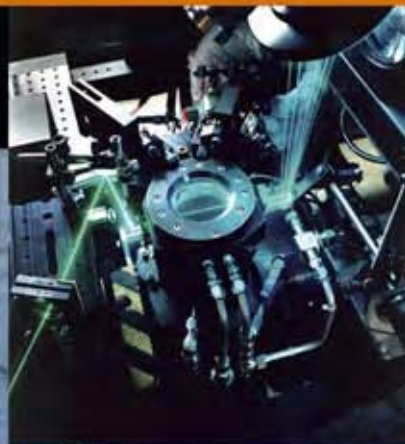


California Council on Science and Technology

2006-2007
ANNUAL REPORT

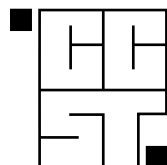


California Council
on Science
and Technology

2006

ANNUAL REPORT

2007



JULY 2007



Karl S. Pister
Board Chair



Lawrence T. Papay
Council Chair



Cornelius (Neal) W. Sullivan
Council Vice-chair

A Climate for Change

It is not easy for society to create effective science and technology policy. Doing so requires an understanding of complex processes and potentials, as well as realizing the risk of acting and the risk of not acting; it raises a host of related questions about resource allocation, ethical issues, and long-term strategies. The debates over greenhouse gas emissions, energy, transportation; the importance of educational infrastructures for science and math; and the challenge of effectively managing an ever more sophisticated (and expensive) healthcare system are critical issues with significant long-term consequences. There are no quick fixes or single solutions for important and complex issues such as these, and, consequently they are difficult to address.

But there has been a crucial shift in the public sphere in recent years, with a new willingness to look beyond easy fixes. Policymakers and the public are spending less time debating whether to act, and more time discussing how to act. We have reached consensus on the existence and the seriousness of the shortcomings in our science and math education system, on the challenges facing our water supply and on the need for a long-term energy strategy that meets our growing needs and is less harmful to the environment. There is not yet consensus on how to address these problems, but the recognition that they must be addressed now is a major and encouraging step forward.

The National Academies' report *Rising Above the Gathering Storm*, which warned of America's impending and possibly permanent fall from its position as the world's high-tech leader, has been a major factor in building this momentum. CCST has worked to effectively translate what this national report means for California, and how our state can best respond to challenges in education, research and development, and innovation. In fact, over the past year CCST has been actively working with many state agencies, the legislature, and the governor's office on major science and technology related issues facing the state. As CCST nears the end of its second decade, it has never so effectively fulfilled its mandate to keep California's policymakers connected with the expertise of the state's science and technology community as it is doing today. These are exciting times as we look forward to helping California shape a better future for its citizens.

About CCST

CCST is a nonpartisan, impartial, not-for-profit corporation established in 1988 by state legislation. It is designed to offer expert advice to the state and provide solutions to science and technology-related public policy issues. CCST is modeled in part on the National Research Council, and has developed a close working relationship with the National Academies. More than half of CCST's members and fellows are members of the National Academies, and several are Nobel Laureates.

Since its creation, CCST has worked directly with the governor's office, state and federal legislators, and agencies to recommend policies that will maintain California's role as a leader in generating science and technology innovation and maintaining a vigorous economy.

Sustaining Institutions

The strength of CCST lies in the support and resources provided by its sustaining institutions, the University of California system, the California State University system, California Institute of Technology, Stanford University, University of Southern California, and the California Community Colleges, as well as its affiliate members, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories/California, Stanford Linear Accelerator Center, and NASA's Jet Propulsion Laboratory and Ames Research Center. CCST also has strong connections to industry through its membership.

Board and Council

A board of directors and council volunteer their time to govern and guide CCST. The board, which meets twice a year, is made up of 15 leaders from industry and academia. Karl Pister, UC's former vice president for educational outreach and chancellor emeritus of UC Santa Cruz, serves as CCST board chairman.

The council, which meets three times a year, currently includes 28 corporate leaders, academicians, scientists, and scholars of the highest distinction. Lawrence T. Papay, CEO and principal of PQR, LLC, is the chair, and Cornelius (Neal) Sullivan, professor of biological sciences and former provost at the University of Southern California, is the vice-chair.

The board establishes CCST's policies and provides oversight, while the Council translates those directives into programs and projects that will ensure the state's science and technology leadership. The council is divided into subcommittees that manage and plan specific projects and studies.

Fellows

CCST fellows are a select group of scientists, engineers, and technical experts who volunteer their time to address specific projects or conduct reviews. CCST created the program in 1997; since then, CCST has appointed 121 fellows who are engaged in all aspects of CCST's work addressing important science and technology issues facing government, education, and industry.

California Teacher Advisory Council (Cal TAC)

Cal TAC is a group of 11 outstanding K-14 science and math classroom teachers modeled after the successful National Teacher Advisory Council, established in 2002 by the National Academies. Cal TAC works to provide a valuable connection between the teaching community and the educational experts and policymakers who are shaping California's educational system. Stan Hitomi, math & science coordinator of the San Ramon Valley Unified School District, is the chair, and Janet English, science teacher at Serrano Intermediate School (currently on leave as director of educational services at KOCE-TV, PBS) is vice-chair.

Staff and Offices

Susan Hackwood is CCST's executive director and provides overall day-to-day leadership; she also sits on the board and council. CCST has three offices. One is in Southern California adjacent to UC Riverside; another is one block from the State Capitol in Sacramento. Annzella Loufas directs the Sacramento office. The third is in Capitola and is directed by Donna Gerardi Riordan.

Highlights 2006–2007

Publications

Critical Path Analysis of California's Science and Mathematics Teacher Preparation System

This report, released in March 2007, analyzes the production and retention of elementary and secondary math and science teachers in California. The study builds upon the foundation of the original *Critical Path Analysis of California's Science and Technology Education System* (2002), and systematically analyzes the current teacher production system and the existing science and math teacher workforce. It was prepared in collaboration with the Center for the Future of Teaching and Learning.

Shaping the Future: California's Response to "Rising Above the Gathering Storm"

This letter, released in December 2006, answered Governor Schwarzenegger's request that CCST help California respond to the National Academies' report, *Rising Above the Gathering Storm*. CCST convened four industry-led task forces to develop actionable items addressing each of the four principal recommendations related to increasing the science and technology talent pool, research base, and business climate in California.

"Focal Point" Series

CCST launched a new publication series designed to highlight important technological contributions from California's federal funded laboratories. A total of six Focal Point brochures are being prepared, each of which explores a particular research area or project at one of the six largest federal laboratories in California. The series is a follow up to the broader overview of the labs' capabilities and contributions in the 2006 CCST report *California's Federal Laboratories: A State Resource*.

Initiatives

Energy, Transportation, and Climate Change

CCST has been involved in discussions with various state agencies and government officials on all of these related issues. CCST has worked on long-term energy strategies for the state, investigated the transportation infrastructure, and focused on how California can best understand and adapt to challenges posed by climate changes at the regional level, having the potential to affect issues from the state's water supply to agriculture.

Healthcare Information Technology (HIT)

CCST has been actively engaged in urging the state to address HIT since 2005, when it held a joint meeting with the Institute of Medicine. During the past year, the governor has signed three Executive Orders aimed at facilitating the adoption of HIT in California. Two comprehensive HIT bills have been proposed (one in 2006 and one in 2007) in the California State Senate, on which CCST has consulted.

California Teacher Advisory Council

Cal TAC worked directly with the National Research Council Center on Education to plan a meeting in February 2007 on "Enhancing Professional Development for Teachers: Potential Uses of Information Technology." Cal TAC is in great demand throughout the state, and Cal TAC members have participated in the education task force for Shaping the Future, as well as contributing input to the recently released *Critical Path Analysis*, CCST's education strategy for the coming years, and the California Space Authority.

Workforce Innovation in Regional Economic Development (WIRED)

CCST is a member of a coalition led by the California Space Authority implementing a workforce development project funded by a \$15 million U.S. Department of Labor contract. CCST's role involves, among other things, assisting with the development of an economic model, developing worker profiles on selected high-tech sectors, and analyzing how local Workforce Investment Boards can interface with education and industry.

Setting the Standard



Susan Hackwood
Executive Director

California has long been considered the nation's leader in advanced science and technology research and in the creation of new technology enterprises. Like the rest of the nation, California has faced significant challenges in recent years, including an education system that has struggled to provide suitable science and math education to its enormous and growing K-12 student body (over six million and counting—the largest in the country). However, while its challenges have been large, its responses have been correspondingly ahead of the curve in many cases.

As other states seek ways to respond to the stark warnings in *Rising Above the Gathering Storm*, CCST has already presented the Governor with a set of tangible, significant steps that the state could take to improve California's competitiveness and strengthen its supply of top high-tech talent. This response, drafted with four industry-led task forces coordinated by CCST, represents the input of California's private sector, universities, science centers, federal funded laboratories, and K-12 education system; it is already considered a national model.

California set the national standards for greenhouse gas emission legislation last year, with the passage of AB 32; California also was at the forefront of the new National Climate Registry announced in May—a grassroots coalition of 31 states using California's own greenhouse gas emissions registry as a template for other states to follow in setting common standards for measuring and, ultimately, controlling these emissions across the nation.

California was first in creating a state-funded research institution to pursue stem cell research when federal funding was not available. The California Institute for Regenerative Medicine (CIRM) is now just one of several

large state-funded stem cell research initiatives. Partially in response to the establishment of CIRM, California (through a study group convened by CCST) was also the first to comprehensively study what kind of intellectual property policies the state would need to consider.

Perhaps one of the most enduring firsts California has accomplished was the creation of CCST itself, 19 years ago. Although several states have some type of official science advisory mechanism, none has the scope and the independence of CCST. CCST's connections throughout the science and technology sector allow it to tap into the best scientific and technological talent in the state and make its expertise available to policymakers in a manner that is both effective and timely. Recent meetings have included a discussion of telemedicine implementation with administration and UCOP officials, and an intersegmental meeting on expanding the "Teachers as Scientists and Engineers" professional development programs at the federal laboratories and industry. CCST is able to bring together agents of change from different institutions, agencies and offices working independently on similar areas. It is this interconnectivity that distinguishes CCST and drives its effectiveness as a convener.

Though California remains the nation's high-tech leader, its challenges are correspondingly large. Nonetheless, the state remains in many ways at the forefront of science and technology policy, and CCST will work to ensure that California benefits from a level of science and technology policy knowledge and wisdom suitable to its status as America's leading science and technology state.

A handwritten signature in black ink, reading "Susan Haddwood". The signature is written in a cursive, flowing style.

Energy, Transportation, and Climate Change

The production, distribution and use of energy are increasingly serious issues in California. The state has been struggling to balance a growing demand for energy with a pioneering environmental focus. Many efforts to devise solutions to California's demand for clean energy have emerged; today, the range of options to reduce greenhouse gas (GHG) emissions includes biomass, fuel cells, hybrid electric vehicles, hydrogen, geothermal, wind, nuclear, and increased energy efficiency.

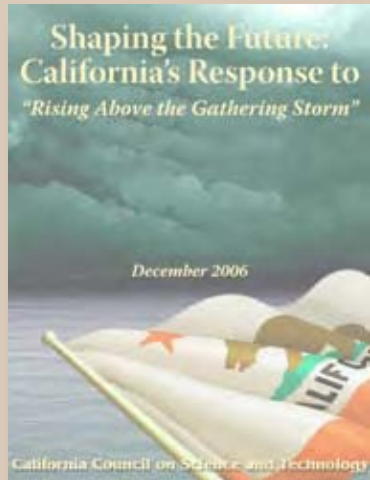
Faced with such a wide array of options, it is difficult for policymakers to know which technologies may offer the best solutions for California, whether to support them, and if so, how. The passage of the California Global Warming Solutions Act of 2006 (AB 32) in September 2006 lent a new urgency to this decision-making process: AB 32 mandates a reduction in GHG emissions by 25% by 2020, which California is unlikely to accomplish without a clearly focused state energy strategy. GHG in California is primarily produced by transportation (40%), electricity production (22%), and manufacturing (20%). To meet the ambitious goals set forth in AB 32, California needs to explore the economic, technical and political factors of energy production, distribution, and usage in these three sectors, and then develop a workable plan.

CCST has been working to engage its network of science and technology leaders from throughout the state to help refine and continuously improve California's energy strategy. The February 2007 council meeting focused on transportation and energy. Subsequently, Senator Alan Lowenthal, chair of the Senate Transportation Committee, asked for CCST's assistance in identifying investments for the state's transportation infrastructure. Further, in May CCST Fellow Charles Kennel, and Jane Long, associate director, Energy and the Environment Directorate, Lawrence Livermore National Laboratory, met to discuss global warming and regional climate change with the Governor's Office of Planning & Research, the California Environmental Protection Agency, and the California Energy Commission, as well as legislative staff and consultants at the State Capitol.

CCST has also been working to identify productive ways for California to follow up on AB 32. With a surge of climate related bills introduced in the California Legislature in 2007 (over 60 so far), there is strong interest in developing California-specific responses and a better understanding of how climate change will affect the state. In order for the state to develop effective strategies for mitigating the effects of its energy needs, California needs to develop regional measurements of mountain snowpack, river flows, coastal ocean circulation, air pollution and circulation, earthquakes, soil moisture, fire hazard, fish populations and many other things. The May council meeting focused on regional climate change analysis and response, and CCST will continue to work on energy and climate related issues with the state in the years to come.

Shaping the Future

California's Response to *Rising above the Gathering Storm*



"My vision for California is complementary in several important ways to the recommendations put forth by the National Academies in its report *Rising Above the Gathering Storm*... CCST is especially well positioned to help the State understand its capabilities and to recommend strategies to meet these goals."

Governor Arnold Schwarzenegger

Four CEO-led task forces convened by CCST to respond to the National Academies' *Rising Above the Gathering Storm* report delivered a strong message to Governor Schwarzenegger in December.

The task forces were convened by CCST in response to the Governor's request. CCST was considered the appropriate organization to convene the task forces because of its ability to bring together leaders from industry, education, and the federal laboratories. The task forces were chaired by industry leaders, as industry is the driver of the state's economy, and science and technology workforce issues affect industry directly.

The task forces were chaired by John Bryson, chairman, CEO & president of Edison International; Alexis Livanos, corporate vice president and president of Space Technology, Northrop Grumman; Corey Goodman, president, CEO and co-founder of Renovis, Inc.; and Larry Papay, CEO and principal of PQR, LLC. Task force members included other members from industry, including Stephen D. Bechtel, Jr., chairman retired and director, Bechtel Group, Inc.; federal laboratories; higher education system; and practicing classroom teachers, through the California Teacher Advisory Council (Cal TAC).

The task forces offered four key recommendations for the governor focusing on bringing and keeping top science and technology talent to the state, and ensuring that the state develops a mechanism to keep S&T issues in the forefront of its policy considerations down the road.

Since its delivery to the governor, *Shaping the Future: California's Response to "Rising Above the Gathering Storm"* has led to numerous discussions between CCST and a variety of institutions on implementing the recommendations in the report. The recommendation to invest in innovation and R&D was reflected in Governor Schwarzenegger's \$95 million Research and Innovation Initiative, announced in December 2006 after receipt of the CCST report. This initiative provides funding for major projects such as the Energy Biosciences Institute intended to grow California's economic strength in key innovation sectors, including clean energy technologies, biotechnology and nanotechnology. The governor's commitment of such substantial resources to innovation was a central factor in the subsequent decision of BP to award a \$500 million energy research program to UC Berkeley and the Lawrence Berkeley National Laboratory.

In addition, the governor's office requested that CCST develop an implementation plan for creating a science and technology policy function in the governor's office similar to the White House Office of Science and Technology, per another recommendation in *Shaping the Future*.

RECOMMENDATIONS TO THE GOVERNOR

“... We see the potential for your administration to leave a powerful legacy—an opportunity to chart the course for systematic and ongoing innovation, leadership, and achievement. Science and technology long have undergirded our state’s economy, but we also know that the future is anything but certain. We strongly believe that an opportunity exists now for bold actions that reassert California’s unique attributes as the premier S&T leader in the nation.”

- ▶ Initiate an aggressive “California Campaign for S&T Talent” by creating a highly competitive environment that attracts and retains top talent in science, technology, engineering, and mathematics (STEM), both from the U.S. and around the world. This initiative is about bringing to California the best and the brightest in all fields—including K-12 teaching—and it will require that we both increase our support for K-12 science and mathematics teachers and reexamine some of the difficult issues of immigration posed by a post-9/11 world.
- ▶ Fully leverage your position with the entertainment industry to make S&T education and careers the envy of all youngsters across all segments of California’s diverse population. Were you to lead this as a key communications campaign, your influence could generate enormous enthusiasm, and gain significant traction across a wide range of sectors—from students across diverse cultural and economic backgrounds, to K-12 teachers and leaders within higher education, entrepreneurial enterprises and industry.
- ▶ Create a science and technology policy function in the Governor’s office, similar to the White House Office of Science and Technology Policy. Doing so would elevate S&T issues to the place where they rightfully belong—among the highest of priorities in the state—and help ensure that California remains the most competitive location in the world for S&T education, research at the frontiers of knowledge, and innovation.
- ▶ Make California the most productive place in the world to do research and to innovate through strategic investments in research that address grand challenges and business-friendly policies that support investments in manufacturing and R&D.

Critical Path Analysis

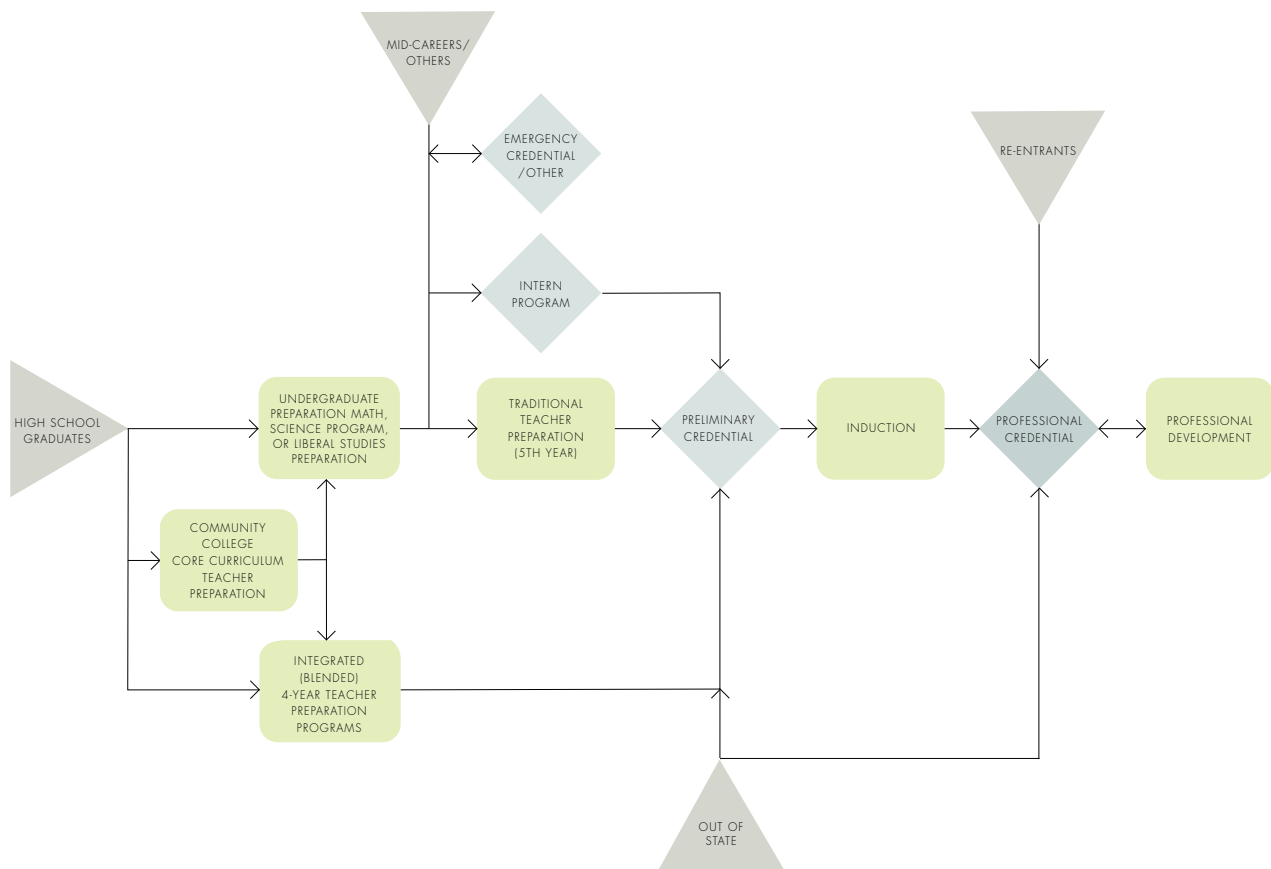
of California's Science and Mathematics Teacher Preparation System

"[CCST's] report concludes that strengthening the teaching of math and science is crucial if California is to maintain its competitive edge and economic growth. That is why it is imperative that we take steps to ensure that our children, as our future leaders, are fully prepared with the skills to take on the demands of the country's changing economy and workplace."

Senator Dianne Feinstein

California faces a persistent and critical shortage of fully prepared math and science teachers and lacks the capacity to produce enough math and science teachers to meet future needs, according to a report released in March 2007 by CCST and the Center for the Future of Teaching and Learning.

The *Critical Path Analysis of California's Science and Mathematics Teacher Preparation System* revealed that more than ten percent of all math and science teachers are underprepared, meaning they lack the training and experience necessary for a teaching credential in the subject they teach. More than one third of first and second year teaching math or science are underprepared. The report also finds that the percentage of underprepared math and science teachers is much higher in low performing schools. The report projects that due to attrition and retirement, the state will need to produce more than 16,000 new math and science teachers within five years and more than 33,000 over the next decade.



At the current rate of teacher preparation, California will fall short by 30 percent of the fully prepared math and science teachers needed by California schools.

Citing recent data projecting significant declines in personal income and a low rate of science, technology, engineering, and mathematics (STEM) degrees produced in California, the report concludes that strengthening the teaching of mathematics and science is critical if California is to maintain its competitive edge and economic growth.

The report has met with a positive reaction and spurred responses at both the federal and state levels. At the federal level, Senator Dianne Feinstein cited the CCST report in a statement of support for a bipartisan measure to strengthen federal investments in educational opportunities for math, science, engineering and technology, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science (COMPETES) Act (S. 761). At the state level, in response to the data in the *Critical Path Analysis*, State Senator Jack Scott announced the **California Math and Science Teacher Initiative** on March 7, consisting of a package of three related bills intended to increase the number of math and science teachers.

► **SB 112: Teachers: Basic Skills Proficiency**

This bill exempts retired teachers who return to service from basic skills proficiency requirements and specifies that retired teachers do not need to participate in induction programs for new teachers.

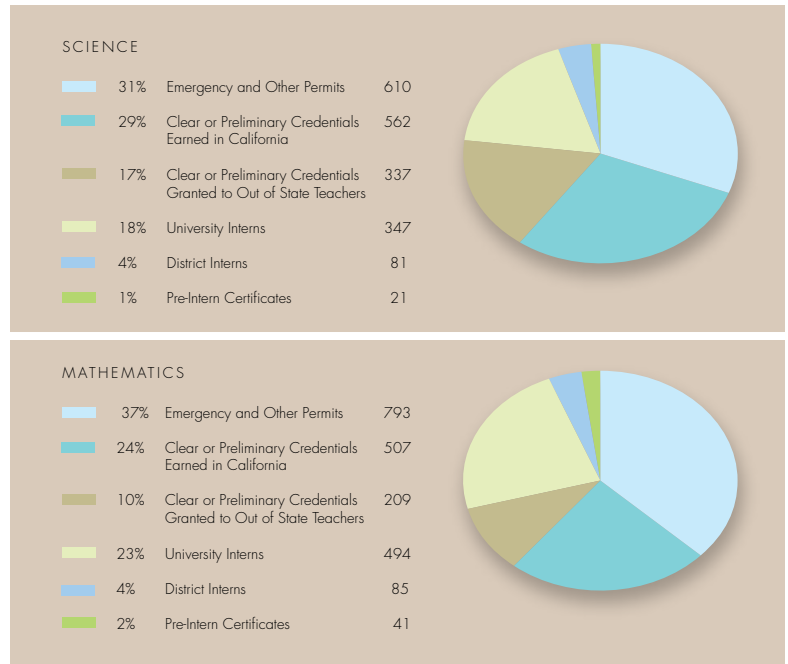
► **SB 858: Teacher Credentialing**

This bill encourages experienced teachers and retiring professionals to become qualified to teach mathematics and science. It also provides incentive funding of up to \$2,500 per teacher to school districts and county offices of education to assist teachers to acquire math or science content knowledge.

► **SB 859: Teacher Credentialing**

Visiting Faculty Permits

This bill would authorize the Commission on Teacher Credentialing to issue or renew visiting faculty permits authorizing instruction in math or science to individuals who satisfy specified requirements.



Left: The teaching profession in California has developed many routes to preparation and entry, resulting in a complex and multifaceted process, but not necessarily a coherent system.

Above: Although definitive statewide hiring totals are not available, it is estimated that a substantial proportion of mathematics and science teachers hired in 2004–5 (the most recent year for which complete data are available) were either interns or hired with an emergency permit—up to 54% of newly hired science teachers, and up to 66% of newly hired math teachers.

Focal Point Series

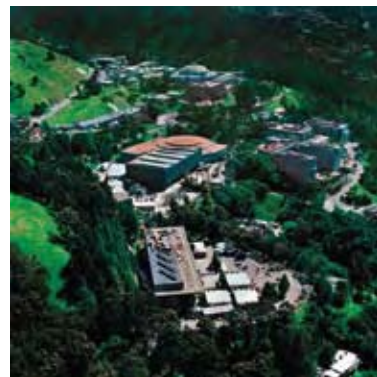
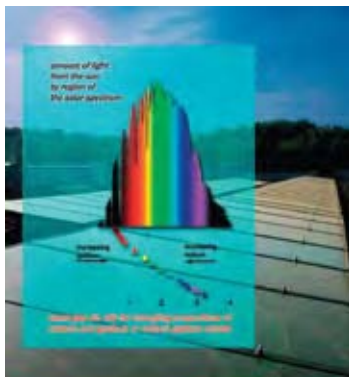
Following on its January 2006 report *California's Federal Laboratories: A State Resource*, CCST has launched a new publication series designed to highlight important technological contributions from the six largest federal laboratories in California—Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories/California, Stanford Linear Accelerator Center, NASA Jet Propulsion Laboratory, and the NASA Ames Research Center—which joined CCST as affiliate members in 2005. The Focal Point series explores a particular research area or project at each facility in much greater detail than the earlier report, highlighting their roles as vital catalysts for California's high-tech sector.

Lawrence Berkeley National Laboratory

Helping to Energize the California Economy

With one of the world's largest economies, California is also one of the biggest energy consumers. California leads the nation in its efforts to reduce the energy consumption of buildings, appliances, and industry, thanks largely to the innovative work of scientists and engineers at the Lawrence Berkeley National Laboratory. Berkeley Lab began to examine energy consumption in buildings during the mid-1970s, when particle physicist Arthur Rosenfeld helped create the Energy Efficient Buildings (EEB) program, which soon led to the Title 24 building codes in California requiring energy-efficient measures in new residences. The total statewide cost savings due to these codes is now estimated at \$4 to 5 billion annually, according to the California Energy Commission. Subsequent EEB work on energy consumption standards has contributed to a 2/3 reduction of energy usage by new refrigerators, specialized inexpensive roofing materials that absorb substantially less sunlight, research in low-energy LEDs, and the new multidisciplinary Helios Project.

Left: Various proportions of indium and gallium in the semiconductor allow indium gallium nitride absorb different parts of the solar spectrum corresponding to different "band-gap" energies as measured in electron volts. Thus a solar cell made with multiple layers of this alloy can convert more than half the sun's energy into electricity.
Right: Aerial view of Lawrence Berkeley National Laboratory.



NASA Ames Research Center

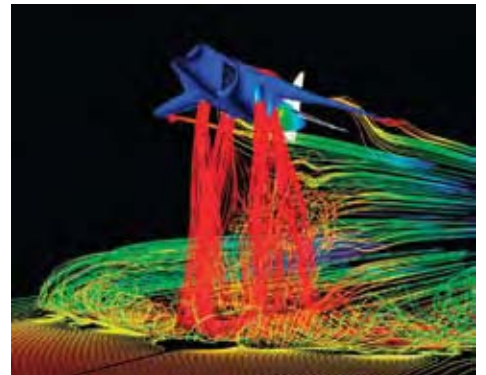
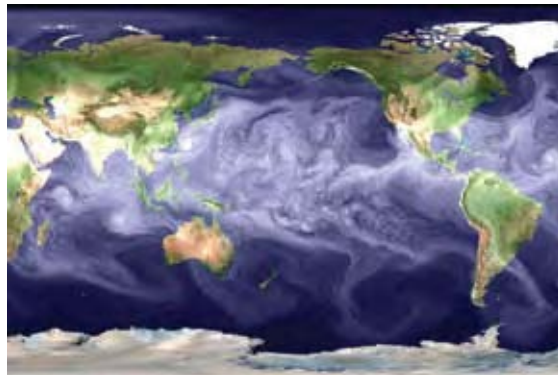
Computer Visualization in Three Dimensions

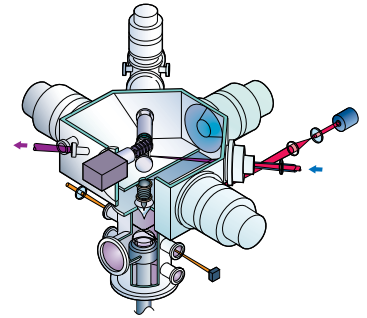
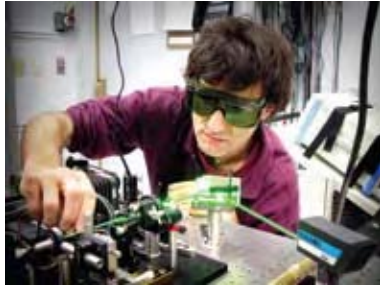
Three-dimensional computer graphic imagery has become commonplace in the entertainment industry, not to mention engineering, manufacturing, and medicine. The widespread use of 3-D computer graphics and visualization technology stems from the founding of Silicon Graphics, Inc (SGI) by former NASA Ames contractor James Clark. NASA Ames was its first major customer, and Ames programmers worked with SGI to develop the sophisticated software packages engineers needed for aerodynamic simulation and design. This mutually beneficial partnership has continued ever since, culminating with the installation at NASA Ames of the Columbia supercomputer in 2003. Built from 20 SGI® Altix® 3700 supercomputers, at the time it was installed it was the world's fastest supercomputer. Today, Columbia is used for complex aeronautical simulations, global warming studies, and supernova simulations.

Left: SGI computers and workstations were used to achieve the strikingly realistic animations of dinosaurs in Jurassic Park.

Center: Based on high-resolution models of ocean circulation, the Columbia supercomputer is being used to study global climate patterns, such as the effects of El Niño and global warming of the planet.

Right: A computer simulation of a Harrier vertical take-off fighter developed by NASA Ames engineers on a Silicon Graphics workstation.





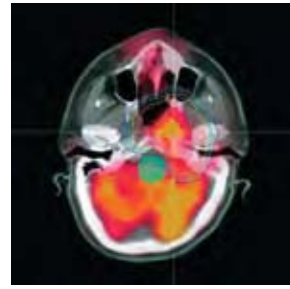
Left: Combustion Research Facility staff member Dahv Kliner is part of a team working on fiber laser technology. Fiber lasers hold great promise for a wide range of applications because they are truly solid-state with a minimum of exposed optical interfaces, have very high efficiency, and are capable of exceptional beam quality. Center: Laser beams are used to study a diesel engine designed for alternative fuels at Sandia's Combustion Research Facility.

Right: Cut-away drawing of a laser test facility used to study the dynamical structure and chemical composition of flames.

Sandia California Combustion Research Facility

Harnessing the Power of Fire

Many Californians can recall the years when their cars got less than 20 miles per gallon and thick smog blanketed the Los Angeles basin. But all that has changed, thanks in large part to the pioneering work of the Combustion Research Facility (CRF) at the Sandia National Laboratory in Livermore. The facility was born in the energy crisis of the 1970s, when researchers recognized that laser-diagnostic techniques developed to observe nuclear weapons tests could be adapted to study combustion processes. CRF research has led to major improvements in the efficiencies of burning coal, oil, natural gas, and even wood. For example, CRF research discovered that energy-conversion efficiencies in natural gas furnaces can be doubled with the use of pulsating jets of gas, a simple modification that has since been incorporated in many residential and commercial heating applications. But the principal thrust of CRF research remains in transportation, which accounts for over 40 percent of California's total energy use. A group of CRF researchers has been studying and developing a new generation of low-temperature internal-combustion engines. By operating with lean fuel-air mixtures at temperatures below 2000°C, these advanced diesel and spark-ignition engines should virtually eliminate soot and nitrogen-oxide formation. At the same time, their fuel-burning efficiencies can be improved by up to 50 percent over existing engines.



Stanford Linear Accelerator Center

Particle Accelerators Help to Advance Cancer Therapy

When Stanford physicists began building linear electron accelerators for particle physics research almost sixty years ago, they did not know that their research could be adapted for widely available medical treatment. Now, one in six Americans will eventually come face-to-face with a particle accelerator during their lifetimes, as the primary means of cancer radiotherapy. The world's leading producer of these radiation treatment systems, Varian Medical Systems Inc., has deep roots in the Stanford physics and electrical engineering departments going back six decades. The company's original goal was to take scientific and technological advances at the university and develop them into marketable products. The idea that linear accelerators might be adapted for cancer therapy arose at a lunch meeting between a physician and a Varian cofounder in 1950; today, Varian is a multibillion-dollar corporation whose systems treat over a million cancer patients annually. The close relationship between SLAC and Varian illustrates how basic research at a national laboratory can contribute to public welfare in unanticipated ways.

Left: Aerial view of SLAC, with the two-mile accelerator running diagonally from the upper right and passing beneath Interstate 280.
Center: Artist's cut-away view of the internal elements of a Clinac radiotherapy system. Several elements, including a set of 120 adjustable tungsten slats, precisely shape radiation so that it is concentrated as much as possible on the tumor under attack.
Right: Blended image from a Clinac treatment plan, showing the cross-section of a patient's head.

CCST Around the State

Healthcare Information Technology (HIT)

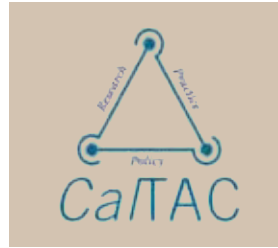
The state is continuing its focus on healthcare information technology (HIT), with new action by both the Legislature and the governor's office to enable the creation and management of an effective HIT system in California. CCST has been actively involved in advising both branches of government on the issues.

In March, the governor issued Executive Order S-06-07 aimed at advancing California's efforts to adopt health information technology (HIT), increase transparency of quality and pricing information, and increase accountability in public and private health care delivery systems. The executive order follows on a number of initiatives related to HIT that the governor announced in January 2007, including the establishment of a Deputy Secretary of HIT and a State HIT Financing Advisory Committee to coordinate the state's HIT efforts and develop financing mechanisms; implementing universal e-prescribing by 2010; developing standardized personal health records (PHR) within the public and private sectors; and implementing a county-level pilot electronic medical record system for mental health patients within the requirements of Proposition 63, the Mental Health Services Act.

On the legislative side, SB 320 (Alquist), introduced in March 2007, establishes the California Health Care Information Infrastructure Program to provide all Californians with a personal health record, improve the quality of healthcare in California, and reduce the cost of healthcare through the advancement of information technology. Alquist introduced HIT legislation last year as well (SB 1338), which was superseded by EO S-12-06.

CCST has been focusing on the potential benefits of HIT to California since 2005, when it featured HIT as the principal theme of its October council meeting (held jointly with the Institute of Medicine). A study by the RAND Institute has suggested that the state could save as much as \$8 billion annually from greater efficiency, reduced medical errors, and improved quality of care. CalRHIO, in a separate analysis, found that without sharing patient records electronically, physicians could not find information previously recorded in a paper chart 30% of the time, and were not aware of 25% of patient prescriptions.

California Teacher Advisory Council (Cal TAC)



Left to right:
Cal TAC Chair Stan Hitomi,
Vice-chair Janet English, and
members Barbara Shannon
and John Peter Arvedson.

Over the past year, Cal TAC has been actively involved with CCST's education related projects. Cal TAC member Juliana Jones participated in the K-12 task force for *Shaping the Future: California's Response to "Rising Above the Gathering Storm"*, providing valuable 'real world' feedback to a group comprised mostly of industry leaders. Cal TAC members also provided important feedback on the *Critical Path Analysis of California's Science and Mathematics Teacher Preparation* report during its completion.

In February 2007, Cal TAC also participated in a meeting at the Beckman Center in Irvine that was organized by the National Research Council Center for Education. Cal TAC members served on the planning committee. "Enhancing Professional Development for Teachers: Potential Uses of Information Technology" brought together educators and academics from around California and the nation to examine the potential of online teacher professional development programs. The purpose of the meeting was to help understand the unique benefits possible through some of these programs, as well as challenges that are particular to an online environment. All California teachers are required to participate in professional development programs annually; while online professional development does not always offer the 'real time' participation benefits of participating directly in a workshop with other teachers, it offers opportunities for teachers to tap into content knowledge and professional communities that may not be present locally. With additional support in 2006-7 provided by the Bechtel Foundation and Washington Mutual, Cal TAC is preparing to look further at issues ranging from professional development to teacher content knowledge in the year to come.

Maintaining a Long-Term Vision

Science and technology policy have traditionally been the province of the federal government. Federal investment in R&D dwarfs public investment by the states, and Washington has the collective expertise of the National Academies to provide guidance on science and technology related issues.

States do not typically have this luxury. They benefit, of course, from the policy advice of the Academies; they avail themselves, to greater or lesser extents, of the expertise residing within their respective borders. But the form that science policy advice takes at the state level varies widely. Many states have some kind of appointed science advisor; some have advisory boards focused on a particular set of issues, generally concerning themselves with economic development. CCST, an independent state analogue to the National Research Council, is an unusual organization with no equivalents.

Yet, increasingly, states are taking a greater role in science and technology related policy decisions. With the federal government hobbled by financial constraints and political divisions, state policymakers have been pressing new initiatives - often with partners in business or foundations - to improve the climate for science-related innovation and education. Several states (California among them, of course) have devoted millions to fund stem cell research when the federal government would not. Pennsylvania is pursuing an ambitious program to promote energy independence, biosciences, nanotech, and 21st-century manufacturing. Georgia has set aside \$400 million to build research facilities and recruit top scholars. New Mexico is joining with Virgin Companies Chairman Richard Branson to build a spaceport.

There is a strong impetus at the state level to take charge of their respective science and technology policies. The movement offers the prospect of welcome clarity to a landscape of confusing, contradictory, or simply absent state policies while laboring to keep up with a rapidly changing high-tech world. But suitable information is vital to such a process, and states are not always equipped to collect it.

California is, fortunately, a notable exception. A number of CCST's recent projects have centered around translating federal policies and policy discussions into terms relevant for California. CCST prepared the first comprehensive examination of what a state-level set of intellectual property policies should include, and helped convert the broadly serious message of *Rising Above the Gathering Storm* into specific actions that California could take to address the challenges of slipping innovation and science and math education. But while it is important to amass such information, it is also important to retain what is learned through a viable institutional memory.

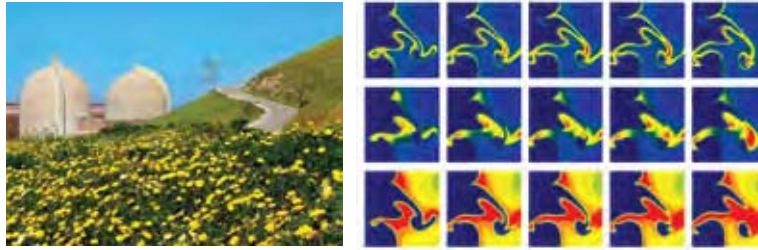
CCST is able to play this role to an extent. The recently proposed California Office of Science and Technology Policy, a position in the Governor's office recommended in CCST's *Shaping the Future: California's Response to "Rising Above the Gathering Storm,"* would be a significant and suitable step in the right direction. As states such as California step up to assert ever greater roles in driving U.S. innovation, it makes sense to ensure that science and technology policy receive the support and the informational infrastructure necessary to allow state policymakers to do their jobs.

Council Meeting Summaries

October 2006 – Major Theme
California's Energy Future

Robert Fri

Left: The Diablo Canyon Nuclear Energy facility in San Luis Obispo County. Together, the twin 1,100 megawatt reactors supply the electrical needs of more than 2.2 million people. Right: Supercomputer simulations of turbulent combustion processes.



Energy needs in California need to be put into context with respect to new data on sustainability and global warming and suggesting how to frame the costs, benefits, and trade-offs of California's complete energy needs in the short and long term, according to Robert Fri, vice-chair of the National Research Council Board on Energy and Environmental Systems.

“Imagining a sustainable energy future is difficult enough, but predicting how it will come about is really risky,” said Fri. “The challenge for energy policy is to foster technological innovation in the private sector that will meet national goals. The challenge for science and technology is to build the knowledge base that maximizes the opportunities for successful innovation.”

The issue of using nuclear power in California was a major component of discussion at the October meeting, which helped put into perspective the challenges and opportunities facing California in the production, distribution and use of clean, reliable energy sources and economical energy efficiency options, including nuclear energy.

“The time is right for a deeper analysis of the costs, benefits, and public perception issues concerning nuclear energy,” said CCST Executive Director Susan Hackwood. “Just the fact that we are seriously considering nuclear in our energy mix is a very strong signal to the rest of the country who may be considering nuclear energy but are further along than we are.”

The meeting was conducted in collaboration with the National Academy of Engineering.

January 2007 – Major Theme

Transportation, Energy, and Infrastructure

Lee Schipper



Left: The Santa Clara Valley Transportation Authority operates three 40-foot, low-floor, hydrogen fuel-cell buses as part of the Zero-Emission Bus Demonstration Program.

Center: Fuel cell hybrid buses are clean, quiet, electrically propelled vehicles that emit only water vapor from the tailpipe.

Right: Nissan Xterra fuel cell vehicle being fueled with hydrogen.

Technology and infrastructure are only part of the solution to developing sustainable transportation systems, said Lee Schipper, director of research at EMBARQ, the World Resources Institute (WRI) Center for Sustainable Transport.

“The technology really isn’t a limiting factor; the problem is that people lack incentives to change their behavior,” said Schipper. “The key is in choosing cost-effective technologies and using them effectively. Even an expensive, fuel-efficient bus will be wasteful if it is stuck in traffic all the time or carries few passengers.”

EMBARQ functions as a catalyst for socially, financially, and environmentally sound solutions to urban transport problems around the world. Established as a unique center within the WRI in 2002, it is now the hub of a network of centers for sustainable transport in developing countries.

“Culture and social factors are important in determining how transportation infrastructures are designed and implemented,” said Schipper. “There needs to be effective macro-management, which is governance – including engagement of the right stakeholders – and micro-management of behavioral factors.”

The development of effective and environmentally friendly transportation solutions is particularly critical for developing countries where high levels of pollution have a significant toll on health. However, a consistent long-term vision needs to be exerted in the United States as well.

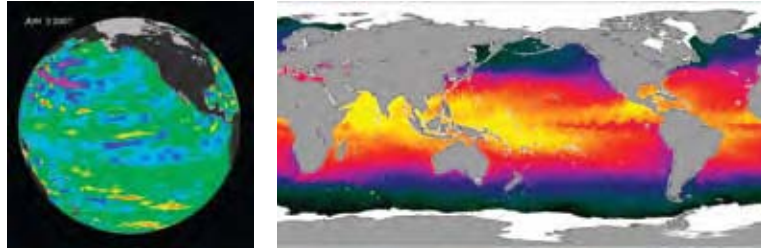
“Hybrids began as modest cars with excellent fuel economy, but now are giving way to hybrid SUVs with only modest fuel economy. We need stronger signals to channel the development of such technologies effectively.”

May 2007 – Major Theme
Regional Climate Change

Charles Kennel

Left: The data from the TOPEX/Poseidon and Jason satellite missions help us study and understand the complex interactions between the oceans and the atmosphere that affect global weather and climate events.

Right: An image of global sea surface temperatures taken by NASA's Aqua spacecraft.



With increasing consensus among policymakers that global warming is more than a hypothesis, the time is right for California to take on a leading role in understanding how climate change could affect it and how best to cope with it, according to CCST Fellow Charles Kennel, professor at the Scripps Institution of Oceanography at UC San Diego.

“We have already ‘bought’ climate change,” said Kennel. “A change in public opinion is occurring, and we are going beyond asking whether global change is real to developing solutions. But doing so requires an understanding of our own regional measurements of how climate change is affecting California.”

Regional climate change studies would enable the state to track such areas as mountain snowpack, which impacts the water supply. Being able to connect global climate change tangibly to regional impacts is essential to motivating appropriate state and local responses, according to Kennel, although doing so often requires smaller scale data than is currently available. Consequently, California may need to invest more in developing its own data collection on river flows, coastal ocean circulation, air pollution and circulation, earthquakes, soil moisture, fire hazard, fish populations and many other things.

“Talking about global temperature variations doesn’t have much meaning for the average citizen,” noted Kennel. “But talking about, for example, the effects on the California citrus crop due to such variations can be much more compelling.”

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Left to right: CCST Council Member Jeffrey Rudolph, CCST Council Vice-chair Cornelius “Neal” W. Sullivan, and CCST Board Chair Karl S. Pister.

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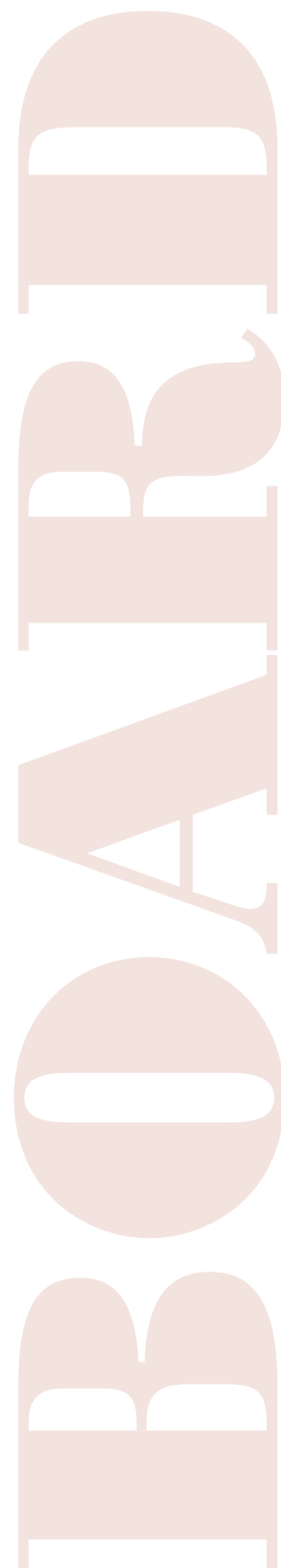
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