation, but I don’t think money itself is the central incentive to drive the interest or drive the activity.

Zingg observed that the discussion had returned to a point that former President’s Cabinet chair, Don Fowler had made earlier when he said that the President’s Cabinet at Cal Poly represented “a partnership community in a very real way.” Zingg praised the Cabinet, noting, “What they have done for this university represents engaged, informed commitments.”

Zingg next asked President Natalicio if she would expand on one of her previous points, her belief that “successful and effective partnerships include all the key players in the education of children, including civic and business leaders, and, most importantly, parents.”

Natalicio first expressed her excitement with the ideas being discussed concerning discovery and invention. However, Natalicio admitted that she was “struck by the disconnect between this conversation and what Susan Hackwood discussed in her keynote address, about how we’re not preparing the next generation of young people to experience that excitement and to be a part of it, to become stakeholders in it.”

While acknowledging that “money isn’t everything,” Natalicio argued that the “model we currently have isn’t working.” She stressed that good teachers are leaving the profession and they are not being replaced. In addition, she emphasized that the demography is changing, and that there are increasing numbers of immigrants who lack education: “In Texas, nine out of 10 future Texans will be minorities and seven of those nine will be Latino.”

Natalicio suggested that educators and industry leaders must do more to reverse teacher attrition and to meet the growing educational needs of minority groups and new immigrants:

The partnerships that we have to build must reflect a willingness to believe, and at a very basic level to change our attitudes about who can do science, who can do engineering, who can do math. I believe that there is talent everywhere, that it crosses gender and ethnic and geographic and socioeconomic boundaries, and that what we’re doing is squandering talent.

Somehow, we have got to change the way people think about each other. And somehow we have got to begin to believe that everyone really does have the potential to contribute. We don’t really believe that now, as a society. But we’re all stakeholders in our society, which is a partnership. What will happen in the future, if we...

1 In introductory remarks before the Panel discussion, Don Fowler noted that the President’s Cabinet has provided vital leadership in representing the special needs and interests of Cal Poly and the California State University System before federal and state officials. These efforts have resulted in increased understanding and support for Cal Poly’s special mission in preparing students for jobs in the S & T workforce.
don’t believe in the human potential that we have, whatever its color or gender or socioeconomic level?

This is not about charity, it’s not just about social capital-it’s about us as people and how we think about our future. I believe partnerships are absolutely critical and I think higher education has a very important role, because we are the connection between the professional community and the rest of society. We are the link. We can do a lot more than we have done in encouraging everyone to become believers in the potential of all our people.

In the general discussion following the panelists’ remarks, Jaime Oaxaca indicated that California, like Texas, is facing a demographic challenge that is putting tremendous pressure on K-12 to successfully educate an increasingly diverse and needy population. Latinos face particularly difficult challenges, Oaxaca stressed, because they lack effective political representation and strong community support. Oaxaca congratulated President Natalicio for her efforts in El Paso and indicated that similar but frustrating attempts have been made in Los Angeles “to stimulate that kind of relationship between universities, community colleges, K-12, and the citizens and local elected officials.”

Oaxaca emphasized that an effective way to break the cultural cycle of failure is to make child rearing and education “process driven.” Oaxaca added that “This requires that you address the problems very early on, and that you address those issues along the whole continuum of education.”

President Natalicio expressed her belief that one of the problems that contributes to the reluctance of universities to get involved in K-12 issues is that higher education is driven by the desire for prestige:

Institutions that are not ‘trendsetters’ but ought to be on the front lines in improving K-12 education are reluctant to become involved because there’s a fear that their efforts in this vital area will reinforce perceptions that they are not ‘prestigious’ institutions. At least, that is how many institutions view involvement in K-12 education. Somehow we’ve got to escape this pressure for prestige.

Intrigued by the panelists’ varied observations, Peter Wiley asked panelists “to see around the corner and assess the efforts that have been made in the K-12 area and tell us what works and what doesn’t work.” He asked President Natalicio to respond first by describing the El Paso Collaborative for Academic Excellence and indicating what progress it is making.

Natalicio noted that she chaired the board of the Collaborative, which included superintendents of school districts, the president of the city community college, the mayor, representatives of chambers of commerce, and the county judge. The university conducts workshops that make parents aware of opportunities for college financial aid. In addition, workshops for continuing professional education are offered in science curriculum for K-12 teachers and are taught by faculty from the University of Texas at El Paso. She explained that each new faculty member at UTEP is offered free Spanish lessons and is
Goodstein urged that efforts be mounted to both “revolutionize” and “professionalize” teaching. He argued that this would require that teaching be made “a sufficiently attractive profession that young people would be willing to undergo the difficulties of a serious scientific and technical education . . . .”

David Goodstein
Vice Provost and Professor of Physics,
California Institute of Technology

Bordogna added that the National Science Foundation was involved in supporting projects such as the Collaborative, and in finding out what programs work best where and why. He said that he and his colleagues favor an experimental approach, because there are many different local cultures and diverse ways to engage universities, industry, and K-12 in partnerships. “We should allow for different approaches,” Bordogna urged. “Trying to force every situation into one mold doesn’t work.”

Bordogna announced that the NSF has been given the science and math partnership portion of President Bush’s “No Child Left Behind” legislation. The planned investment is $200 million a year for five years to find “prototypes and best practices” and to enunciate the principles that have guided them and made them successful.

Goodstein expressed his admiration for President Natalicio’s leadership and stated his personal support for the NSF initiatives. He stressed that the one central problem that requires more attention is the current status of the teaching profession in the United States. Goodstein urged that efforts be mounted to both “revolutionize” and “professionalize” teaching. He argued that this would require that teaching be made “a sufficiently attractive profession that young people would be willing to undergo the difficulties of a serious scientific and technical education . . . .” Goodstein recommended that teachers be given more pay, professional respect, and independence.

A participant from the audience stated that he had graduated from Cal Poly in architecture in 1972. He attributed his successful academic career to the continuous encouragement and advice that he received from his parents, grade school teachers, and Cal Poly professors. He emphasized that the mentoring he received throughout school made a tremendous difference in his attitude and performance and carried forward into his professional career. He has worked closely with school board officials in his former school district and has pushed tirelessly for better compensation for teachers, especially for those who work closely with parents and their children to ensure that students fulfill their academic potential.

Zingg then brought the panel discussion to a close:

There can really be no final word or final question. This is an ongoing conversation and we are all in midstream, at best. But let me leave this session with one more quote. It’s a little dated, in terms of political correctness and reference to gender, but I think we can forgive Albert Einstein for that.

Concern for man himself and his fate must always form the chief interest of all technical endeavors, concern for the great, unsolved problems of the organization of labor, and the distribution of goods, in order that the creations of our mind shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.
Ethical Challenges
Fueling the Pipeline
Business/Industry Connection
After the Baker Forum Panel, Forum participants, meeting in three breakout sessions, considered issues and questions related to the Forum theme, “The Future of Polytechnic & Science and Technology Universities.” Forum attendees then reconvened in general session to hear reports and recommendations from each of the breakout groups. President’s Cabinet Vice Chairman, Dick Hartung, introducing the reports, shared these remarks.

Before we begin the session summaries, I would like to acknowledge two former members of the President’s Cabinet who have assumed important positions in the Bush administration. Joe Jen, former Dean of the College of Agriculture, who is here today as a participant, is Undersecretary of Agriculture for Research, Education and Economics—a very important job in Washington. And Joe’s boss, who is not here but is another former President Cabinet’s member, is Ann Venneman, who is the Secretary of Agriculture. So two of Warren Baker’s cabinet members have moved on to another cabinet, and we recognize their accomplishments.

The Baker Forum was designed to enable participants to candidly discuss and analyze, in concurrent breakout sessions, how polytechnic and science and technology universities can:

• effectively respond to key ethical challenges,
• adequately prepare a diverse generation of students for the S & T workforce, and
• creatively explore the opportunities for forging business-industry partnerships.

I think the participants in each session succeeded in formulating thoughtful recommendations.

The participants in each session designated a representative to summarize their findings and recommendations. Bob Leach presents his summary of the session on ethical challenges first, followed by Jaleh Daie on fueling the pipeline and finally, Steve Giesinski on the business and industry connection.
ETHICAL CHALLENGES
How do we define the social and ethical responsibilities of PS&T institutions?

Our breakout session first examined whether graduates from polytechnic universities who enter industry have the necessary awareness to ask hard questions about issues of social and ethical responsibility.

Session members concluded that although ethics, per se, cannot be taught in a university environment, students can be shown examples of ethical and unethical conduct and become aware of the kinds of challenges and dilemmas they may encounter in their professional careers. Students can learn to pose better questions about, and to be better prepared to meet the various problematical situations they will face in the working world.

Our panel recommends that science, engineering, and other Cal Poly departments collaborate to present a series of case studies in the classroom or in colloquiums. These case studies should deal with real issues that graduates are likely to confront. Cabinet members have made ethical judgments in the course of their careers and their experiences could serve as valuable learning tools, moving the dialogue beyond a theoretical discussion of ethics and enabling students to “learn by doing.”

We then examined the university’s ethical responsibility in helping students succeed academically.

Breakout session members believe educators need to better anticipate students’ and parents’ expectations of what a university education will provide. The university needs to convey its commitment to helping students gain a successful education, while adjusting its educational strategies to respond to changing student attitudes and expectations and changing professional demands.

For several decades, Alexander Astin, director of the Higher Education Research Institute at UCLA, has been tracking the attitudes of incoming freshmen. His surveys have established that students’ attitudes and interests have indeed changed. We believe that studies like Astin’s establish “expectations baselines” and provide indicators the university can use in better responding to the circumstances, needs, values, and attitudes of incoming students.

Our group also discussed how universities have their own ethical challenges that are related to workforce development: Participants were particularly concerned on learning from Susan Hackwood’s keynote address that 60 percent of students who study for careers in science and technology are weeded out before graduation.

We recommend that polytechnic and science and technology universities send all incoming freshmen a letter that clearly states the university’s commitment to, and expectation of, new students successfully completing degrees in science, engineering, and/or technology programs.

Session participants, including our academic colleagues, candidly acknowledged that “weed-out” thinking persists in the universities. Participants pointed out that this strategy can be harmful to students’ self-esteem and their subsequent educational achievement, and that these negative results of “weeding out” have long-term detrimental consequences for both students and institutions.
President Natalicio’s initiatives at UTEP were singled out as showing promise in increasing retention and graduation rates by helping minority students overcome personal challenges and respond successfully to degree course requirements. One of our panelists from outside the United States, José Zaglul, indicated that 82 percent of students in science and engineering degree programs at EARTH University eventually graduate. These students come from around the world and from an incredible variety of educational backgrounds.

We believe that there is absolutely no reason why other polytechnic and science and engineering universities can’t also increase their retention and graduation rates. Universities must aim for a 100-percent delivery on their original commitment to incoming students. Obviously, such an ambitious goal requires changes: Universities need to create more mentoring and support structures, tasks that our breakout session participants and Cabinet members are ready to aid in, in whatever ways we can.

Finally, we discussed the need for a Cabinet member to report to our session members on Cal Poly’s progress in preparing students for the ethical challenges they may encounter in their professional careers, and in fulfilling a university commitment to aid incoming students in science, engineering, and technology in successfully pursuing their studies. We believe a report on progress should be made in the near term and another in a year from now. We also recommend that a quarterly report be sent to Baker Forum participants indicating how Cal Poly is responding to the breakout session recommendations. Our session members are willing to report back to all Forum participants on our own progress in reaching these goals.

**RECOMMENDATIONS:**

**Fostering Professional Integrity and Social Responsibilities**
- In classrooms and/or colloquiums, use real case studies which set forth real ethical issues.
- In assembling and developing instruction materials, draw on Cabinet members’ experience in facing ethical challenges in the professional world.

**Mechanism for Tracking Changing Student Attitudes and Needs**
- Conduct surveys to find out what motivates students to major in science and engineering, and gather timely information about their attitudes and desires.
- Consult Alexander Astin’s UCLA studies of changing student attitudes.
- Create a “letter of commitment” and send it to each new, incoming student.
- Eliminate “weed-out” thinking.
- Create mentoring and support structures.
- Target 100-percent degree completion.

**Tracking and Follow-Up**
- The President’s Cabinet should report on progress toward goals.

... students can be shown examples of ethical and unethical conduct and become aware of the kinds of challenges and dilemmas they may encounter in their professional careers. Students can learn to pose better questions about, and to be better prepared to meet the various problematical situations they will face in the working world.

**Robert Leach**
Private Investor and Member, Cal Poly President’s Cabinet
Our session participants believe that the metaphor of a “pathway,” rather than a “pipeline,” best represents the dynamics of workforce development. A “pathway” enables us to visualize the three important stages in workforce training and maintenance, what I call the “Three R’s”:

- Recruitment: The student’s entry point onto the pathway.
- Reward: The student’s movement along the pathway to its end, which is employment, a key ultimate goal of the student’s education.
- Retention: The student’s choice of whether or not to take an exit from the pathway before completing education or after gaining employment.

How do we influence or persuade people to become well-prepared members of the workforce and not take pathway exits, and opt out of S&E majors and careers?

In her keynote address, Susan Hackwood clearly demonstrated that there is a workforce gap in California, an annual shortage of 17,000 workers. A failure to address this workforce shortage would pose severe implications not only for the state but also for the country: Indeed, it is true that “as California goes, so goes the nation.”

How do we close the workforce gap?

At the level of K-12 education, we need to reach out to parents and to students with a compelling and inspiring message and better use of media resources. Session participants agreed that local commitments are essential for any reform in science education. We need better informed and more committed local leadership among parents, educators, and members of industry, all of whom must have the latest information about successful science-education methods and practices.

We concluded that national teaching standards need to be set and uniformly recognized and pursued. Although there are many good teaching practices, much innovation, and some successful science-education programs, improvements have not been widely identified and applied. The complexity of developing and standardizing America’s scientific educational system should not deter us. Indeed, important lessons can be learned from industry, where we can find prototypes and successful examples of scaling up.

Almost everyone at the Baker Forum agrees that educating and retaining qualified science and math teachers in K-12 is one of the best ways to close the workforce gap. Improving K-12 instruction will require special emphasis on elementary instruction along with better pay and more recognition for teachers. And we cannot afford to ignore present elementary instructors who need to obtain ongoing professional development to enhance their expertise. (Our panel discussed bureaucratic and collective bargaining issues that could serve as impediments to these initiatives unless such issues are properly acknowledged and creatively approached.)

We all recognize that community colleges are a critical part of the pathway and that they provide important entry points for women and minorities. Unfortunately, our nation’s community colleges are under-funded, especially in California, where, as Dr. Hackwood indicated, the problem is severe.

Universities must take a leadership role in forming partnerships with the K-12 system.
and in supporting improvements in K-12 science education. Our session members realize that without appropriate incentives and rewards it will be difficult to gain the whole-hearted support of university faculty in improving the K-12 educational system and helping with the professional development of their K-12 colleagues.

Another “pathway” concern is the high attrition rates among women and minority undergraduates, and the significant attrition among these groups in the workforce. This failure to achieve a higher rate of return on our educational investment in diversity is costly. Strategies to help women and minorities complete their university degrees and sustain professional careers in the science and technology workforce include better faculty advising and mentoring of students, and increased employment of women and minorities as role models for students, among other approaches.

Our session members recommend the creation of a central web-based clearinghouse that is readily accessible to students and teachers providing them with critical information regarding scholarships and financial aid, best practices, and good mentoring programs. Easy access to complete information on scholarships in selected disciplines should be part of the effort to increase their access to relevant, comprehensive information.

We believe that universities must be responsible for results and that ways need to be found to tie some portion of university funding to performance.

Because government is an important source of funding, we believe it is incumbent upon us as educators and community leaders to provide government agencies and legislators with very clear recommendations that can be implemented. Jaime Oaxaca especially emphasized that we must give guidance to elected officials regarding specific legislative proposals. As President Natalicio pointed out, federal agencies like to fund new, innovative programs. Our panel recognizes that we need to encourage the new while finding ways to sustain long-term funding for already successful programs that use the best practices.

Finally, our session’s participants discussed industry’s role in improving the workforce pathway.

We recommend that educational institutions and industry place special emphasis on liaison staff dedicated to fostering and maintaining partnerships between the two. Liaison personnel are already widely in place in industry and at universities, but education and industry leaders need to recognize the importance of supporting and expanding liaison efforts. Indeed, the personal involvement of CEOs has been instrumental in forming successful industry-university partnerships.

Our session members recognize that universities have tended to pursue partnerships with only the largest corporations. President Natalicio pointed out that the University of Texas at El Paso has found ways to create successful partnerships with medium-sized and small businesses that are not Fortune 500 companies. We also believe that public relations, advertising, and media firms can provide valuable expertise in promoting university-industry partnerships.

Finally, we agree that corporate and private foundations sensitive to the systemic nature of the workforce shortage and the demands of a successful workforce pathway should be asked for their aid in guaranteeing that America has the scientists, engineers, and technical workers it needs to maintain its leadership role in the world.

Almost everyone at the Baker Forum agrees that educating and retaining qualified science and math teachers in K-12 is one of the best ways to close the workforce gap. Improving K-12 instruction will require special emphasis on elementary instruction along with better pay and more recognition for teachers.

Jaleh Daie
Managing Partner, Aurora Equity LLC and Former Director of Science, David and Lucile Packard Foundation
Strategies to help women and minorities complete their university degrees and sustain professional careers in the science and technology workforce include better faculty advising and mentoring of students, and increased employment of women and minorities as role models for students, among other approaches.

Jaleh Daie
Managing Partner, Aurora Equity LLC and Former Director of Science, David and Lucile Packard Foundation

RECOMMENDATIONS:

K-12
- Inspire parents and students with exciting and compelling message and better use of the media.
- Encourage informed, engaged leadership at the local level to reform science education.
- Obtain and disseminate information on science-education best practices.
- Increase parents’ awareness and knowledge of the importance of science education.
- Set national education standards.
- Use industry models for scaling up best practices.
- Recognize that having qualified science and mathematics teachers is the most important step toward closing the workforce gap.
- Provide better pay and recognition for teachers.
- Emphasize the importance of elementary school instruction.
- Provide inducements to college faculty to help elementary teachers increase science/math expertise.
- Address bureaucratic and collective bargaining impediments to progress.

Community Colleges
- Community colleges are a critical gateway for all students, especially female and minority college students.
- Community colleges are critical initial training grounds for science and math teachers.
- Community college funding levels are inadequate and must be strengthened.

The University
Recruitment:
- Partner with the K-12 system and commit to support improvement in science education.
- Create central one stop clearinghouses (e.g., global Web sites) with information regarding financial aid, best practices, mentoring, and career options for S&E study.

Retention:
- Recognize that loss of S&E students and S&T workers through attrition are critical elements of the workforce gap.
- Minimize attrition of women and minorities from degree programs and the workplace through better advising and mentoring and the increased employment of women and minority faculty role models.

Accountability for Results:
- Tie some portion of university funding to successful university performance.

Government
- Provide elected representatives and government officials specific education recommendations that can be implemented.
- Encourage government to sustain and scale up best practices and proven teaching methods and programs.
- Promote long-term solutions.

Industry
- Make expanded use of university and industry liaison staff in fostering university-industry partnerships.
- Increase CEO personal interest, visibility and involvement in partnerships.
- Encourage partnership with small- and medium-sized businesses.
- Tap the resources of public relations, advertising, and media firms.
- Encourage corporate and private foundations to focus on systemic solutions to workforce pathway problems.
- Encourage industry to look beyond short-term solutions, like the H1-B visa.
- Encourage industry to become more politically active and communicate severity of workforce gap problem to state legislatures (who are more likely to listen to business than academe).
our session members believe that industry and university partners must be honest about their own self-interests if they are to sustain long-term partnerships. Partners may have both similar and different goals, and achieving them requires mutual cooperation and an understanding of each partner’s distinctive mission.

Partnerships should be guided but not limited by three principles:
• Partnerships should be mutually beneficial.
• Partnerships should be easy to implement.
• Partnerships should serve long-term rather than short-term interests.

Session participants also are cognizant of the numerous challenges that confront successful partnerships. Partners must understand the different goals, organizational cultures, and constraints that each faces. For example, we discussed how questionable accounting practices affect research and development partnerships. Universities and corporations need to acknowledge that these practices are wrong, and policy-makers must propose novel and creative economic models for partnerships that guarantee both effectiveness and strict adherence to the law.

In addition, the public and the government need to be better informed about the adverse consequences of under-funding education. Industry and the university need to reframe and amplify their case for the importance of the educational system in supplying a well-prepared workforce. Together, they need to galvanize public opinion and inspire elected officials to increase support for education.

Additional challenges also require special consideration. Industry executives must understand why relationships with universities are valuable and a benefit to industry, that industry-university partnerships are not philanthropic ventures but wise business investments. And universities must deal constructively with traditions, customs, and cultural orientations that may enhance or limit the potential value of their partnerships with industry.

Our session believes that effective partnerships have several key attributes:
• Partnerships should be institutionalized: Partnerships often begin as one-on-one relationships between alumni who have become chief executives of firms and their counterparts in the university. Such arrangements need to be institutionalized, so that the partnership’s future success is not dependent upon any one individual.
• Partnerships should be based on a feasible financial model: Benefits of the partnership should be tangible and measurable in terms of yearly progress toward goals.
• Universities should initiate and play a lead role in the partnership: Universities that take the lead role have a much better chance for success.
• Partnerships that are well organized with clear expectations have an improved chance for success.
• Partnerships thrive when the participants mutually address the practical aspects of implementing the projects or programs.

University and industry partnerships should meet industry needs while supporting the mission of polytechnic and science and technology universities. Industry wants
Industry executives must understand why relationships with universities are valuable and a benefit to industry, that industry-university partnerships are not philanthropic ventures but wise business investments. And universities must deal constructively with traditions, customs, and cultural orientations that may enhance or limit the potential value of their partnerships with industry.

Steve Ciesinski
Managing Partner, Earlybird LLC and Member, Cal Poly President’s Cabinet

highly qualified graduates, access to individual faculty members and their expertise in research and development, and association with prestigious universities. Universities seek new funds and in-kind gifts, and new opportunities for both faculty professional development and enhanced training for students.

Session participants noted that polytechnic and science and technology universities face special challenges in forging partnerships involving research and development. Universities need to promote outstanding talent, tout their special accomplishments, and showcase their resources to attract industry partners. As Gary Bloom pointed out, university administrators and faculty need to know which companies are industry innovators with strong records of growth and financial stability.

In conclusion, I would like to refer you to the list of recommendations below, as our session’s guidebook or blueprint for successful partnerships.

I would also like to suggest a further potential role for the President’s Cabinet. As you know, this body, for over two decades, has enabled Cal Poly to engage in an ongoing dialogue with industry leaders and experts, and to benefit from their informed views and insights. We recommend that the President’s Cabinet establish a smaller subgroup of five to eight people to set milestones for measuring progress in implementing our session’s recommendations, and to determine what positive changes have been made in a year’s time. Of course the university needs to take the lead on this, but I think many industry executives and former executives would be willing to participate in such an assessment and share their comments. And certainly an inventory of partnerships that Cal Poly already has with industry would provide valuable information.

RECOMMENDATIONS FOR FORGING EFFECTIVE UNIVERSITY-INDUSTRY PARTNERSHIPS:

Challenges
• Partnerships should be based on a clear understanding of the goals, organizational cultures, and constraints of each participant.
• The public, government, and industry need to be better informed about the consequences of the increased shortfall in funding for education.
• Partnerships should be based on economic models that work.
• Industry needs to understand the importance of their relationships with universities, that these partnerships benefit business and are not “charity.”
• Universities need to be aware of industry’s traditions and cultural constraints.

Principles and Goals of University-Based Partnerships
Principles:
• Partnerships should be mutually beneficial and complementary.
• Partnership projects should be easily implemented.
• Partnerships should be long-term endeavors.

Goals:
• Provide training for students to make them job-ready.
• Create joint university-industry partnerships in research and development.
• Provide industry access to highly qualified students.

Characteristics of Effective Partnerships
• Partnerships should involve governmental participation.
• Partnerships should be institutionalized and not depend on a particular individual.
• Partnerships need feasible financial models.
• Partnerships should result in tangible benefits for all participants.
• Universities should take the lead in initiating industry partnerships.
• Partnerships must be based on well-organized projects that can be effectively implemented.

Supporting the Mission of Polytechnic and Science and Technology Universities
• The interests of the partners should be defined.
• Industry wants access to students and seeks to employ highly qualified graduates.
• Industry also desires access to faculty expertise and university research and development resources, and corporations seek prestige by being associated with academic institutions.
• Universities seek additional sources of funds from industry. They also want to create opportunities for faculty professional development and training opportunities for students.

Forming Mutually Beneficial Partnerships
Examples of effective partnerships:
• The Berkeley Sensor and Actuator Center is a good example of a model whereby industries support research and development in exchange for access to new knowledge.
• There are also useful models of how to establish industry advisory councils in university colleges and departments.

Addressing Special Challenges of R&D and Other Partnerships
• Universities need to promote outstanding talent and tout their accomplishments to alert industry to attractive opportunities for partnership.
• Universities should use market analysis to determine what industries or companies are most likely to become good, productive partners.
• Intellectual property issues must be addressed explicitly in any partnership.

Additional Recommendations
• Polytechnic and science and technology universities should develop a guidebook for developing university-industry partnerships.
• The guidebook should describe the elements of a successful program, articulate rules, and provide some examples that document the best practices.
• Session members suggest that milestones be established to measure progress toward goals and that a progress report be issued in a year’s time.
• Session members recommend that Cal Poly inventory the partnerships that have been established with industry in the last few years.

Steve Ciesinski
Managing Partner, Earlybird LLC and Member, Cal Poly President’s Cabinet
CLOSING REMARKS
Warren J. Baker
I'm not sure I can fully capture in my concluding remarks all that has transpired in the past two days. But I do think a number of ideas have been advanced that will help us formulate solutions to the problems that we have considered. I’d like to devote a few minutes to these key points.

We obviously recognize that the quality and the productivity of the nation's workforce is very much dependent on the quality of our educational system, and particularly on science, math and engineering, where our inadequacies are serious and growing. We also know that we cannot determine with certainty what specific demands, skills or knowledge the social and economic infrastructure will require of our workforce in the future. And this should caution us to avoid shortsightedness in what we teach and what our students learn.

"Job readiness” is certainly an important aspect of higher education and indeed a well known characteristic of a Cal Poly Education. In fact, recent surveys of freshmen entering universities today in the U.S. point out the primary reason they give for going to college is to secure a good job. However, with the pace at which we are uncovering new knowledge and the rapid advancement of technology we must strive to be sure our programs focus on the future. Our technical programs must be informed by directions suggested in technological trends and scientific discovery. Moreover, the human, social, political and ethical dimensions of our society are increasingly bound to our scientific and technological progress. In this new century it is more important than ever in our history that our scientific and technological workforce also possesses the traits, openness and critical thinking skills we attribute to having a liberal education. It is of utmost importance to our nation to educate our diverse young men and women so they have the skills, knowledge and insight to expand and apply science and technology, to protect our national security, to improve the quality of life for all citizens, and to expand opportunities for those historically left behind.

At the same time, our view of a liberal education as the cornerstone for preserving our democracy must take into account today’s reality, with particular reference to science and technology. If an educated citizenry is fundamental to preserving our democracy, as well as improving our quality of life and assuring prosperity for all, we need to be sure that we give education our highest priority for investment. And our investment must give appropriate focus for science and the role that technology plays in our lives.

We know, as has been pointed out again and again over the past two days, that our educational system is closely linked, kindergarten through Ph.D. Its success depends on effective partnerships among its various parts. And to improve education and opportunity for all of our people we need to address critical issues in a systemic way, taking into account both the internal and the external relationships and influences. By external influences I mean the electorate, the taxpayers, the elected officials, the press and the business community. I believe, as David Goodstein observed, that those who teach and those who directly influence our students are the most important link between our aspirations and hopes for our educational system and the reality of education today. I wholeheartedly concur with the suggestion that we should focus our efforts on professionalizing teaching. We should create an environment that attracts and keeps quality teachers motivated to help students learn in classrooms that reflect
the power of our technology and our understanding of the many ways young people can learn.

These views, and others that were expressed over the past two days, suggest a comprehensive action plan, a plan that does not require totally new thinking but can build upon approaches that have been proven to succeed. Such an action plan must recognize that a systemic solution will take a long time. It will need to gather public awareness and garner public support. It will need articulate and dedicated champions. And finally, since this has been a forum that brings the academy and the business community together, it must engage the power of the business community.

Education and industry must come together in a consistent and continual partnership to influence policy and investment, to articulate the consequences of complacency and neglect, to inform the public of changes necessary in both attitudes and in practices, and to undertake collaborative programs and practices that will really make a difference. Here’s just one example of such collaboration: in trying to professionalize the teaching corps, we might expand the scale and scope of opportunities for teachers to work in industry, to help them learn about the connections between what they teach and the careers their students might step into. If we can do this on a significant enough scale, particularly beginning with science and math teachers, it seems to me that we can make great strides in retaining and attracting gifted teachers in our schools.

A competent and motivated teacher is far and away the most important ingredient for student success.

Here in California, we have an immediate opportunity to make a difference. The State is reviewing the kindergarten through Ph.D. master plan for education. The California Council for Science and Technology has produced a report that documents the extent to which California students are being left behind because of gross inadequacies in our educational system with respect to science, mathematics and technology. We know that our nation’s security is threatened in ways that we had never imagined before, and that the undermining of our scientific and technological workforce contributes to the growing concern for our security. These are issues that should heighten resolve to open effective pathways into science, engineering and technology for more of our young people.

So let’s hope that we can walk out of here today with a commitment to follow through, recognizing that two years from now we will not have seen dramatic progress but that we will have put in motion a process that will make a significant difference in a decade. We need to think in those terms, we need to be consistent, we need to use the vehicles that are available to us today and we need to recognize that progress will be slow, but if we head in the right direction, we will get there and achieve lasting solutions.

I want to close by thanking all of you for being here, and offering a particular expression of appreciation to the Cabinet and to the friends of the University who made this Forum possible. It’s not a forum for Cal Poly; it’s a forum for the young people of our state. This particular issue is extremely important to all of us, but it’s most important to the young people who will create the future of this state and this nation. We cannot afford to leave them behind, we cannot afford not to give them opportunities, we cannot afford to divert resources away from creating a good educational system, from the very beginning to the very end,

In this new century it is more important than ever in our history that our scientific and technological workforce also possesses the traits, openness and critical thinking skills we attribute to having a liberal education. It is of utmost importance to our nation to educate our diverse young men and women so they have the skills, knowledge and insight to expand and apply science and technology to protect our national security, to improve the quality of life for all citizens, and to expand opportunities for those historically left behind.

Warren J. Baker
President, California Polytechnic State University
for the young people of this state.

It’s particularly challenging at this time. California did step up to the plate in meeting the educational needs of the first tidal wave of students. The students today don’t look like those students 40 years ago, they look different. And we can ill afford to turn our back on this group of people, this diverse group of young people, who will be the future of this state. You have greatly helped us with ideas to meet critical state and national educational challenges. But I think, in the final analysis, what Dick Hartung said is important: it’s consistency, consistency, and consistency.

So thank you very much. Thank you all for coming. We deeply appreciate the contributions that you have made to this effort over the past two days.

Warren J. Baker
President, California Polytechnic State University
INVITED COMMENTARIES

KENNETH BALDWIN, M.D.
Meeting the Challenge of Designing a User Friendly Educational System

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JALEH DAIE
The Three R’s for Closing the Talent Gap: Recruit, Reward and Retain Women in Science and Technology
The California Council on Science and Technology identified a number of deficiencies in the State's educational system that it attributes to the declining number of graduates in the sciences and technology. A number of factors, including inadequate scholastic preparation, student difficulty in science courses, lack of support services and targeted planning for science programs contribute to the decline. While there is no dispute that the present system is failing to prepare all students for the needs of the nation's technology-based industries, the increasing number of qualified students applying to the State's colleges and universities suggests that there may be other issues that contribute to a lack of interest in committing to a career in the sciences and technology.

In redesigning an educational system that enhances the chances of graduating more students in these demanding fields, a broader perspective should be adopted to make the "new" system user friendly. By failing to view the problem from the students' point of view one is at risk of creating an attractive model for its designers, while failing to satisfy the needs of its users.

In the last three decades the state-funded colleges and universities have seen a doubling in the number of enrolled undergraduate students. Given this increasing number of well-qualified students, blaming an inadequate primary and secondary education system for the poor graduation rates seen in science, engineering, and technology seems too simplistic.

The present generation of students face social, economic, and demographic issues that are immensely different from the preceding generations for which the present educational system was designed. The student of today is more likely to come from a single-parent home or is from an ethnic background whose family lacks a tradition of educational advancement. Common to both groups is an economic status that makes achieving a higher education often a dream rather than a reality. These types of contemporary issues must be acknowledged and addressed prior to designing a system that is to attract and retain students.

The State's educational crisis is a paradox. California's publicly funded colleges and universities are world-renowned for their quality and affordability. However, the state's high cost of living, especially in the area of housing, prevents many potential students from applying for graduate and post-graduate studies. The University of California has seen such a progressive decline in the number of qualified applicants to its graduate schools that the issue is of critical concern to its administrators. Between the 1970's and 2000, the percentage of graduate students of the total enrollment in the UC system has decreased from 30 to 17 percent. The most prevailing reason for this decline is the increasing cost of housing and living. The state-funded colleges and universities encounter the same issue in their recruitment of highly sought after teachers and professors. At CSU Northridge, 78 percent of recruited and accepted faculty applicants rejected the academic position because of the high cost of housing.

2 Peabody, Zanto “High Home Prices Turn Some Faculty Away From Cal State.” The Los Angeles Times; 21 February 2001.
The economics of pursuing and completing graduate and post-graduate education cannot be underestimated, especially in California. The student’s ability to graduate in a timely manner with minimal debt no doubt plays an important part in the final decision as to what type of graduate degree he or she will commit to.

While economic and social factors may strongly influence the decision of pursuing advanced degrees, post-graduate opportunities may similarly dictate the choice of fields, which students choose. Many studies have identified that today’s graduate is not only concerned about income, but also the quality of life. Professions that traditionally have left little time for leisure and family are experiencing a notable lack of interest, whereas occupations in which control of one’s lifestyle is possible have become more popular. Prospective female applicants continuously confront the issue of choosing between profession and family. Twenty-five percent of female graduates at the Harvard School of Business left the workplace within twenty years of graduating.\(^1\) Forty percent of female physicians are only interested in working part-time.\(^2\)

The future success in attracting and retaining highly qualified and motivated students for careers in engineering, science, and technology will only come when these contemporary issues are fully identified and studied. The results of this endeavor must be implemented in a new system that is flexible to the vagaries of a rapidly changing society and is user friendly.

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\(^1\) ABC Nightly News, April 23, 2002
The Three R’s for Closing the Talent Gap: Recruit, Reward and Retain Women in Science and Technology

I
t is a forgone conclusion that we must close the technical talent gap lest we compromise our economic well being, national security and global leadership. Demographic projections indicate that in less than a decade, nearly two-thirds of new entrants in the job market will be women and minorities. The writing has long been on the wall—we cannot rely on one-third of our population to fill the growing number of high tech jobs. Nor can we, forever, rely on importing skilled workforce. To close the gap for highly skilled workforce we must grow our own and expand the overall pool. Our best hopes rest on ensuring that women are attracted into, and remain in science and technology fields and careers.

At the inaugural Baker Forum we asked the question: what can polytechnic and science and technology colleges and universities do to ensure an adequate supply of diverse S&T workers? In short, these institutions are at the leading edge of national efforts that can improve science education along the entire system, K-20 and beyond into the workforce. Needless to say, there are multitudes of successful approaches across institutions of size to achieve this goal. The crucial next step is to scale up—identify, replicate and adapt proven programs. Expanded use of targeted programs that have proven to be effective will go a long way toward achieving this objective.

The three pillars on which an adequate and diversified work force is built are Recruitment, Rewards and Retention. Using the pathway analogy (rather than pipeline) three critical points are envisioned: 1) entry into the path (recruitment), 2) cruising on the pathway (experiences and reward systems that keep entrants fulfilled and ensure their advancement), and 3) exiting the path (strategies to optimize retention, preventing cruisers from taking an early exit). Moreover, minimizing high rates of attrition among students who enter college with intention to pursue S&T degrees ensures that our valuable and costly recruitment efforts bear fruit.

At the Forum we heard many thoughtful ideas and concrete suggestions to address retention. In the interest of space, I mention one targeted program, which I was involved with during my tenure at Rutgers University, Residential Learning Communities (RLCs), as an example of how the experience and rewards components can be improved leading ultimately to enhanced retention. The strategy provides a seamless educational experience and integrated curricula that connect students, faculty, disciplines and life experiences, ensuring academic success through peer reinforcement. Such residential programs offer integrated academic and social life leading to collaborative learning communities and peer reinforcement, all of which contribute to academic success and retention. The effectiveness of integrated academic and social activities is greatly enhanced if they are offered in the context of campus housing and incorporated student life services.

Based on the observation that successful transition from high school to college is a strong predictor of academic performance and graduation rates, RLCs are critical to entering students and offer an enriched and supportive climate. RLCs emphasize the following factors: learning beyond the confines of the classroom; connected academic and social life; support of like-minded peers to minimize isolation; positive reinforcement through peer-to-peer mentoring and coaching; availability of faculty and advanced student mentors and role models for both academic advising and personal...

Demographic projections indicate that in less than a decade, nearly two-thirds of new entrants in the job market will be women and minorities. The writing has long been on the wall—we cannot rely on one-third of our population to fill the growing number of high tech jobs. Nor can we, forever, rely on importing skilled workforce. To close the gap for highly skilled workforce we must grow our own and expand the overall pool. Our best hopes rest on ensuring that women are attracted into, and remain in science and technology fields and careers.

Jaleh Daie
Managing Partner, Aurora Equity LLC
and Former Director of Science, David and Lucile Packard Foundation
At the inaugural Baker Forum we asked the question: what can polytechnic and science and technology colleges and universities do to ensure an adequate supply of diverse S&T workers? In short, these institutions are at the leading edge of national efforts that can improve science education along the entire system, K-20 and beyond into the workforce. . . . The crucial next step is to scale up—identify, replicate and adapt proven programs. Expanded use of targeted programs that have proven to be effective will go a long way toward achieving this objective.

Jaleh Daie
Managing Partner, Aurora Equity LLC
and Former Director of Science, David and Lucile Packard Foundation

relationship; hands-on activities; and experiential research opportunities.

To address retention of women who entered college with the interest and intention to pursue S&T degrees, Rutgers University’s Douglass College pioneered a program in 1986 by establishing an academic-based, all women residence hall for students of similar academic interests (the Bunting-Cobb Hall for women in math, science and engineering). Graduate students serve as resident advisors and faculty is actively involved. The model greatly facilitates peer identification and reinforcement, a strong sense of community, unique opportunities for collaborative learning and working among a population with similar learning styles. The presence of resident graduate mentors and meaningful participation of faculty and private sector scientists help undergraduates to grasp the formula for a smooth completion and then transition into science and technology careers. The Program received the 2000 Presidential award for Excellence in Math and Science Mentoring. By all indications the program continues to be a successful model for improving science education and retaining female students in related majors. In fact it has already been adapted by several other colleges and universities.

While RLCs have especially been great tools to retain women in science and engineering majors, all students who participate in unified life-academic programs express a greater degree of satisfaction and personal growth. While academic rigor and soundness is the bedrock of such programs, a well-thought-out administrative organization, continuity and adequate resources are crucial. Key operational elements of an effective RLC include

• shared interest in related disciplines
• provision of regularly scheduled seminars, lectures and discussion groups
• availability of key resources such as “quiet” study rooms, internships and research experience
• purposeful inclusion of social activities underpinned by the common academic interest (field trips, lab visits and campus clubs).

Modeling best practices, such as RLCs, is an efficient and low cost way to apply and propagate already proven programs regardless of an institution’s size, mission and culture.
ROBERTA ACHTENBERG

Senior Vice President for Public Policy, San Francisco Chamber of Commerce and Business
Member, Board of Trustees
California State University
Baker Forum CSU Trustee Participant

Roberta Achtenberg is Senior Vice President for Public Policy, San Francisco Chamber of Commerce and Business, member of the CSU Board of Trustees and member of the Board of Directors, Federal Home Loan Bank of San Francisco. Her recent professional experiences include: Senior Advisor to the Secretary, U.S. Department of Housing and Urban Development (1996-97); Assistant Secretary for Fair Housing and Equal Opportunity (1993-95); Supervisor, City and County of San Francisco (1991-93); and member, Board of Directors, Bay Area Air Quality Management District (1991-93). A member of the State Bar of California, her legal career has included service of Counsel to the law firms, Lilienthal and Fowler (1991-93) and Weller and Drucker (1992-93), service as Executive Director, National Center for Lesbian Rights (1989-90), service as Staff Attorney, Equal Rights Advocates, Inc. (1982-90) and service as Law Professor and Dean at the New College of California, School of Law (1976-81). Achtenberg received her J.D. from the University of Utah, College of Law and B.A. in history from UC Berkeley.

WARREN J. BAKER

President
California Polytechnic State University
Baker Forum Closing Commentator

Warren J. Baker has been President of Cal Poly since 1979. He served previously as Vice President for Academic Affairs at the University of Detroit and was Dean of the College of Engineering. His academic appointments have included Chrysler Professor of Civil Engineering, University of Detroit and Visiting Faculty Fellow at MIT. Among Baker’s current public and professional appointments, he is a member of the Board of Directors of the California Council on Science and Technology, a member of the Business Higher Education Forum, chair, NACULGC Commission on Information Technologies, and Co-Chairman, Joint Policy Council on Agriculture and Higher Education. Among his past appointments, he has been a member of the National Science Board, the Board for International Food and Agricultural Development, and founding Chairman of the Civil Engineering Research Foundation. He received his Ph.D. Degree in Civil Engineering from the University of New Mexico and his M.S. and B.S. in Civil Engineering from the University of Notre Dame.

GARY BLOOM

Chairman, President and CEO, VERITAS Software
Baker Forum Keynote Commentator and Panel Member

Gary Bloom is Chairman, President and CEO of VERITAS Software. He oversees all corporate and board functions. He directs the Company to ensure attainment of sales and profit goals and maximum return on invested capital, is responsible for the formulation of current and long-range plans and objectives and represents the organization in relations with its customers and the business and non-business communities. Bloom joined VERITAS from Oracle, where he most recently served as Executive Vice President. During his fourteen-year career at Oracle, Bloom led Oracle’s core database business and the execution of Oracle’s Internet and e-business vision. Bloom also led Oracle’s worldwide marketing, support, education and alliance organizations and was responsible for mergers and acquisitions, global information technology and the Oracle Venture Fund. Before joining Oracle in 1986, Bloom held various technical positions at
both Chevron Corporation and IBM Corporation. Bloom earned his Bachelor of Science degree in computer science from California Polytechnic State University, where he currently serves on the President’s Cabinet.

JOSEPH BORDOGNA
Deputy Director and Chief Operating Officer, National Science Foundation
Baker Forum Panel Member

Joseph Bordogna is Deputy Director and Chief Operating Officer of the National Science Foundation (NSF), having served previously as head of NSF’s Directorate for Engineering. Immediately prior to his appointment at NSF, he served at the University of Pennsylvania as Alfred Fitler Moore Professor of Engineering, Director of The Moore School of Electrical Engineering, Dean of the School of Engineering and Applied Science, and resident Faculty Master of Stouffer College House, a living-learning student residence at the University. During 1998, he served as worldwide President of the Institute of Electrical and Electronics Engineers (IEEE). Bordogna holds the B.S. and Ph.D. degrees from the University of Pennsylvania and the S.M. degree from the Massachusetts Institute of Technology.

STEVE CIESINSKI
Managing Partner, Earlybird LLC
Baker Forum Breakout Session Presenter

Steve Ciesinski is a managing partner at Earlybird, a leading international venture capital firm with about $300 million under management. Prior to Earlybird, Ciesinski held executive positions at Resumix (applications software), Octel (voicemail), and Applied Materials (semiconductor capital equipment). Earlier in his career, he also held positions at Procter & Gamble and Booz Allen & Hamilton. He is currently Chairman of the Board of Trustees of Union College. Ciesinski also sits on the Boards of Directors of a number of private companies. He holds a B.S. in electrical engineering and A.B. in modern languages from Union College in New York and M.B.A. from Stanford University.

JALEH DAIE
Managing Partner, Aurora Equity LLC
Baker Forum Breakout Session Co-Leader

Jaleh Daie is a managing partner, Aurora Equity LLC. She was formerly Director of Science and Senior Advisor at the David and Lucile Packard Foundation. Daie has held faculty and administrative appointments at two major universities. She was Professor at the University of Wisconsin, Madison and Senior Science Advisor for the 26 campus UW System. At Rutgers University, she was Professor and Department Chair. In addition, Daie served as Science Liaison to the President’s National Science and Technology Council, working with White House staff on presidential initiatives and serving as Special Assistant to the Chief Scientist at the National Oceanic and Atmospheric Administration (NOAA). Daie is on the Executive Committee of the US Space Foundation, a Trustee of the World Affairs Council and Director of Sigma XI and Leadership Foundation.
MARILYN EDLING
Vice President and General Manager, Enterprise Systems, Business Customer Organization, Hewlett-Packard Company
Baker Forum Breakout Session Co-Leader

Marilyn Edling is responsible for HP’s multi billion dollar Unix Server business and Unix and NT Technical Computing business in North America. Previously, she was Vice President and General Manager of the Enterprise Storage Business Unit. Before this, Edling was the Worldwide General Manager for the Unix server supply chain. Edling joined HP in 1989 when the company acquired Apollo Computer. While there, she worked in strategic planning and manufacturing. She has also done extensive business and financial consulting for Fortune 500 companies. Edling holds a bachelor’s degree from Boston University and masters degrees from Harvard University and MIT. She is a member of the President’s Cabinet at Cal Poly and serves on the board of directors for Ruby-Gordon, Inc.

FRANK ELLIOTT
Vice President, Storage Systems OEM, Storage Products Division, IBM Corporation
Baker Forum Breakout Session Convener

Frank Elliott assumed his current position in January 2002. He also has held numerous senior management positions in IBM’s Storage Systems Division since 1995. In addition to serving on the Cal Poly President’s Cabinet, he has served on the Board of Directors for the California State Chamber of Commerce, the United Way of the Bay Area, and the Visiting Trustees Committee for the William E. Simon Graduate School of Business, Rochester, New York. He graduated from the College of Wooster in Ohio. He earned an MBA from William E. Simon School at the University of Rochester in 1973.

DON FOWLER
Entrepreneur
Baker Forum Breakout Session Convener

Don Fowler is an independent entrepreneur. He is a past Chairman of the Cal Poly President’s Cabinet and serves on the board of directors of both public and private companies. Fowler was CEO of two early stage companies, eT Communications and Worlds Inc., and now advises a dozen CEOs of startup companies. Fowler also works closely with several venture capital firms in identifying, evaluating, and managing new ventures. Previously Fowler was Senior Vice President at Tandem Computers and earlier held a variety of executive positions at Bechtel Group and IBM. Fowler has a bachelor’s of science in mathematics and a masters in business from the University of Washington in Seattle.
HAROLD GOLDWHITE
Professor of Chemistry, California State University, Los Angeles
Member, Board of Trustees
California State University
Baker Forum CSU Trustee Participant

Harold Goldwhite is Professor of Chemistry at California State University, Los Angeles and a member of the CSU Board of Trustees. He received his B.A. degree in 1953 and his Ph.D. in 1956, both from Cambridge University. He was a Research Associate at Cornell University from 1956-58 and was Lecturer in Chemistry at the University of Manchester Institute of Science and Technology from 1958-62. He joined the faculty of Cal. State L.A. in 1962 as an Assistant Professor and was promoted to Professor in 1967. He was department Chair from 1971-77, and 1992-93. He was Faculty Director of the California State University Institute for Teaching and Learning (1996-98). Goldwhite has held executive leadership positions in the Cal. State L.A. Academic Senate, the California Faculty Association and Statewide Senate of the California State University.

DAVID GOODSTEIN
Vice Provost and Professor of Physics and Applied Physics
California Institute of Technology
Baker Forum Panel Member

David L. Goodstein is Vice Provost and Professor of Physics and Applied Physics at the California Institute of Technology in Pasadena, where he has been on the faculty for more than 30 years. In 1995, he was named the Frank J. Gilloon Distinguished Teaching and Service Professor. Goodstein has served on numerous scientific and academic panels, including the National Advisory Committee to the Mathematical and Physical Sciences Directorate of the National Science Foundation. He is a founding member of the Board of Directors of the California Council on Science and Technology. His book, States of Matter, published in 1975 by Prentice Hall and reissued by Dover Press in 1985, was hailed by Physics Today as the book that launched a new discipline, Condensed Matter Physics. Goodstein was also the host and project director of The Mechanical Universe, a 52-part college physics telecourse based on his popular lectures at Caltech. He also co-teaches a course on Research Ethics.

LAURENCE K. GOULD, JR.
Attorney at Law
Sheppard, Mullin, Richter & Hampton
Former Chair, CSU Board of Trustees
Baker Forum CSU Trustee Participant

Laurence K. Gould, Jr. is Attorney at Law, Sheppard, Mullin, Richter & Hampton and is a former member of the CSU Board of Trustees. Gould is a Trustee of the Della Martin Foundation. He is also Treasurer of the John and Beverly Stauffer Foundation, President of the California Mission Studies Association, Director of the California State Summer School for the Arts and a member of the Channel Islands Site Authority. Gould received his J.D. from Stanford Law School and his B.A. in history from Yale University.
Susan Hackwood is Executive Director of the California Council on Science and Technology and Professor of Electrical Engineering at the University of California, Riverside. CCST is a not-for-profit corporation sponsored by the key academic institutions in the State, which advises the State on all aspects of science and technology including energy, information technology, biotechnology and education. Hackwood received a Ph.D. in Solid State Ionics from DeMontfort University, UK. Before joining academia, she was Department Head of Device Robotics Technology Research at AT&T Bell Labs. She later served as Professor of Electrical and Computer Engineering University of California, Santa Barbara. Hackwood was also the founding Dean of the Bourns College of Engineering at the University of California, Riverside.

Richard F. Hartung
Sonoma Consulting Group
Baker Forum Breakout Session Co-Leader

Prior to retiring in 1999, Richard Hartung was Executive Vice President of Lockheed Information Management Services Company from 1992 until 1999. He joined Lockheed in July of 1958 and held various technical management positions. He serves as a member of the Dean’s Advisory Committee for the College of Engineering at Cal Poly and Vice Chairman of the Cal Poly President’s Cabinet. He has also held part-time appointments as Assistant Professor in Civil Engineering at San Jose State University.

Paul Jennings
Professor, Civil Engineering and Applied Mechanics, California Institute of Technology
Baker Forum Breakout Session Co-Leader

Since joining the faculty of Caltech in 1966, Paul Jennings has served as Chairman of the Division of Engineering and Applied Science from January 1985 to November 1989. He was Caltech’s Vice President and Provost from November 1989 to February 1995. Following that, he became Acting Vice President for Business and Finance until September of 1995; he held this post again in 1998-1999. Jennings is a member of the National Academy of Engineering, a past President of the Earthquake Engineering Research Institute, and a past President of the Seismological Society of America. Jennings is the author of numerous technical papers on earthquake engineering and dynamics of structures and has served as earthquake engineering consultant on the design of high-rise buildings, offshore drilling towers, nuclear power plants and other major projects. He received his B.S. degree in civil engineering from Colorado State University and his M.S. and Ph.D. degrees, also in civil engineering, from The California Institute of Technology.
Robert Leach retired from Cadence Design Systems where he served as Senior Vice President. Prior to joining Cadence in 1993, Leach worked 22 years at Andersen Consulting. At Andersen, he was Partner-In-Charge of the firm’s Electronics Consulting effort where he worked with such technology clients as Sony, Hewlett-Packard, Lockheed, Motorola, Intel, and Toshiba. Leach holds a masters degree and a bachelor of science degree in industrial engineering from Stanford University, as well as a bachelor of arts degree in economics from Claremont McKenna College. In addition to the academic credentials earned in college, he was also a two-time All American and national record holder in swimming. Leach is a member of the Cal Poly President’s Cabinet.

Walter E. Massey is the ninth President of Morehouse College in Atlanta Georgia. Under former President George Bush, Massey served as Director of the National Science Foundation, the government’s lead agency for support of research and education in mathematics, science and engineering. Massey’s other administrative and academic positions have included: Provost and Senior Vice President for Academic Affairs of the University of California System; Vice President for Research at the University of Chicago and Director of the Argonne National Laboratory. He was Dean and Assistant Professor of Physics at the University of Illinois. Massey is past President and Chairman of the American Association for the Advancement of Science and a member of the President’s Council of Advisors on Science and Technology. He is a graduate of Morehouse College and received his masters and doctorate in physics from Washington University, St. Louis, Missouri.

Diana Natalicio has served as President of the University of Texas at El Paso (UTEP) since 1988. Prior to her appointment as president, Natalicio served as UTEP’s Vice President for Academic Affairs, Dean of the College of Liberal Arts, and Chair of the Modern Languages Department. In addition to her duties as UTEP’s president, Natalicio serves on numerous boards and commissions that include: the National Science Board (appointment by President Clinton); the Advisory Commission on Educational Excellence for Hispanic Americans (appointment by President George Bush); and the President’s Committee on the Arts and Humanities (appointment by President Clinton). She is a graduate summa cum laude of St. Louis University, and earned a masters degree in Portuguese and a doctorate in linguistics from The University of Texas at Austin.
JAIME OAXACA
Chair, Cal Poly President’s Cabinet
Chairman of the Board,
United States Space Foundation
Baker Forum Convener

The Honorable Jaime Oaxaca chairs the Cal Poly President’s Cabinet, Chairs the Board of the United States Space Foundation and serves as Chairman of the Oaxaca Group. He was previously Corporate Vice President of Northrop where he held several other executive and division management positions. Oaxaca received Presidential appointments to The National Science Board (1990-1996) and the General Advisory Committee on Arms Control (1981-1992). Oaxaca is on the board of Sandia National Laboratories and a member of the Board of Governors of the United States/Mexico Foundation for Science. He has a BSEE in engineering from the University of Texas at El Paso and is a graduate and Sloan Executive Fellow of the School of Business at Stanford University.

CLINT E. SMITH
Vice Chair, Board of Governors, United States-Mexico Foundation for Science
Stanford Institute for Economic Policy Research
Baker Forum Breakout Session Co-Leader

Clint E. Smith is currently a policy research scholar affiliated with the Institute for Economic Policy Research at Stanford University, where he specializes in United States-Mexico relations and economic and political developments in the Western Hemisphere. Prior to this appointment, Smith was a senior Foreign Service Officer, who served in U.S. embassies in Buenos Aires, Madrid, Mexico City, Lima, and Bucharest, as well as at the Department of State in Washington, D.C. Smith has held a number of academic appointments, among them: Consulting Professor of Latin American Studies at Stanford, Visiting Professor at the Monterey (CA) Institute of International Studies and Santa Clara University, and Senior Research Scholar at the Institute for International Studies at Stanford, where he was Executive Director of the North America Forum. Smith is a member of the Council on Foreign Relations and currently serves as Vice Chair of the Board of Governors of the U.S.-Mexico Foundation for Science. Smith received his undergraduate degree from the University of New Mexico, and his graduate degree from the University of California, Berkeley.

KEITH UNCAPHER
Senior Vice President, Corporation for National Research Initiatives
Baker Forum Panel Member

Keith Uncapher was co-founder and Senior Vice President of the Corporation for National Research Initiatives (CNRI) from 1986 until his death in October 2002. In the 1950s, Uncapher directed the computer systems center at the RAND Corp, Santa Monica, California. In 1972, he founded the USC Information Science Institute and was founding Executive Director until 1986. In 1974, he became Associate Dean for Information Sciences at the University of Southern California, as well as Professor of Computer Sciences. Uncapher was a member of the National Academy of Engineering and former President of IEEE Computer Society and the American Federation of Information Processing Societies. Uncapher was a 1950 graduate of Cal Poly and was a member of the Cal Poly President’s Cabinet.
PETER B. WILEY
Director, John Wiley & Sons, Inc.
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Peter Booth Wiley is the Chairman of the Board of John Wiley & Sons, a global publishing house with which his family has been associated for 197 years. He received a Bachelor of Arts degree in English literature from Williams College, and a masters in American history from the University of Wisconsin. A journalist, author, and editor, Wiley founded and edited a political review, covered resource issues for Pacific News Service, coauthored a newspaper column on the American west, and has written five books. Wiley was a founder and President of the board of the San Francisco Bay Area Book Festival and is currently a member of the Executive Committee of the Board of the Friends & Foundation of the San Francisco Public Library.

JOSÉ ZAGLUL
President, EARTH University
Baker Forum Breakout Session Co-Leader

José Zaglul has served since 1989 as the President of EARTH University (Escuela de Agricultura de la Región Tropical Húmeda), Limón, Costa Rica. Previously, he served as Head of the Animal Production Department at the Centro Agrícola Tropical de Investigación y Enseñanza (CATIE) in Cost Rica. From 1981 to 1985, Zaglul was Professor of Food Science and then Vice President of Research and Extension of the Instituto Tecnológico de Costa Rica (ITCR). Zaglul serves on the Executive Committees of the Global Consortium of Higher Education and Research for Agriculture and the Pan-Pacific Basin Workshop on Microgravity Sciences, among several other professional organizations. Dr. Zaglul obtained his B. S. and M. S. degrees from American University of Beirut, Lebanon. He received the M. S. and Ph.D. degrees from the University of Florida.

PAUL J. ZINGG
Provost and Vice President for Academic Affairs
California Polytechnic State University
Baker Forum Panel Moderator

Paul J. Zingg is currently the Provost and Vice President for Academic Affairs at California Polytechnic State University, having served previously as Dean of Cal Poly’s College of Liberal Arts. Zingg served as Dean of the School of Liberal Arts at Saint Mary’s College of California from 1986-1993. He also spent several years at the University of Pennsylvania, serving as Assistant to the President from 1984-1986, as an American Council on Education Fellow in Academic Administration and Special Assistant to the President in 1983-1984, and as Vice Dean of the School of Arts and Sciences, 1979-1983. Zingg received his Ph.D. in History from the University of Georgia; an M.A. in History from the University of Richmond, VA; and a B.A. in History from Belmont Abbey College, NC.
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