GOVERNOR'S GUIDE ON STATE RESEARCH & DEVELOPMENT FUNDS

NGA Center on Best Practices & Pew Center on the States

STATE PROFILE

CALIFORNIA

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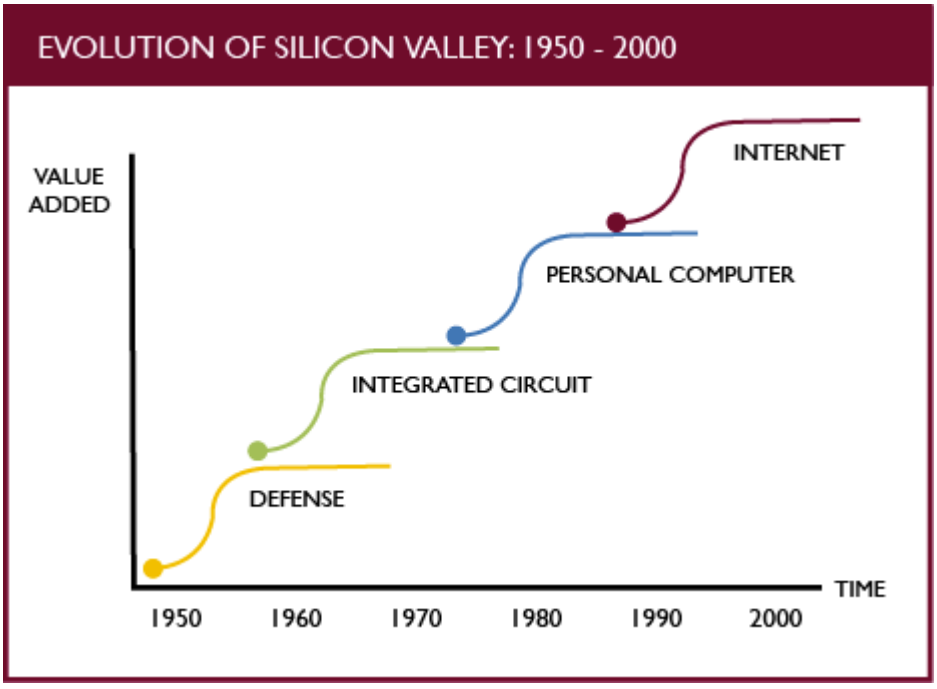
CALIFORNIA

WHY

While California is a national leader in overall R&D spending, the state has increasingly recognized that it has a role to play in bridging the gap between early stage research and commercial application. This gap was first recognized in the 1980s when the state's microelectronics industry was threatened by competition from Japan. Since the late 1980s a series of state initiatives have been launched to fill this gap through industry-university partnerships, matching grants to industry and most recently a several strategic investment funds focused technology fields such as stem cell research and clean energy.

Since World War II, beginning with the massive federal investment in the Manhattan Project at University of California followed by the establishment of several major national laboratories including Lawrence Berkeley and Lawrence Livermore as well as significant investment in the Apollo program, California became the national leader in technology during the decade of the 1950s and 1960s. While these large federal investments were mission driven - winning World War II and the Cold War and putting a man on the moon - they had commercial impact on the California economy through the growth of the aerospace industry both in Southern California and the Bay Area.

In addition, the state's innovative Master Plan for Higher Education in the 1950s established California's institutions of higher education, especially UC Berkeley, UCLA and UC San Diego, as leading public research universities. Silicon Valley evolved initially as a result of defense and space investment in the 1950s and 1960s into a private sector led by technology clusters - driven first by integrated circuits, then personal computers, software and internet with each wave setting the stage for the next. Even after the dot.com decline in 2000, a growing bioscience cluster has continued Silicon Valley's waves of innovation and there is now convergence of information and bioscience along with nanotechnology in the Valley's next evolution. This new wave is moving into new directions such as applications clean technology, as well as personalized medicine.



In the 1980s, as the semiconductor and computer industry began to face international competition, especially from Japan, the issue of competitiveness became a public policy issue. When semiconductor companies, many based in California, decided to organize Sematech as a collaborative effort to improve semiconductor manufacturing as a way to compete with Japan and then decide to locate Sematech in Austin, Texas and not Silicon Valley, this moved the competitiveness issue from an economic and policy discussion among business and academics to the political agenda. Both the Governor and Legislature decided to act by creating a California Council on Science and Technology to develop state Science and Technology Policy, and a California Competitive Technology Matching Grant program in 1988 after a series of reports on the state's competitive challenge.

While there is now a focus on innovation today as a result of the rise of China and India, it is important to recall that the competitive challenges facing California's economy today are not new. In fact a series of reports since the mid 1980s have identified the core challenges as increasing global competition, new technologies, and changing demographics.

> California's economic future depends on the ability of the public and private sectors to join together to build a strong foundation for competitive society. California and the United States face a series of difficult competitive challenges. Despite these challenges, a future of growing wealth, expanding employment and increasing opportunity can be achieved if certain factors critical to success are met. These include keeping California on the leading edge of technological innovation and entrepreneurship, promoting growth in high value productivity, enhancing international marketing and investing in human resources.
>
> California's Economic Future: Build New Foundations for A Competitive Society Report of the Joint Committee on Science and Technology January 1986.
>
> Technological advances, the growing internationalization of the economy and rapid population growth will change our economy and way of life perhaps more than any time in our history. New technologies in information processing, biotechnology and advanced materials will transform the world. The future promises changes that may not be satisfactory unless we shape it to meet our goals. The overriding message of this report is that "business as usual" will not maintain California's leadership position in the world.
>
> Vision: California 2010 Report prepared by the California Economic Development Corporation March 1988.

In the mid 1980s, a number of concerns had already surfaced about the California economy. These included the following:

- Foreign and domestic competition: Increasingly foreign competitors are finding they can compete with products made in California both on cost and quality.
- Rising cost of doing business: California has found firms deciding not to locate in the state or moving out because they find the cost of doing business too high relative to other places either in the United States or off shore.
- Declining quality of life: One of California's greatest attractions has been its high quality of life. It is now facing the challenge of preserving its natural environment in face of rapid growth and making necessary investments to maintain high quality transportation, parks and public facilities.

- Changing demographics: Immigration and aging are changing the demographics of California. Hispanics and Asians are the fastest growing population groups. The changing composition of the labor force presents employment and training challenges for California.

- Rising housing costs: Housing costs in California are the highest in the nation and have begun to act as a constraint of recruitment personnel.

- Water availability: In recent years, the state has not been able to reach consensus on how to get water to the southern part of the state.

- Uneven growth: While economic growth has been rapid in some urban regions of the state, other more rural regions have not shared in the prosperity of the state.

California: *The Megastate Economy* in The Economic Role of American States prepared for the Committee for Economic Development 1987

Many of the forces shaping the California economy in the 1980s are still important today.

Some of the solutions to these challenges are also clear. Here are the recommendations from the California Economic Strategy Panel established by the Legislature in 1993 to develop a statewide vision and strategy to guide public policy decisions for economic growth and competitiveness.

In its 2002 report California Economic Strategy Panel found

- California needs a focused strategy with responsibility shared for stewardship of the economy by business, workers, communities, education and training institutions as well as government to ensure the economic well being of our state and regions. California currently lacks this focused economic strategy with accountability for investment and outcomes.

- Local and state policy makers need reliable and timely economic information about the changing dynamics of industries and regions to improve decision making.

- Economic strategy and workforce development need to be better connected based on real time information and joint planning.

- Infrastructure investment needs to focus on the "triple bottom line" of economic impact, environmental sustainability and equitable development.

- Concerns about the rising cost of doing business in California need to be addressed through state policy reforms.

- The long term fiscal health of state and local government is dependent on a strong and competitive California. Ensuring such an economy requires strategic planning and state leadership combined with regional and local collaboration to ensure better accountability and investment through a stronger California economic leadership network.

California has been a national leader in technology and has faced a number of key competitive challenges for over two decades. While steps have been taken to address these challenges, according to many sources, including a recent report of the California Council on Science and Technology, the state has several technology programs and many research assets but still lacks an innovation strategy.

WHAT

Since the 1980s, California's technology programs have evolved from an initial focus on matching grants to institutional support for research institutions to investments in strategic R&D funds. There has been a shift in emphasis from funding university research to public-private partnerships with more industry leadership. California has many programs in addition to its overall university R&D funding.

Several of the studies of the California competitive challenge in the 1980s found that while California was a major recipient of federal R&D funding and its universities are leaders in early stage research, there was a perceived gap between upstream R&D and downstream application. In short, California was much better at the creation of new products and not as effective in production.
(Source *Vision: California 2010 Report prepared by the California Economic Development Corporation March 1988)*

In 1988, the California Council on Science and Technology was created to identify ways to bridge the gap, and the state trade and commerce agency was authorized to make competitive technology matching grants to help connect research with application. The competitive technology matching grant program evolved into a California Technology Investment Partnership Program. By 2000, the Program was spending $6 million on matching grants to industry to commercialize new technologies. In 2003, the California Legislature abolished the California Technology Trade and Commerce Agency and the Office of Strategic Technology that administered the program was transferred to the Business, Transportation and Housing Agency without budget authorization.

At the same time, there has been evolution in university-industry partnerships. The University of California has a long standing commitment to industry-university cooperation research. Since 1981, the MICRO Program has played an important role in nurturing the microelectronics and computer industry through an annual $4.6 million in matching grants. In 1996, the University established the Biotechnology STAR (Strategic Targets for Alliances in Research) project which awarded $12 million in matching grants to industry. In 2002, STAR and MICRO were then consolidated into the UC Discovery Grants that provide matching grants focused on six technology fields: biotechnology, microelectronics, communications and networking, digital media, electronics manufacturing, and information technology for the life sciences. Funding was $24 million from the state and university and $60 million from industry.

In 2001, the Governor and University of California launched California Institutes for Science and Innovation focused on establishing multidisciplinary, public-private partnership at UC campuses that would address strategic technology opportunities. $75 million annually was committed to the California Institute for Quantitative Biomedical Research (UCSF, UCB, UCSC), California Nanosystems Institute (UCLA, UCSB), Calit: California Institute for Telecommunications and Information Technology (UCSD, UCI) CITRIS: Center for Information Technology Research in the Interest of Society (UCB, UCD, UCM, UCSC)

In 2004, the voters of California voted for Proposition 71 to fund stem cell research. The measure authorized the issuance of bonds in amounts of $3 billion by the Institute for Regenerative Medicine. It authorizes up to $350 million in funding per year over a 10 year period. The Institute has developed its

strategic plan but the issuance of bonds has been delayed due to lawsuits. The Governor provided a $150 million loan to help start up the program.

Recently, the Governor authorized $95 million to support Green Energy, Biotech and Nanotech through university based projects. $30 million would go to the Helios Project at the Lawrence Berkeley Lab for sustainable energy research and $40 million in matching funds to attract an Energy Bioscience Institute funded by a $500 million competitive grant from British Petroleum. In January 2007, BP decided to locate the Institute at UC Berkeley. The Governor's Innovation Agenda also included $19.8 million for continued support for the four California Institutes of Science and Innovation sponsoring multidisciplinary research in biomedicine, nanotechnology and information technology at the state research universities.

CALIFORNIA TECHNOLOGY INVESTMENT PARTNERSHIP

In 1986, the California Legislature authorized the Competitive Technology Program which provided matching grants for universities to work with industry. The program was administered by the California Trade and Commerce Agency but the general consensus was that it was not very effective in stimulating industry engagement or promoting commercialization.

In 1993, in response to the Clinton Administration's Technology Reinvestment Program (defense conversion funding from Department of Defense) California's Trade and Commerce Agency created the California Technology Investment Program (CALTIP) and provided organizational funding to three Regional Technology Alliances: BARTA (Bay Area), LARTA (Los Angeles region), San Diego RTA. In 1996, the Trade and Commerce Agency added the Space Coast authority (initially the Central Coast RTA) These RTA funded projects provided $250,000 in matching grants to federal programs (TRP, ATP, SBIR—any nationally competed federal program was eligible for state matching funds). State funding for the program was allocated from the Petroleum Violation Escrow Account (a repository for settlement payments from 1970 oil overcharges) and the funds were overseen by a Defense Conversion Council established by the Legislature.

In 2003, CALTIP was terminated when the Legislature eliminated the Trade and Commerce Agency. According to OST, between 1994 and 2003, CALTIP spent $721 million of state funds through 237 awards leveraging approximately $210 million in federal and state funds. OST reported that approximately 20,000 direct jobs resulted from these investments. CALTIP had been administered by an Office of Strategic Technology in Trade and Commerce Agency. OST is now located as a division in the Business, Transportation and Housing Agency without the budget authority of CALTIP. The focus is linking government administration officials with technology stakeholders including establishing the Life Sciences CEO roundtable and promoting the deployment of broadband telecommunications.

UC DISCOVERY GRANTS

The Industry-University Research Cooperative Program (IUCRP) was established by University of California President Richard Atkinson (former Director of NSF and Chancellor at UC San Diego) in 1996 building on the success of the MICRO program established in 1981. The purpose of MICRO was to support innovative research in microelectronics technology and its applications in computer sciences by maintaining leadership by expanding cooperative research with industry as well as graduate education at the University of California. IUCRP expanded the university's focus to include bioscience with an initial base of funding of $3 million for UC and $5 million contribution for the state of California. In 1996, applications carrying commitments from the private sector grew to $8 million.

In 2002 IURCP reorganized as UC Discovery Grants focused on biotechnology, communications and networking, digital media, electronics manufacturing and new materials, information technology for life science, as well as microelectronics (the initial MICRO program. By 2006, UC Discovery Grants provides up to $60 million per year in state, industry and university funds for new research partnerships. Between 1996 and 2006, UC Discovery Grants have provided a total of $281 million in state, industry and UC investments.

The UC Discovery Grants:

- Promotes early stage research and aim at attracting talent to academic and commercial R&D communities in pursuit of a broad range of technology applications and needs.
- Creates incentives for research collaboration and alignment of different cultures and perspectives.
- Builds networks of research and R&D leaders and increases awareness of who wants what and who is doing what.
- Provides disciplined and accountable management and investment decision making that accommodates rapidly changing research opportunities and ensures quality through expert peer review.

According to the 2003 annual report IUCRP, UC Discovery Grants have

- Enabled 352 firms to strengthen their competitive R&D programs through partnerships with UC researchers.
- Drew more than 550 researchers into joint action with California companies on R&D problems relevant to the California Economy.
- Influenced the ability of promising young R&D firms to raise capital investments in very difficult economic times.
- Enabled competitive young firms to leverage substantially their very limited R&D funds through partnerships with UC researchers.

IUCRP Economic Research estimates that 336 UC Discovery grant sponsored firms resulted in 307 surviving firms (well above the average for surviving small firms) and created a net of 5,000 new jobs (primarily in smaller firms employing under 500) (Source: Annual Report 2003 Industry University Cooperative Research Program)

The board impact of the University on the biotechnology cluster in California is demonstrated by an assessment of the impact of the University of California on the state's biotechnology economy that found:

- 1 in 4 US public biotechnology firms is within 35 miles of a UC campus
- 1 in 6 US public biotechnology firms was founded by UC scientists

- 1 in 3 California biotechnology firms was founded by a UC scientist including 5 of the world's 10 largest: Amgen, Genetech, Idec, Applied Biosystems and Chiron

Source: *Assessing the Role of the University of California in the State's Biotechnology Economy* March 23 IUCRP Working paper 02-5

CALIFORNIA INSTITUTES OF SCIENCE AND INNOVATION

In 2000, California authorized $75 million annually for three years for four California Institutes for Science and Innovation at University of California campuses to promote multidisciplinary research in collaboration with industry on strategic technology challenges.

The California Institutes for Science and Innovation are an unprecedented three-way partnership between the state, California industry, and the University of California. Each focuses on a research field key to the future of California's economy, bringing together UC's world-class scientists and students with industry researchers in a cooperative research and education effort that will produce both new knowledge and the next generation of scientists and technological innovators. The California Institutes for Science and Innovation will undertake basic, multidisciplinary research on complex problems requiring the kind of scope, scale, duration, equipment, and facilities that they uniquely provide. The cooperative UC-industry effort will speed the delivery of public benefits through new products, technologies, services, and jobs.

The Institutes announced in December 2000 were:

- QB3: California Institute for Quantitative Biomedical Research (University of California San Francisco, UC Berkeley and UC Santa Cruz)

- Calit2California Institute for Telecommunication and Information Technology (UC San Diego, UC Irvine)

- CITRIS (Center for Information Technology and Research in the Interest of Society (UC Berkeley, UC Davis, UC Merced, UC Santa Cruz)

- CNSI California Nanosystems Institute (UCLA, UCSB)

The state provided initial capital expenses for the Institutes through revenue bonds. Ongoing expenses are within the annual state operating budget. Governor Schwarzenegger has proposed $19 million for operations of the Institutes in the current budget.

While it is too early to tell the impact of the program, each Institute has been promoting multidisciplinary research and educational programs across universities in partnership with industry. There is a required private sector match for each Institute and a requirement for multi industry partners. The expectation for the Institutes is stated by the Office of the President of the University of California as follows:

> In the last part of the 20th Century, California created the high tech and biotechnology innovations that formed today's New Economy. As we begin the 21st Century, the state of California, and the University of California and hundreds of leading edge businesses have joined together in an unprecedented partnership for the "Next New Economy."

> The new ideas and technologies developed by researchers at the California Institutes for Science and Innovation will help expand our economy into new industries and markets - and bring the benefits of innovation more quickly into the lives of people everywhere. These institutes will open the doors to new understanding, new applications and new products through essential research in biomedicine, bioengineering, nanosystems, telecommunications and information technology.

INSTITUTE FOR REGENERATIVE MEDICINE: STEM CELL FUND

In November 2004, the voters of California approved Proposition 71, the California Stem Cell Research and Cures Initiative establishing the California Institute for Regenerative Medicine to make grants and loans for stem cell research, for research facilities and for other research opportunities to realize therapies, protocols and medical procedures that will result in the cure for and/or substantial mitigation of, major diseases and injuries.

An Independent Citizen's Oversight Committee was authorized to govern the institute and create a strategic plan for the Institute. Proposition 71 also created the California Stem Cell Research and Cures Bond Act which authorizes $350,000 annually in bonds to be sold over the next decade up to at total of $3 billion.

The Institute has developed its strategic plan that identifies long term objectives over the next ten years. It proposes funding a series of 25 initiatives intended to advance stem cell research in California, including $822.8 million to develop and enhance fundamental knowledge of stem cell biology, $898.9 million for pre-clinical research and development and $656 million for clinical trials and related research as well as $272.7 million for renovation and construction of new laboratories and related facilities. At the end of 10 years, the Institute expects therapies to be advanced to early stage clinical trials.

Proposition 71 has been challenged by several law suits, so its implementation has been delayed until these lawsuits are settled. For example, the California Family Bioethics Council, National Tax Limitation Foundation and People's Advocate have claimed that the stem cell institute is unconstitutional. However, after a Superior Court in Alameda County, CA ruled that Proposition 71 was constitutional in its entirety, CIRM decided to move forward on its initial grants, despite continuing legal challenges and appeals. CIRM announced $12 million to train the next generation of stem cell researchers using funds from $14 million in bond anticipation notes in April 2006.

Using part of the $150 million loan from the Governor and additional private foundation funding, CIRM announced it first round of peer reviewed research grants in February 2007. There were 2321 applications from 36 California institutions, 72 two year grants were awarded totaling $45 million. 20 state universities and nonprofit institutions received grants. Examples of grants include a researcher who plans to study what happens when stem cells are injected into the damaged hearts of mice. Another researcher plans to evaluate how these cells can be turned into possible treatments by adding or subtracting genes.

At the February 2007 announcement event, Governor Arnold Schwarzenegger said:

> "Today we are making history by approving the first grants for stem cell research. We all know that we cannot afford to wait when it comes to advancing life science. This research brings hope for an eventual end to suffering from chronic disease—such as Alzheimer's disease, cancer and multiple sclerosis—and a promise for people who love someone with one of these terrible illnesses."

While there is much hope and anticipation for cures from stem cell research, the California Council on Science and Technology cautions "that research may take years, decades even, before payoffs in the form of therapies and treatments are seen."

In addition, CCST expresses concern that heightened expectations about quick returns on investment could result in policies that require unrealistic revenue returns to the state. CCST's report states that while it is unlikely that the program will quickly generate a new direct revenue stream to the state, over the long term substantial economic benefits can be expected to come through the creation of new jobs and industries and associated increased taxes.

CCST recommends priority is given to publication of research over licensing. Making research tools developed by CIRM funding largely available to other scientists is critical. "Progress in stem cell research, like other research, will depend on researchers' ability to access and use information in the public domain and to combine public and proprietary data into new databases as well as reevaluate and reuse existing data" As a result, CCST urges CIRM and the state to proceed with caution and not set overly prescriptive policies for intellectual property. The report emphasizes balancing the state's interest in receiving benefits from its investment in research with the need to bring actual therapies to market through workable IP agreements. The CCST encourages timely publication of research results to maximize public benefit from the project (Source: California Council on Science and Technology Policy *Framework for Intellectual Property Derived from Stem Cell Research in California* (2005)).

However, some legislation introduced in California seems to go in the opposite direction of the CCST recommendation as the state seeks a return on its investment. A bill introduced in February 2007 would require companies doing business with California's $3 billion stem-cell institute to give the state a larger portion of their revenue than the institute has proposed. The bill would require businesses that make products based on the institute's stem-cell grants to pay the state up to 5 percent of the product's lifetime revenue. Under a policy tentatively adopted Dec. 7 by the Institute, formally known as the California Institute for Regenerative Medicine, the most a company would pay the state would be 1 percent of its product's revenue, plus nine times the amount of the grant.

California's Stem Cell Initiative has stimulated much national attention both because of its size ($3 billion over 10 years) and the bioethical debate over stem cell research. Other states have either enacted stem cell programs or are considering them. A recent research paper by the noted Stanford Economist Roger Noll is worth considering as he says:

> This area of policy is at best difficult to implement effectively, but all the more difficult because these research programs are narrowly focused and highly controversial.
>
> The best advice to states that are embarking on these programs is not to try to be very innovative in creating agencies or policies to make grants or oversee IP rights. In practice, the federal government system of supporting fundamental research works quite well. Moreover, even if a state wants to pursue different objectives than the federal government and so design its grant-making institutions differently, state stem cell programs will not succeed if they ask grant recipients to behave a great deal differently than they are required from other larger sources of funds. As an illustration, Stanford University receives almost as much revenues in a year as CIRM is likely to spend on external grants in a decade. The lesson here is that CIRM cannot expect to have much leverage over either Stanford or the entities it supports. Any attempt to change the way research organizations do business with an annual expenditure of $300 million is doomed to failure.

Source: Roger Noll, The Politics and Economics of Implementing State Sponsored Embryonic Stem Cell Research

CIRM is using NIH peer review procedures and standard IP practices. The basic message is that any attempt to do otherwise would be a mistake.

ENERGY BIOSCIENCES INSTITUTE

The most recent California Fund is the Energy Bioscience Institute established in January 2007. British Petroleum (BP) announced that the University of California at Berkeley, in partnership with the University of Illinois Urbana-Champaign (UIUC) and Lawrence Berkeley National Laboratory, will receive a total of $500 million to host a research center dedicated to developing biofuel technologies. The Energy Biosciences Institute (EBI) will conduct both basic and applied biological research relevant to energy. BP and the university plan to launch research programs this summer.

UC Berkeley was one of five universities around the world invited to apply when BP announced last July that that the company would dedicate $500 million over the next 10 years to a biofuels research facility. Other applicants included UC San Diego, UIUC, Massachusetts Institute of Technology, Cambridge University, and Imperial College London. To improve the bid from the California universities, Gov. Arnold Schwarzenegger's proposed budget for fiscal year 2008 includes $40 million in lease revenue to support the research center if either of the two California institutions won. The state also plans to contribute $70 million to build a headquarters for the institute, which will temporarily be housed within existing buildings on campus.

Researchers initially will focus on developing renewable fuels for automobiles. This work will incorporate many areas of research and will include creating new biofuel components and enhancing the efficiency of fuel blends, improving the existing technologies that convert organic matter into biofuels, and developing new plant species that produce a higher fuel yield. Later investigations will address the conversion of heavy hydrocarbons to clean fuels, improved recovery from existing oil and gas reservoirs, and carbon sequestration. Much of the research produced by the institute will be commercialized through BP Alternative Energy, an offshoot of the corporation launched in 2005. In addition, up to 50 BP personnel will be placed on the campuses to carry out the work of the institute.

UC Berkeley will host the majority of EBI's 25 teams of researchers. BP Group CEO John Browne explained that UC Berkeley was chosen because of its strong track record of "big science," or long-term research involving multiple teams of researchers across many disciplines. The university plans to house EBI in the same building as other ongoing energy research projects to encourage cross-disciplinary thinking.

According to Tom Kalil, Assistant to the Chancellor at UC Berkeley, "BP knew they could not do this research themselves because they are an oil company. They came to UC Berkeley because they knew they couldn't solve this problem on their own." This is a good example of the emerging model of open innovation.

This new Institute fits very well with California's growing interest in clean technology - an opportunity for venture capital investment and a way to address the issue of climate change. California has become leader in this area with the enactment of AB 32, the California Global Warming Act, which requires reductions in carbon emissions, thereby stimulating the need for more innovative technologies such as biofuels.

HOW MUCH

While it is difficult to determine the exact amount of R&D spending by the state since so much is funded through the University of California, it is possible to estimate how much state R&D spending for these special funds is relative to total R&D spending in the state.

These California special R&D funds can be summarized as follows

UC Discovery Grants	$60 million per year
Institute of Science & Innovation	$20 million ($75 million capital spending)
Institute of Regenerative Medicine	$350 million annually
BP BioFuel Institute	$50 million annually
TOTAL	**$480 million (or about 1% of total R&D spending in California)**

As the nation's leading technology state, California ranks 1st among the 50 states in overall R&D expenditures from all sources ($55 billion). While it is the number one recipient of federal R&D ($14 billion), industry R&D ($42 billion) represents the vast majority of overall R&D spending in the state.

Industry is the leading performer of federal R&D in California receiving a near majority of federal funds with $7 billion. Department of Defense is by far the largest federal supporter of R&D in California spending $7.7 billion; NASA comes in second at $2.4 billion: HHS and DOE come in third and fourth at $2 billion and $1.6 billion respectively.

Universities performed $4.1 billion in R&D of which 57.6% came for the federal government. Industry funded $295 million of R&D at California universities. Leading recipients of industrial R&D include Stanford ($41 million), UC San Francisco ($35 million) UC San Diego ($35 million) and UCLA ($33 million).

More than half of federal R&D to California universities comes from HHS mostly from the NIH. The next largest source of federal support for university funding is NSF.

ROLE OF STATE R&D FUNDS IN THE INNOVATION SYSTEM

The finding that these State R&D funds represents a small percentage of the total of R&D spending in California suggests that it is more important to focus on how the state is spending these funds than how much they spend. In this regard, there is a unique bridging role that state R&D funds can play in the innovation system.

While federal R&D, especially funding for universities, provides support for fundamental research and industry R&D is focused primarily on commercialization and product development, state R&D funds can provide support for the essential "bridging" function that cover the gap between the two by creating an environment for translating ideas into commercial products and processes. Therefore, state R&D funds need to be structured in a way that supports interaction between researchers and industry, and builds strong linkages between fundamental research and application.

State R&D funds need to be industry led, focused on major technology opportunities facing the state and should promote "downstream" applications of new discoveries.

As Nathan Rosenberg of Stanford points out in *Inside the Black Box: Technology and Economics:*

> In addition to nourishing the supply side in a broad range of areas, intelligent policies must be directed at the institutional aspects of innovation processes, working to encourage the interaction of users and producers as well as the iterative interactions between basic and applied enterprises.

A STRATEGY FOR INNOVATION

The challenge facing California is not that it has too few technology initiatives, research assets or even special R&D funds on the supply side. The problem over the past several decades is that California does not have an innovation strategy that supports interaction between universities and industries and connects the demand side more effectively to California's wealth of R&D resources.

The California Council on Science and Technology was asked by the Governor to prepare a response to the National Academy of Sciences *Rising above the Gathering Storm* Report. CCST recommends a more strategic approach to science and technology including four basic recommendations:

- Create a cabinet level advisory function to the Governor to highlight the importance to the state of science and technology
- Invest in S&T research and innovation in California focused on "California's Grand Challenges" through a State Innovation Fund
- Create a "California Campaign" for S&T Talent
- Champion S&T in California: Annual California Innovation Awards, Make S&T attractive to young people

Source: California Council on Science and Technology Shaping the Future: California's Response to Rising Above the Gathering Storm 2006

At the same time, a group of private technology leadership organizations – TechNet, California Health Institute, Joint Venture: Silicon Valley and Silicon Valley Leadership Group have joined together as part of a "California Competes" Coalition to ask the Governor to make science and technology a priority for the state. Specifically, California Competes has asked for:

- Increased annual operating funds for the California Institutes for Science and Innovation
- Increased funding for higher education to train high quality K-12 math and science teachers
- A more strategic focus on science and technology within state government

LESSONS LEARNED (from Interviews)

- Create senior advisor to the Governor with experience in science and technology
- Not many state legislators are interested or aware of S&T issues and the problem has gotten worse with term limits
- Without legislative awareness, interest programs like CALTIP are terminated
- CALTIP had no champions in the legislature interested in technology
- The key is to make sure the grant programs are not politicized. (My note: Regional Technology Alliances as a way to allocate funds seems like an obvious way to politicize research and encourage "pork barrel" spending)
- There has been an evolution of programs in California from early matching grants that had strong university focus without much industry involvement (Competitive Technology Matching Grants) to programs that require more industry partnerships (CALTIP to Institutes for Science and Innovation) to industry driven models (BP Biofuels Institute). The direction is moving toward more industry driven.
- ROI is a problem because most return from R&D is long term
- You need to find business people who can see the whole industry, not just the needs of their company
- R&D funds have to be demand driven, set up intermediate metrics and demand accountability. Do not let universities set the research agenda
- The role of the state is "active management on the ground" to promote commercialization. NIH supports PI but does not encourage collaboration. Need more support for collaborative research like DARPA and SEMATECH (My note: early examples of Open Innovation?)
- States should act as catalyst to encourage business collaboration through research incentives
- States should focus on industry sectors that create wealth
- It takes a lot of time to get a good research program going. Stable funding is important because it takes time to generate results (My note: do states have the patience for long term research ROI)
- Definition of success: the training of scientist and engineering talent who are going to work in an industry and develop new knowledge and products. Training talent is most important (My note: this may be the key to UC Discovery Grants success)
- What needs to be done is build institutions that have momentum going so they can fight for themselves over the long term. The problem with most state governments (especially state commerce departments) is that they are not competent. State initiatives are short lived.

- UC Discovery Grant is successful because it builds on UC strengths - five areas- they fund on a peer review competitive process and they benefit from the fact that UC is a strong university in a dynamic economy. It is not difficult to find good proposals.

- In general, states in the US have done a poor job with R&D funds. California may be an exception but CA still needs a more focused strategy to leverage all its assets.

- Proposition 71, the California Stem Cell Initiative, was a one time phenomenon—the Bush Administration would not fund cell research, President Reagan died, Chris Reeves became an advocate and then died. Robert Klein, a venture capitalist mounted a public relations campaign for the ballot initiative.

- Most of the biotechnology community including BayBio, the largest biogroup in the Bay Area opposed Proposition 71 saying it would diverge research from other important areas

- NIH should support this work not states—this will change after the Bush Administration leaves office in two years.

- States should support generic life science research and education and not target narrowly on a specific area like stem cells

- States should avoid the "copy cat" phenomena. Just because CA did this doesn't mean others should. In fact it might be bad public policy with little economic payoff for states since results of R&D will be a public good

- The key lesson for states—focus on leveraging federal dollars through investments in early stage research (a kind of SBIR or like the UC Discovery Grant)

- UC Connect at UC San Diego is a good example of the kind of "bridging" mechanisms between university researchers and entrepreneurs within a cluster to promote interaction and conversation—a kind of public space. This has worked for bio in San Diego.

Interviews

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