# California Seeds Science Institutes with $300 Million

New nanoscience, wireless communications, and quantitative biology institutes are intended to forge collaboration among scientific disciplines and with industry, as well as fuel California's future economy.

Fifty years ago, there was no Silicon Valley. Thirty years ago, there was no biotech industry. Ten years ago, there was no Internet. Who knows what new enterprises will be created or what medical breakthroughs will result because of our institutes? But this we do know: Breakthroughs will occur. And I want to make sure they will occur right here in California." That was California Governor Gray Davis at his State of the State address in January 2000, when he pledged to seek $300 million to launch three interdisciplinary research institutes at the University of California.

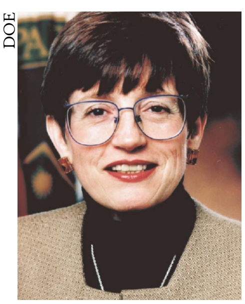
Less than a year later, in December, Davis announced the winners of a competition to become the California Institutes for Science and Innovation. They are the California NanoSystems Institute, with Los Angeles (UCLA) as the lead campus in a joint venture with Santa Barbara (UCSB); the California Institute for Bioengineering, Biotechnology and Quantitative Biomedicine, with San Francisco (UCSF) heading a three-way collaboration with Berkeley and Santa Cruz; and the California Institute for Telecommunications and Information Technology, with San Diego (UCSD) leading a partnership with Irvine (UCI). The governor also promised to ask the state legislature to seed a fourth institute, in information technology, which would be based at Berkeley.

The three institutes are starting off with a total of about $1 billion: $300 million from the state—$25 million apiece annually for four years—plus more than twice that in matching funds from industry, foundations, projected federal grants, and other nonstate sources. It's the largest state investment in basic research in California history, says Hilary McLean, a spokeswoman for the governor. "And what's being done here is on a much larger scale than we've heard of in other states."

"It's a very, very big deal," says Roberto Peccei, UCLA's vice chancellor for research. "At first, everyone was extraordinarily skeptical that we could raise the money in a short time—and whether it was a sensible idea to ask universities to work so closely with industry. I've changed my mind. It's a terrific idea. It opens lots of different avenues for universities, and creates natural and terrific partnerships. As a public university, it has been difficult competing with the really substantial endowments of our private friends. The new institutes give us a way to battle on a level playing field. They permit UC to remain at the forefront in research."

## Learning each other's languages

The California NanoSystems Institute "is very well poised to be highly competitive for federal investment," the institute's director, Martha Krebs, says, alluding to the multiagency National Nanotechnology Initiative, which has $422 million for fiscal year 2001. Krebs will liaise with industry and work to keep the institute in the black after state funding ends in four years. "This is a long-term effort to build the fundamental understanding of how nature works at the nanoscale. We are going to build from the beginning an environment where physicists, biologists, chemists, and engineers can work together and learn each other's languages—that's as much of a challenge as anything else." In her previous job as director of the US Department of Energy's Office of Science, Krebs says, "I spoke often about collaboration and partnership, and the fact that the science of the future will be at places where biology, chemistry, and physics intersect, and where universities and national labs and industry collaborate. That's what Governor Davis's concept is all about."



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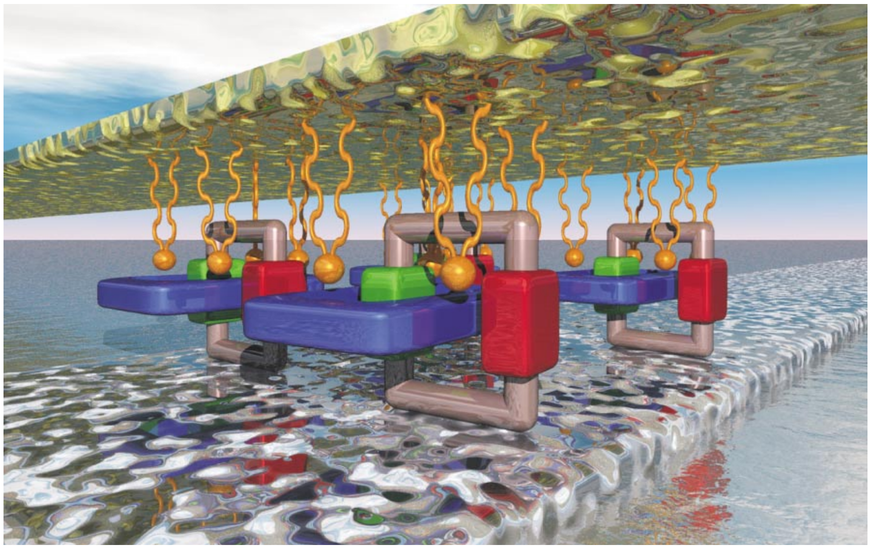
The thrust at the nanoscience institute will be to create miniature systems that may someday be used in electronics, computing, the environment, and molecular medicine. Planned projects involve, among other things, long-lasting quantum-dot lights, quantum computing, spintronics, molecular switches, and growing living cells on chips for medical research. One of the biggest challenges, says James Heath, a chemist at UCLA and one of the institute's codirectors of science, "will be to develop clean rooms that couple chemical and biological materials with silicon technology."

UCLA and UCSB will each get such a "dirty" clean room, in new buildings that will also house office and lab space. The plan is to have shared experimental equipment and flexible lab space for teaching, research, and industrial partners.

At all three institutes, the state money will go to erecting new buildings and buying large equipment. "Everyone has been overjoyed," says Heath. "Individual research groups [at UC] are well equipped, but user facilities are hard to come by. So here we have a great chance to get superb state-of-the-art research equipment. And, when you have $100 million from the state, it's leverage to get matching funds."

The UCSF-led California Institute for Bioengineering, Biotechnology and Quantitative Biomedicine will bring scientists together to study prevention, diagnosis, and treatment of disease, looking from the molecular up to the human scale, says biophysicist and institute director David Agard. The institute's initial research areas will include cellular molecular motors, prostate and breast cancer, and mining and analyzing vast databases to investigate the functions and behaviors of genes and proteins. Says Agard, "We want to better train biologists to be quantitative, and teach physicists what the problems in biology are. People are going to need this combined expertise. We can imagine tying all this together to tackle large-scale problems."

At the UCSD–UCI California Institute for Telecommunications and



**MOLECULAR SWITCHES:** An applied voltage rotates the vertical rings (crown ether), turning the catenane switches on—that is, increasing current flow across the molecules. In the off position, the blue rings (cyclobis(paraquat-paraphenylene)) encircle the green blocks (tetrathiafulvalene); in the on position, the blue rings encircle the red blocks (1,5-dioxynaphthalene). The catenane molecules are embedded in a layer of phospholipids (orange) and sandwiched between electrodes. Each junction of the criss-crossed electrodes can be independently switched. (From the work of the California NanoSystems Institute's James Heath, Fraser Stoddart, and colleagues. Schematic courtesy of Anthony Pease, UCLA.)

Information Technology, the idea is to create a wireless Internet infrastructure that would support remote monitoring and manipulation of, among other things, seismic measurements, city traffic, and medical sensors. "Wherever there is air, there are bits—that's the fundamental mission," says the institute's director, Larry Smarr.

As a testbed, Smarr says, UCSD is designing a new undergraduate college that will be "born wireless." Students will experiment, and be an experiment, with being hooked to the Internet all the time. One of the main tools in the making is a handheld "personal data assistant," which would continuously transmit and receive information to tell students, for example, where to find their friends or professors (and vice versa), when to go to class, and where they can find a parking spot. Along the same lines, UCI plans to build a "smart house," with infrared, heat, sound, bio-, and other sensors to automatically respond to the environment—doing everything from adjusting lighting, temperature, and music to transmitting the blood pressure and weight of the house's occupants to a medical clinic.

Basic research at the telecommunications institute, says UCSD physicist Ivan Schuller, coleader of research in materials and devices, will include fabricating and characterizing new materials, "miniaturization and nanostuff," quantum computing and communication, and "nonvolatile memory," which uses spintronics and other approaches to save data. "It's very interdisciplinary—the group includes physicists, chemists, engineers, and materials scientists." The institute will integrate research vertically, all the way from basic science to technology, Schuller adds.

In fact, that integration extends even further: "We are going to have people in policy, ethics, and regulations. With broadband Internet coming into tens of millions of American homes and wireless Internet allowing billions of new devices to join the global Internet, there are tremendous problems with privacy and security, and we will look at those as well," says Smarr. The issues are international, he adds, and include environmental health, setting technical standards, and sharing the electromagnetic spectrum.

## Fueling the economy

In knitting close ties between academia and industry, the new institutes are part of a worldwide trend. Says Schuller, "The governor has hit a chord. He is funding the scientific underpinnings of new technologies. Very few companies are still willing to look 20 years into the future."

"What everyone understands is that you can't do anything alone nowadays. That's not the way to fly anymore," says Stan Williams, head of quantum science research at Hewlett-Packard Co, which is investing $2 million a year in the nanosystems institute. For companies, he says, teaming up with the California Institutes for Science and Innovation "is an issue of cross-fertilization and of having people with different timelines come together. Finally, it's this word: leverage. We are supplying a significant amount of funding, and we get a lot of privileges for our investment." The arrangement, Williams adds, "gives us a sandbox to play in. We can try out weird and wonderful ideas without building a lot of infrastructure. If it works, wonderful. If not, no harm, no foul."

For their part, university researchers—each institute has 100–220 affiliated faculty members and a few dozen corporate partners—see the close collaboration with industry as a chance to both ensure the health of long-range research and give students and faculty a better sense of the links between fundamental research and applications. "We look on our work with industry as informing our research, rather than dictating its direction," says UCSB's Evelyn Hu, codirector of science with Heath at the nanosystems institute. The landscape of science is changing, adds David Awschalom, head of UCSB's center for spintronics and quantum computation, which has become a part of the nanosystems institute. "Look at the scanning tunneling microscope, the transistor. . . . It's remarkable how many Nobel Prize discoveries came from industry. Research was very much steeped in science and technology—from medicine to molecular electronics to quantum information. With the departure of basic research from industrial labs, it needs to be taken up somewhere. These institutes are being formed to train students in a very multidisciplinary way. It's a plan to break down the conventional academic barriers between departments, and blend with industry."

"I think these institutes will do what the governor wanted to do—use education and research as a basis to keep fueling the economy," says Hu. Williams predicts that start-up companies will spin off from the nanosystems institute, leading to the development of a "nanotech coast" along Highway 101 in Southern California. The other institutes, too, hope to spawn new incarnations of Silicon Valley. **TONI FEDER**