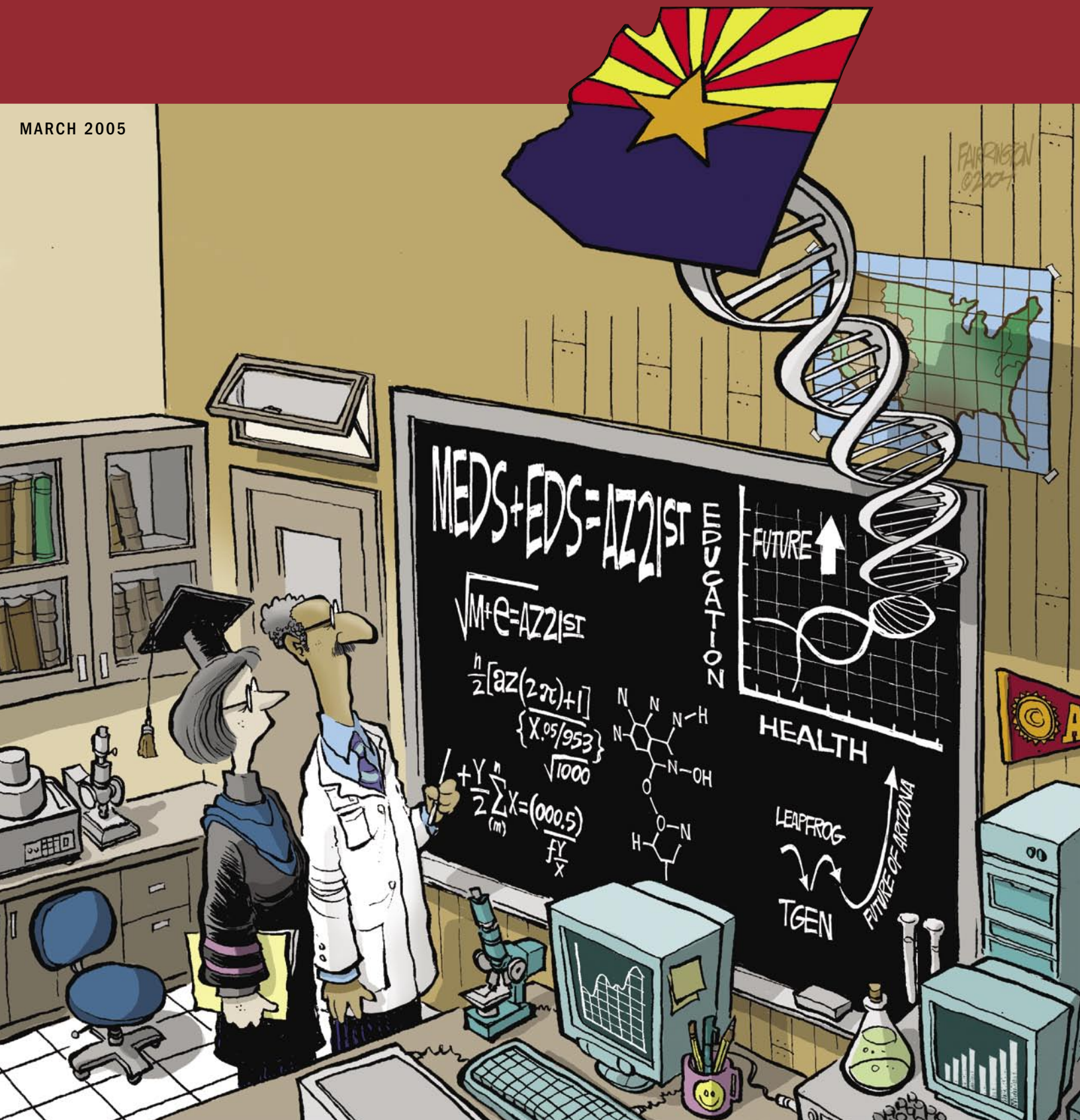
Meds and Eds

THE KEY TO ARIZONA LEAPFROGGING AHEAD IN THE 21ST CENTURY

MARCH 2005



Genesis of this Report

Much of the excitement in medical science and care is found in collaborative work between research and clinical practice. The Arizona Board of Regents has taken steps to ensure that collaboration is a hallmark of Arizona's educational and medical institutions.

In 2003, the Regents created the Arizona Biomedical Collaborative (ABC) to plan and coordinate joint efforts among Arizona's three universities. At the same time, the Regents created a committee, dubbed the Health Sciences CEO Input Group, to focus on coordinating health research and health care efforts and to ensure that vital knowledge and information is transmitted to Arizona policy makers and citizens. Chaired by Regents Don Ulrich and Ernest Calderon, this CEO Group consists of chief executive officers for the state's universities, community colleges, hospitals and health care enterprises.

In July 2004, this group asked Mary Jo Waits to analyze the challenges that lie ahead and frame the issues that require collaborative work — largely because of her track record with such reports as *Five Shoes Waiting to Drop on Arizona's Future*, when she served as Associate Director of the Morrison Institute for Public Policy. We are pleased to share *Meds and Eds: The Key to Arizona Leapfrogging Ahead in the 21st Century* with Arizona leaders and citizens.

Funded by Horace W. Steele Foundation

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Publication Design by Rain Visual Strategy + Design

Cover Art by Brian Farrington

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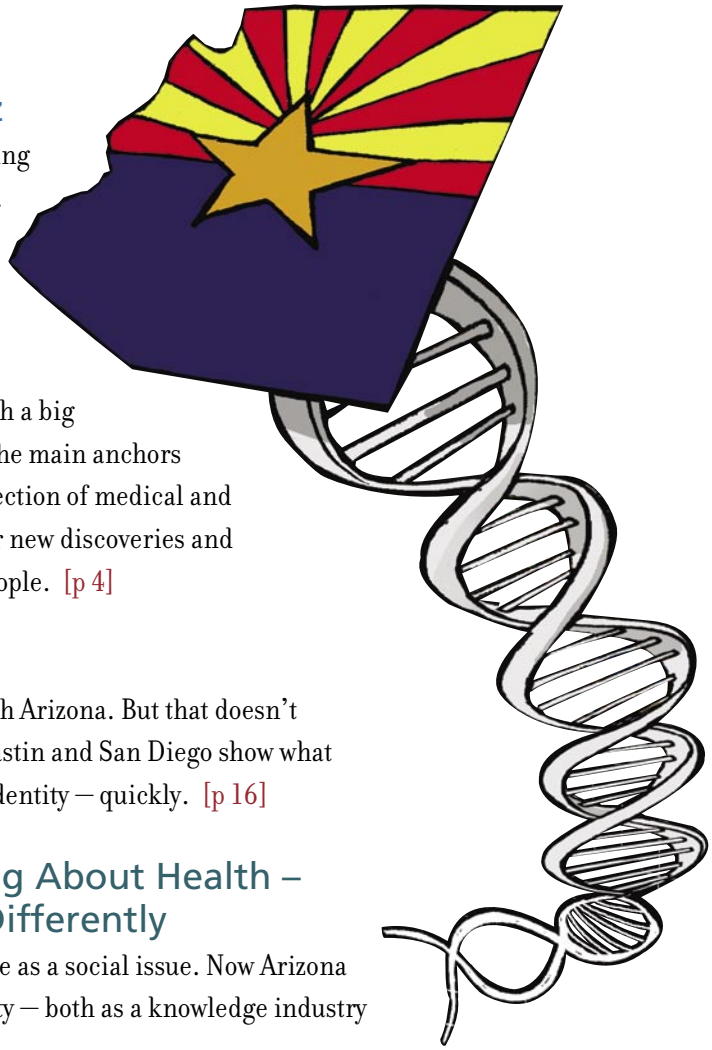


ARIZONA'S GOT BUZZ — GOOD BUZZ

WE'VE GOT new-arrival talent like Nobel Prize winner Ed Prescott at Arizona State University and TGen President Jeffrey Trent.

WE'VE GOT visionary university leaders like Michael Crow at Arizona State University and Peter Likins at the University of Arizona — each aiming to make Arizona's universities among the leaders in the nation.

WE'VE GOT regional stewards — such as Penn West CEO Bill Post, Arizona Republic CEO Sue Clarke Johnson, DMB President Drew Brown, former ASU-chief Lattie Coor — who are refusing to stick their head in the sand and are focusing instead on keeping "The Five Shoes" from dropping on Arizona's future.

WE'VE GOT cities thinking out-of-the-box — Phoenix anchoring its downtown revitalization with "knowledge assets;" Scottsdale turning Los Arcos into a tech and innovation hub rather than a shopping center.

WE'VE GOT foundations building Arizona's intellectual capital — Flinn in the biosciences, Rodel in education, and Piper and Flinn in world-class culture.

WE'VE GOT two governors in a row focused on big change — Proposition 301 from Governor Hull and funding for all-day kindergarten from Governor Napolitano.

In other words, Arizona is getting the "right people on the bus," as *Good to Great* author Jim Collins might say, and "Bus Arizona" is headed in the right direction — towards the 21st century.

But we've been here before. The state has a long history of leading the nation in vision and strategies — from its award-winning groundwater management code to its much-copied cluster-based economic development strategy to its trend-setting charter schools legislation.

Yet Arizona has rarely been able to shake off low rankings in critical areas. And the state has always had trouble reinventing its economy when it really counts.

This history leads us to whisper a "code blue." There's real danger ahead.

And that danger is in the very area where Arizona has pinned its hopes — the scramble for a big chunk of the emerging bioscience economy.

Code Blue

Arizona is going after the biosciences in a big way. That's a good thing, because the 21st century has been dubbed "the biology century." But as it does, the state faces two major challenges:

First, the state has some serious kinks in its "Meds and Eds" base — the medical and educational institutions that serve as the foundation for the biosciences. Among the kinks:

>> **Talent Shortages:** Arizona has among the lowest number of working nurses and physicians per capita of all 50 states.

>> **Research Weaknesses:** Arizona's universities are not top ten in capturing science and technology research dollars or producing patents, startups and commercial ventures.

>> **Medical Schools:** Unlike most bioscience leaders, Arizona lacks a top 25 medical school — more precisely, a research-focused medical school.

>> **Health Care Transformation:** Along with talent troubles, the industry faces pressure to find new cures, lower costs, and end the fragmentation that impedes better health care.

These kinks will need to be fixed. Arizona won't lead in medical discoveries unless its universities and research centers are loaded with top talent and research dollars. And it won't lead in patient care unless its hospitals and clinics are loaded with plenty of nurses and physicians.

Second, Arizona is behind the curve. Boston has been thriving on a super-cluster of Meds and Eds for centuries. Others are far ahead as well. So simply playing "catch up" isn't going to work. Arizona must take its cue from younger regions such as Austin and San Diego. These two regions have "leapfrogged ahead" of the competition in science and technology by creating new assets such as research institutions, university strengthens and clinical institutions — and combining them with existing assets in new ways.

This report probes these realities, serving both as a synthesis of the Meds and Eds evidence and a call to action for the state. Arizona has already taken many important steps in the biosciences arena — but the state must do more. We have a great opportunity to improve both our economy and our quality of life by strengthening the Meds and Eds. But to leapfrog ahead, Arizona must think about Meds and Eds in a whole new way — as an economic driver — and take several bold steps that are outlined in this report.

THE MEDS AND EDS CENTURY

The 21st century will be the century of biology. The most obvious sign of biology's ascendance is the mapping of the human genome. But this breakthrough is hardly the entire story. It is really the beginning of a new era of economic growth that will revolve around human health.

In the decades ahead, advances in human health will be part of the worldwide competition for prosperity and quality of life. On the demand side, people will want better health care and seek out locations where it is readily available. On the supply side, those companies and institutions that are on the leading edge of biomedical advances and health services will shape quality of life, spawn new industries and drive regional prosperity in the 21st century.

For states and regions, this new era of biology is the best of times and the worst of times. The main anchors of this century will be "Meds and Eds"— the medical and educational institutions that form the foundation for researching advances in health and then use those advances to help people.

The good news is that these institutions are deeply embedded in American communities and are not easily "outsourced" overseas — making them an excellent bet for prosperity in the 21st century. Furthermore, they can be magnets for millions of dollars in research grants and top scientists, and for companies that benefit from close association with cutting-edge research and talent.

At the same time, however, not all states and regions are ready to face the Meds and Eds century — and not all of them will be winners. In a recent report on biotechnology, the Brookings Institution reported that about one-quarter of the nation's 50 largest metropolitan areas is ahead of the Meds and Eds curve, while one-quarter is far behind and about half is in the middle *(Cortright and Mayer, 2002)*. Another recent survey found that 41 of the 50 states have engaged in some kind of effort to lure the biosciences *(Battelle, 2002)*.

Most of these strategies are big on rhetoric and short on new dollars. But some of them are real. Palm Beach County, Florida, for example, is spending $200 million to purchase the land and build an East Coast facility for the Scripps Research Institute, while the state is covering the institute's operating cost for the first seven years — totaling another $310 million. In Kansas City, American Century Funds founder James Stowers is spending close to $1 billion to build a mega-biomedical research complex, and leaving another billion on the table to endow its growth. In Indiana, Lilly Endowment Inc. has offered $100 million to recruit "intellectual capital"— star researchers, faculty and students — to the state's colleges and universities.

That's big money being invested in Meds and Eds. In the past, cities and states looking for an economic boost have laid out this kind of money only for automobile assembly plants, sports stadiums and the like. And while regional or statewide foundations often drop hundreds of millions of dollars, it's often to help the underprivileged, not the highly educated. All of which is a pretty strong indication of how seriously states and regions around the country are working to cash in on the pending marriage between the health sciences and health services.

These efforts are driven by five realities that all state and regional leaders — including those in Arizona — must understand if they hope to climb to dominance in health sciences and health services.

First, the 21st century will be driven by innovation — and so the coveted identity will not be "grown here" or "made here," but "invented here" and "started here."

Second, innovation is largely place-based — and most of the ingredients that give regions and states an innovative edge are created — not inherited.

Third, as the new economy moves more into biology-based innovation, health care is being recast as an economic priority — both as a knowledge industry (driven by new discoveries, cutting-edge technology and top talent) and as a quality of life amenity.

Fourth, Meds and Eds are a sustainable economic foundation for a state or region because — contrary to most worldwide trends today — they are rooted in place, they hold the potential to create a high-wage economy, and they can improve people's quality of life.

And finally, even though some states or regions have a big head start, it is still possible to leapfrog ahead of the competition in Meds and Eds, and therefore, get a leg up on the 21st century.

1. The Innovation Imperative

More than ever, regional prosperity in the 21st century will depend on new discoveries, new knowledge and new ideas. New technology and new markets will require far more research and development than ever before. And the value added to the worldwide economy will increasingly come from creativity — the generation of something new or original — not from actual production.

As Seth Godin writes in *Fast Company*, "The first 100 years of our country's history were about who could build the biggest, most efficient farm. The second 100 years were about the race to build efficient factories. The third 100 years are about ideas."

Godin has captured the essence of prize-winning Stanford economist Paul Romer's New Growth Theory. Romer makes the case that, in advanced economies, smart people and new ideas are the primary catalysts for economic growth *(Romer 1994)*. This stands in marked contrast to the raw material of our previous agricultural and industrial economy: natural resources, low-cost labor and mass production abilities.

New ideas — or what Romer calls "recipes"— generate growth by reorganizing physical resources (natural, human, capital) in more efficient and productive ways. Think about what's valuable in a floppy disk or a latte: it's not merely the ingredients (iron oxide, coffee beans), which have been around forever, but the new ways the ingredients are combined and presented to the customer. Today, new recipes are fundamental to devising new products, services, technologies, business models, and ways to make a living.

We are just beginning to understand the recipes possible with nanotechnology and biology, as Charles Lieber, Harvard Chemistry Professor and co-founder of Nanosys, notes:

> **Nanotech:** "You start with building blocks like nanowires, nanotubes and nanoparticles. Put together one way, these building blocks make a computer. Put together in a different way, they make a biological sensor."
>
> **Biology:** "You have a limited number of building blocks, like proteins and DNA. Depending on how you put them together, you end up with a tissue, a worm or a human being."

So the companies and regions that will prosper in the 21st century — especially in the United States — will be those that master the innovation process. For industry, the challenge is to be an innovation machine that can churn out new ideas, new discoveries, new knowledge in assembly-line fashion. For states, the challenge is to elevate their economy and brand from "grown here" and "made here" to "invented here" and "started here."

People within the innovation world have found that it takes three key ingredients to be an innovative place — whether a company, research facility or region.

1. Expertise in the form of smart, talented people and strong research and development capacity.

2. Interaction in the form of strong networks, well-designed research facilities and compact geographic areas that facilitate easy interaction and spontaneous dialogue.

3. Diversity, in the sense that people from disparate knowledge fields and cultures must work together because "sparks fly" when people interact with people less like themselves.

Must-Haves for Innovation

An innovative place is not accidental. It's the result of strategic and sustained effort – and therefore can be a goal that any place can pursue. What are companies, universities, cities and states doing to make this happen?

1

They are building EXPERTISE by attracting world-class talent and developing strong research capabilities:

>> **Georgia** – The Georgia Research Alliance, established in 1993, brings together universities and businesses to build strength in biotechnology, advanced communications and environmental technology. The Alliance makes investments of $1.5 million for eminent scholars in each of the three focus areas. Forty have been recruited so far. That's halfway to the goal of 98.

>> **Indiana** – Lilly Endowment Inc. has committed $100 million to "recruit and retain intellectual capital" at Indiana colleges and universities. The program is necessary, says Lilly, because faculty salaries are below the national average and no Indiana college or university is on the list of the top 50 higher education institutions capturing federal research and development expenditures.

>> **University of Southern California** – This well-known private university has committed $100 million to some 100 high-profile professors over the next three years, focusing on three broad thematic areas. The reason: "stars" attract colleagues, research grants, top students and companies.

2

They are orchestrating INTERACTION through strong networks, well-designed research facilities and compact geographic areas:

>> **UCSD CONNECT** – The University of California in San Diego established CONNECT in 1985 to better assist startup companies and link UCSD, the region's primary research university, to the business community. CONNECT sponsors Meet the Entrepreneur and Meet the Researcher events.

>> **Arizona State University** – ASU has built the $69 million Biodesign Institute research facility to combine many of the university's biomedical and engineering programs.

>> **Research Triangle Park in North Carolina** – This area thrives on the close proximity of the University of North Carolina, Duke University, North Carolina State University and many other research institutions and companies.

3

They are ensuring that sparks fly by putting people from DIVERSE knowledge fields and cultures together:

>> **National Institutes of Health** – NIH – the leading funder of biomedical research in the nation – starts to use its grants to encourage interdisciplinary research and collaborations with industry.

>> **UC Discovery Grants** – State of California invests up to $20 million a year in UC Discovery Grants to encourage research at University of California's ten campuses and five medical centers in collaboration with California companies in five science and technology fields. Companies match grants $1:$1.

There's a lesson here for states. Most of the inputs for innovation these days are created — things like top scientists, networks, and multidisciplinary research. And that's different than it used to be.

In the 20th century, many states and regions — including Arizona — were successful largely because of what might be called "inherited" assets — a good climate, natural resources, a strategic geographical location. But it has become clear that 21st century places will succeed because of assets they build, not assets they inherit. The states that succeed in the 21st century will be the states that build these assets so that innovation is institutionalized. Instead of relying on chance, successful states will build strong multidisciplinary universities and research institutions, as well as engage and foster research and development divisions of major companies and encourage the spin-off of new firms and new industries, to create a system of mechanisms that makes innovation and entrepreneurship less random and more intentional.

This approach transforms universities and other research complexes — loaded with academic talent and research dollars — into the most highly prized economic assets of the 21st century. As CEOs for Cities recently reported, "the bell towers of academic institutions have replaced smokestacks as the drivers of the American urban economy" *(CEOs for Cities, 2003)*.

2. The Proximity Edge

The tremendous pressure on industry to innovate more — and do it more quickly — is transforming business location priorities. Two years ago, Intel Corporation opened "lablets"— small-sized research facilities. Instead of placing them next to its own fabrication laboratories — the typical practice — Intel placed the lablets adjacent to three top university research centers. And, in another step that's not typical, Intel won't own the research output. The company hopes instead to benefit from being connected more closely to leading academic research and gaining early access to promising new technologies *(Chesbrough, 2003)*.

Other companies are reaching out in more radical ways. Procter & Gamble, for example, has set a goal of obtaining 50 percent of its innovations from outside the company. Why? The answer is simple: There are 8,600 scientists and researchers inside the company; there are 1.5 million scientists on the outside.

That's a far cry from the traditional approach to research and development, which assumed that all knowledge of any significance lay within a corporation and needed to be maintained there, for control and profit. Harvard University Professor Henry Chesbrough calls that the "closed innovation" paradigm, in which companies assumed that they would hire the best and brightest people in an industry, develop new products and services internally, and bring those to market before competitors.

The new approach, which Chesbrough calls "open innovation," has companies increasingly searching the whole world for new innovations. But it also makes proximity to knowledge and technical expertise more important than ever.

Indeed, the proximity edge is one of the primary building blocks of the open innovation approach to creating and inventing new products. In large part, this is because top talent in the 21st century must be plugged in — plugged into the world, and plugged in with each other.

This can mean something as simple as having partnerships among researchers and scientists in government, universities, research institutions and private industry. But on a larger scale it means creating a critical mass of people who are located in close proximity to one another and have many opportunities to interact — even if they do not work on the same project.

The possibility of innovation increases exponentially once you start to network — and increases again when you put many people and institutions in close proximity.

Take, for example, the San Diego area, which is now one of the top biotech hubs in the country. In less than a generation, the region has created a densely packed two-mile area that includes the University of California at San Diego (UCSD), Scripps Research Institute, Salk Institute for Biomedical Studies and dozens of private companies. The density supports the "accidental collisions of ideas." As a vice president of the Salk Institute says "We can throw a rock and hit UCSD. I can hit a golf ball and hit Scripps. Everything is within walking distance. That means more heads get together, and we do a lot of collaboration" *(Nature, 2003)*.

Increasingly, cities and states are learning that companies competing on innovation are likely to be attracted to places that offer assets that can help them spur innovation — a rich research heritage, a critical mass of talent, a collaborative mind-set and cultural beacons *(Porter, 2001)*. This stands in stark contrast to companies that compete on cost, which will move great distances — even to other continents — in search of lower costs, leading them to China and other developing countries.

When Face-to-Face Interaction is a Location Priority

Product Age	Examples of Product	Location Priorities	Cost Sensitivity	Preferred Location Examples
Young	Biotech: new prescription drugs, diagnostic breakthroughs, medical devices	· Concentration of universities · High face-to-face interaction · Availability of talent from multiple disciplines: life sciences, health care, nanotechnology	Less sensitive to cost	San Diego, San Francisco, Boston
	New media: digital arts, Internet product development; web site design	· Urban lifestyle · High face-to-face interaction · Availability of talent from multiple disciplines: designers, computer technicians, advertising, telecommunications	Less sensitive to cost	Silicon Gulch, Silicon Alley
Mature	Small electronic goods manufacture, athletic shoes	Low cost entry level labor Low cost space Affordable low-income housing	Heavy sensitivity to cost	Far East, less-developed countries

Adapted from: Cohen, N. *Business Location Decision-Making and the Cities: Bringing Companies Back*, April 2000.

3. Health as a Knowledge Industry

Prosperity in the 21st century will be driven by innovation. But just as important, that innovation will have a focus: the improvement of human health.

Our new understanding of the code of life — genomics — has a broad swath of researchers across the world determined to ferret out the factors that confer disease and health on individuals. They are toiling in government labs, academic settings and tiny startups.

Many will figure out how to turn their research into products and fast growing enterprises — much like the two university researchers did with Hybritech 25 years ago in San Diego. It produced another 50 firms for the region, and was the seeding firm of the area's thriving life science industry cluster of today. It came to represent the most noticeable first step in economically elevating the region, far beyond being merely a pleasant location for conducting not-for-profit biomedical research.

This reality turns our traditional idea of health care on its head. For a long time, health care has been in the bailiwick of social policy, much like welfare or affordable housing. The question has been, how to provide low-income families with basic health care. But in the 21st century, there is a strong rationale for treating health as an economic opportunity. As companies realize the treasure trove hiding in the life sciences, a great deal of research and development money will flow into biology, creating all sorts of revolutionary products and well paying-jobs. And there is the prospect of ushering in entirely new industries such as bioinfomatics and genetic modification. According to Battelle, "four of the ten most strategic technological trends that will shape business and our world over the next 20 years are life sciences based."

But medical breakthroughs from companies such as Hybritech are only the beginning. Since many of these industries are still nascent fields of study by top university researchers and entrepreneurial R&D firms, it is the combination of health sciences research and health care delivery that makes health a truly driving industry. This combination includes many sectors — research centers, medical device manufactures, pharmaceuticals, research labs, clinics, hospitals, doctors' offices, bioinfomaticians, and telemedicine. Together these sectors are growing much faster than the nation's economy as a whole — due to an aging population, the increase in the number of treatable diseases, and the opportunity to prevent or delay diseases.

Where Innovation has been Explosive

Information Technology	Health Care
Television	Antibiotics
Transistors	MRI and CT
Microprocessors	Antidepressants
Fiber Optics and Lasers	Heart surgery and pacemakers
Internet	Transplants
Cellular Phones	Oral contraceptives
	Minimally invasive surgery
	Biotechnology

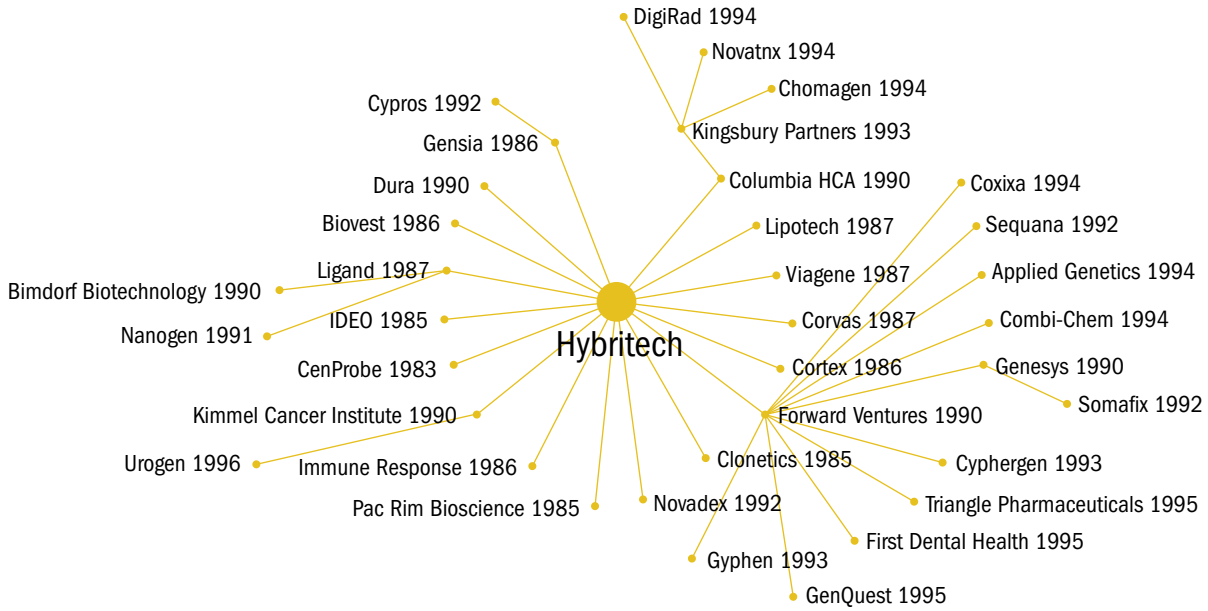
Source: *Business Week*, October 11, 2004.

Recipients of R&D Funding: The bulk of R&D fund increases are in just one area: biomedical research.

R&D Funding (billions)		Percent Increase 1997–2003
$25.70	**Life Sciences**	95.7%
$8.20	**Engineering**	43.0%
$4.70	**Physical Sciences**	14.3%
$3.50	**Environmental Sciences**	17.2%
$2.60	**Math & Computer Sciences**	44.4%
$1.40	**Other Sciences**	52.9%
$0.94	**Social Sciences**	20.6%
$0.86	**Psychology**	49.6%

Source: *Business Week*, October 11, 2004.

HYBRITECH, founded by two university researchers in 1978, produced more than 50 firms for San Diego's thriving biotech hub of today.



Source: *America's Biotech and Life Science Clusters*, Milken Institute, 2004.

Meanwhile, health care is increasingly seen as a "business climate" issue. It is a good bet that companies, researchers, workers and retirees will be attracted to locations with access to outstanding medical care. At the same time, employers in the 21st century will be seeking a healthier work force. We often talk about improving the educational system to create a skilled local work force capable of taking the high-wage jobs that states hope to create in the 21st century. But the health of these workers is equally important. Each worker represents a major investment in the new economy. A good health care system is required to maintain and enhance the productivity of highly skilled workers — and, hence, protect the investment made in educating them. Healthy people will work longer and more productively, which helps reduce the cost of training new workers. For these reasons, many companies are focusing efforts on wellness and prevention programs, areas in which many medical schools are lagging behind in their curricula.

> …it is the combination of health sciences research and health care delivery that makes health a truly driving industry.

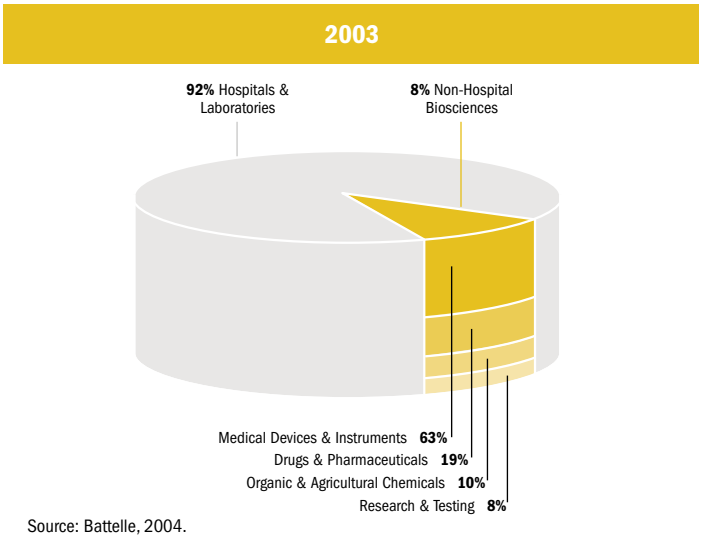
Powerful Combo

All these signals suggest that we are at the beginning of a new era. In the 21st century, prosperity will flow to those regions that create a compelling connection between health research and health practice. It is this combination that will make health a powerful economic engine. And it is the synergy of research and practice that will make the medical magic work. The regions that foster innovative business models connecting bioscience research with clinical health care will be on the cutting-edge of medical practice.

For example, it will take a tightly interwoven combination of health research and health service to lead in the field of personalized medicine — a future in which medications can be tailored to the individual's genetic makeup, minimizing side-effects or affording disease prevention. Researchers will create rapid breakthroughs in drugs and other therapy but physicians and other health care providers will make the "personalized" approach to medicine work.

Arizona's Health Employment is Dominated by Hospitals and Laboratories

As Arizona's health combo shows, it's the combination of health research and health practice that makes health a powerful economic engine.



Source: Battelle, 2004.

4. Meds and Eds as a Place-Based Economic Foundation

During the industrial age — and increasingly in the information age as well — states and regions have struggled with the question of how to sustain an economic base. Over the past century, most advantages that states and regions have used to promote prosperity — proximity to raw materials, the presence of a labor force, good transportation connections, a network of companies and suppliers in a given industry — have been erased by the falling cost of moving both information and goods. There is no longer a guarantee that any private-sector job — or, indeed, any private company — will remain rooted in any given city, region or state.

Meds and Eds, however, are different. Hospitals, medical schools, universities, and academic centers are deeply embedded in the cities and regions where they are located, and they are not footloose in the same sense that private companies are. Obviously, most medical centers and educational institutions have a "sunk cost" in land and facilities. For various reasons, these institutions have proven much less likely to abandon these sunk costs than manufacturers or other private corporations. One big reason is that Meds and Eds are bound together, with each playing important roles in enabling the other. For example, these institutions are unique in the way they combine education with service (clinical practice) and research. Each component is essential for a first-rate organization, which will fuel the economy.

These institutions are strongly identified with the cities and regions where they are located. They serve a local or regional market, and they often have strong relationships with — or are part of — the government and other local institutions. Huge amounts of their land, facility and talent costs are borne by local philanthropy and by government. Over time, through both research and service, they build a body of important knowledge about the region and its markets and population — a major investment and market advantage that would be foolish to discard and expensive to replicate somewhere else. Even their names usually have a geographical reference.

Meds and Eds Jobs Demand More Sophisticated Talents and are Hard to Send Overseas

Over the past decade, an era of rapid technological change and globalization, big employment gains came in occupations that rely on people skills and use analytic reasoning, imagination and creativity. Many jobs requiring muscle power, manual dexterity and formulaic intelligence moved increasingly to workers in other countries or were lost due to changing technology.

Human Talents	Occupations	Employment Gains (1992–2002)	% Change	Percent Change
People Skills/ Emotional Intelligence	Registered nurses	+512,000	+28	
	Financial-services	+248,000	+78	
	Lawyers	+182,000	+24	
	Educational and vocational counselors	+48,000	+21	
	Recreation workers	+35,000	+37	
Imagination/Creativity	Designers	+230,000	+43	
	Hairstylists and cosmetologists	+146,000	+19	
	Architects	+60,000	+44	
	Actors and directors	+59,000	+61	
	Photographers	+49,000	+38	
Analytic Reasoning	Legal assistants	+159,000	+66	
	Electronic engineers	+147,000	+28	
	Medical scientists	+22,000	+33	
	Metallurgical engineers	–2,000	–8	
	Computer operators	–367,000	–55	
Formulaic Intelligence	Cost and rate clerks	–16,000	–24	
	Health records technicians	–36,000	–63	
	Telephone operators	–98,000	–45	
	Bookkeepers	–247,000	–13	
	Secretaries and typists	–1,305,000	–30	
Manual Dexterity	Tool and die makers	–30,000	–23	
	Lathe operators	–30,000	–49	
	Typesetters	–34,000	–62	
	Butchers	–67,000	–23	
	Sewing machine operators	–347,000	–50	
Muscle Power	Garbage collectors	–2,000	–4	
	Stevedores	–3,000	–17	
	Fishing workers	–14,000	–27	
	Timber cutters	–25,000	–32	
	Farmworkers	–182,000	–20	

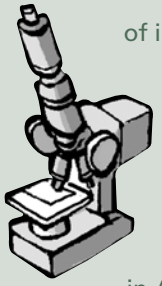
Source: Federal Reserve Bank of Dallas, 2004.

Furthermore, Meds and Eds are unusually dependent on highly skilled labor, such as doctors and nurses, professors and researchers, and clinical technicians. These individual workers can be footloose and are often recruited from one region to another by higher wages or new opportunities. By and large, however, these institutions attract and eventually nurture a highly educated and highly skilled labor force that is dependent on networks to foster and sustain productivity, and therefore is committed to staying in that region where their careers developed.

As the Federal Reserve Bank of Dallas points out, health care and education generate sophisticated jobs that "are hard to send overseas." Better still, health care is expected to be the hottest sector for job growth over the next few years — adding 3.5 million jobs nationally by 2012. Education is expected to add another 2.5 million jobs, partly because more adults are expected to go back to school and learn new trades and new skills, and partly because the children of the large baby boomer generation will continue to reach college age.

There is another way in which Meds and Eds institutions help anchor economic opportunity in the United States — and more particularly in regions: They can help attract the top talent that drives the economy. High-end talent is mobile – and it's concentrating in relatively few places. Such talent will stick around so long as the Meds and Eds institutions in which they work — and the local communities in which they live — offer critical ingredients that are not easily replicated.

Top-notch, well-funded Meds and Eds in close proximity to one another that creates the synergy required to create medical breakthroughs and new companies will help keep talent geographically rooted.

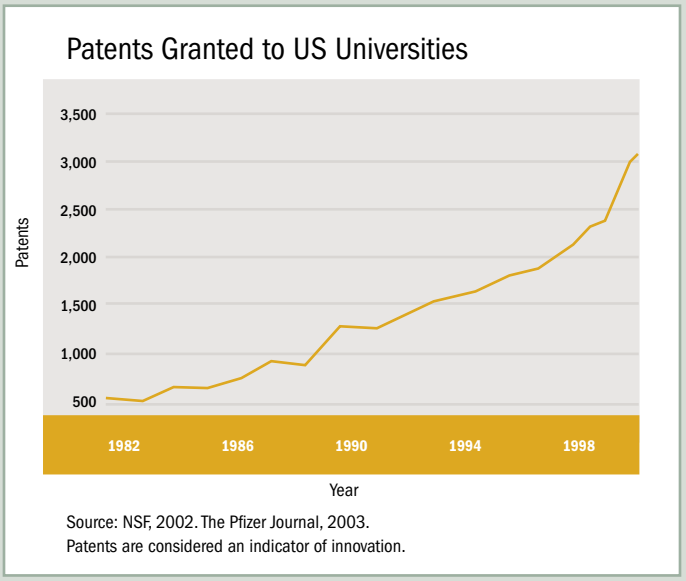


Meds and Eds are not the only sources of innovation but they are proven generators of new ideas, smart people and new companies – all fundamental to economic growth. More profoundly, these institutions are deeply embedded in American communities – contrary to most worldwide trends today – and that makes them an excellent bet for prosperity in the 21st century.

New Ideas:

>> Universities perform just under half – about 44 percent – of the basic research in the US.

>> From 1982 to the end of the 1990s, the number of patents granted to the US universities has risen from less than 500 a year to more than 3,000 a year.



Source: NSF, 2002. The Pfizer Journal, 2003.
Patents are considered an indicator of innovation.

New Enterprises:

>> University of California Scientists founded:
- 1 in 6 communications firms in California
- 1 in 3 biotechnology firms in California (www.uc-industry.berkeley.edu)

>> Biotech startup firms largely cluster around leading research universities in the San Francisco area, Research Triangle Park, San Diego, New York, Boston, and Seattle (Milken, 2004).

5. Leapfrogging Ahead

Because Meds and Eds institutions are deeply rooted in place — and many of these institutions are well established in places like Boston and Washington D.C. — it might seem that a relatively young state such as Arizona would not have a chance in the biology century.

But the nature of these institutions is changing dramatically because their role in the economy is changing. And these great changes are creating an opening for a state and region that is currently behind the curve.

Meds and Eds have always played a foundation role in our nation. They have essentially served as pieces of community and economic infrastructure, providing educational and medical services on a regional basis. This role is not going away, but it is rapidly being augmented by a more dynamic research and development role, especially in the biosciences. They are increasingly playing the key role of "collector of talent" in the knowledge economy, as Richard Florida writes.

This situation provides an opening for a certain kind of state or region to leap ahead. It is an opportunity if a state or region:

>> Already has a strong base of Meds and Eds in place.

>> Is innovative and vibrant enough that it can see new opportunities and prevent its institutions — including economic development ones — from "old think."

>> Has the motivation and financial resources to create new and improved institutions and finds the talent required for them to succeed.

>> Has a small enough scale that networking and decision-making are still relatively easy — a kind of "one degree of separation" in which regional stakeholders, Meds and Eds researchers, hospital CEOs and doctors, and entrepreneurs all know each other and know how to work together.

In a sense, all these opportunities are created by a deft understanding and aggressive pursuit of the other trends listed above — creating new place-based assets to cultivate innovation and enhance quality of life. This, essentially, is what regions such as San Diego did in the 1980s and 1990s with biotechnology. Other cities have done the same thing with high-tech — most notably Austin.

THE POWER OF STRATEGIC MOVES

Arizona's three major regions are starting late in the Meds and Eds game. But does this mean that Arizona has fallen hopelessly behind – with no chance of catching up?

Hardly. If Arizona wants to know how to leapfrog ahead, it has two models: Austin and San Diego. Like Arizona, both are relatively young Sunbelt regions that started out with few assets compared to established giants like Boston. Yet both have leapfrogged ahead in the last 20 years — and show no signs of slowing down. The story of Austin documents a rise in the physics/computer-based innovation era. The San Diego story tells the tale of a region basing its prosperity on biology-based innovation. Both show what a region can do in a short period of time through strategic, aggressive and sustained pursuit of critical talent, institutions and companies.

Austin: Going for High-Tech Gold

In the early 1980s, Austin was still a sleepy state capital and college town torn by growth/no-growth dynamics. The University of Texas at Austin was a state university that did not see itself connected either to the region or to local businesses. Technology manufacturers such as Motorola and AMD had facilities in the region, but the state government was more attuned to traditional pillars of the Texas economy: oil and real estate. Then came an opportunity that would fundamentally transform Austin — and a group of regional leaders who knew how to seize it.

In the early 1980s, civic leaders initiated a process that provided the vision and the collaborative process, which led to Austin's astounding success today. Lee Cooke, director of the Austin Chamber and former manager of a Texas Instruments plant, started asking what Austin wanted to be when it grew up. He believed that the factors that brought Motorola to town — university graduates and research, low cost of living, high quality of life — could bring many similar firms. The future he envisioned was in technology and he believed Austin should aim higher than light manufacturing and branch plants status. Austin should be a center for innovative applications of technology.

In 1983, Austin's business leaders, the university and the state joined forces to recruit MCC (the Microelectronics and Computer Technology Consortium), the nation's first major for-profit R&D consortium assembled to meet the competitive challenge from the Japanese. Austin won MCC over some of the most visible high-tech centers in the United States — including Phoenix. However, they didn't stop there. The Austin Chamber, in cooperation with public and civic leaders, crafted a 1985 plan —"Creating an Opportunity Economy"— that made the case that Austin could become a magnet for high-wage information technology companies and the creative talent associated with those companies. They invested in 32 new faculty chairs in engineering at the University of Texas — and also created entrepreneurial support networks through incubators, seed capital funds and active mentoring because the plan made the case that whereas attraction within growing information-industry clusters would be important initially, "homegrown" entrepreneurship would ultimately determine the level of Austin's success.

Austin attracted a second major research consortium of 13 semiconductor companies — SEMATECH – in 1986. (Phoenix tried and failed to land both MCC and SEMATECH.)

The result: During the 1990s, jobs in the region grew by more than 5 percent per year, and per-capita income rose dramatically, relative to the rest of the nation. As Cooke predicted, the region chosen as the home to MCC would not only get its research facilities and staff but also become a magnet for companies wanting to be near MCC.

With a strategic plan in place, Austin created an ever-expanding body of regional stewards who built and extended a collaborative leadership network, an informal set of relationships that has provided the real foundation for the region's results. As one of the longtime leaders in Austin, Pike Powers said, "We went beyond any normal economic development effort. We created ways to contribute to the large sense of mission or purpose. It was pretty magical…We set high expectations. We planned events and training to integrate new managers into our community. Most responded well."

It's important to note, however, that Austin was not satisfied with one round of success. The city's leaders recognized that sustained effort and ongoing collaboration were required. Many continued to work together in informal and formal ways to mentor the next generation of leaders in the 1990s. An incubator and seed capital effort — the Innovation, Creativity, and Capital Institute (IC^2) — helped to produce several successes, including computer magnate Michael Dell. When local leaders were concerned that Austin's quality of life couldn't be sustained, they organized the Austin 360 Summit to connect the emerging technology community and encourage greater participation in Austin's future; the result was a "declaration of interdependence," acknowledging that the region's resources, institutions, assets, and people are all intertwined.

San Diego: Going For Biotech Gold

In the past decade, San Diego has transformed itself from a defense and tourism region to a leader in biotechnology. At the center of this transformation is San Diego's densely packed research community, located along a two-mile stretch of North Torrey Pines Road that features institutions such as the University of California, San Diego, the Scripps Research Institute and the Salk Institute for Biomedical Studies – and scores of biotechnology firms that generated over $1.8 billion in revenues in 2003. This evolution of the San Diego biotechnology cluster illustrates the power of proximity.

Over the past several decades, the City of San Diego made a series of strategic decisions that has helped to facilitate the biotech corridor. Five years after Scripps Research Institute was founded in the Torrey Mesa area in 1955, the city provided a gift of nearby land to Jonas Salk, who developed the polio vaccine, for his Salk Institute for Biological Studies. At about this same time, regional leaders persuaded the state to establish the University of California, San Diego in a location near the Scripps and Salk Institutes, with the deliberate goal of becoming "the MIT of the West."

Later, the City of San Diego decided to designate the Torrey Mesa area as a zone for biomedical research. This designation has helped to attract several other nonprofit biomedical research institutions, including the Burnham Institute, the Kimmel Cancer Center, the Neurosciences Institute and the La Jolla Institute for Allergy and Immunology. These research centers, along with the 69 biotech firms produced from UCSD, 17 companies launched by Salk and 40 companies created by researchers at Scripps have enriched the geographic density of this already concentrated biomedical research center. World-class talent has been attracted to the opportunity of working in close proximity to world-class talent.

Two critical ingredients of San Diego's success has been informal networking, supported by such groups as BIOCOM (San Diego's Bio Industry Council) and a long tradition of interdisciplinary research established by Scripps and Salk Institutes. In addition, USCD has established the CONNECT program, an arm of the university that helps to develop and foster startup technology firms that benefit from the products of this interdisciplinary research and networking.

After a build-up phase from the 1960s and 1970s, there was a critical shift in mind-set in the late 1980s and early 1990s. Two events triggered the change. First, Richard Atkinson arrived as Chancellor of UCSD — after serving as Director of the National Science Foundation and a Professor at Stanford University — with a vision of connecting the university to the region in new ways. At the same time, the defense downturn hit San Diego with a loss of jobs and prompted the need for a new economic strategy. As a result, The Partnership for the New Century was formed to promote a cluster-based economic strategy, and a new School of Management was created at UCSD to promote entrepreneurship in its science and technology clusters. Between 1995 and 2002, employment in San Diego's science and technology clusters grew by 25 percent. Average annual real wages for science and technology clusters increased from $57,000 in 1995 to $71,000 in 2002.

Five years after adopting The Partnership for a New Century Strategy, the San Diego Science and Technology Commission recently brought back together representatives from each of the cluster groups who developed the initial strategy to revisit progress and identify next steps. While much progress has been made in creating a strong economic cluster, today the focus is on a growing talent squeeze, as housing costs have made it more difficult to recruit and retain high-skilled workers essential for further development of the cluster.

The Leapfrog Playbook

The Austin and San Diego stories provide important lessons for Arizona. In a sense, they represent a "playbook" for the state as it moves forward to leverage health sciences and health care as economic and quality of life drivers. Both regions show the power of knowledge assets, talent, proximity, collaboration and bold moves.

Buildable Assets

Both Austin and San Diego have impressive assets — weather, population growth, and a solid base of governmental jobs. Neither city, however, was content to rest on these "inherited assets." They both recognized the need to build new assets and to build up existing assets — such as universities and government agencies – in new ways. They understood that these institutions were actually innovation assets and tools of prosperity. They understood that location requirements for R&D entities — top universities, research centers, collaborative culture — are different than for branch plant manufacturers or other lower-value economic sectors, and they targeted the R&D enterprises. They also understood they were in competition with many other regions for these new assets, and they organized themselves to get them.

People Matter

With its music scene and funky college-town atmosphere, Austin provided a creative community where creative talent would feel comfortable. With its beach-town atmosphere and world-class culture, San Diego provided an unusual combination of amenities that don't usually go together. Both cities understood something important: that an attractive place to live can create a snowball effect in drawing talent. Top talent came to San Diego and Austin partly because of the distinctive amenities those cities had. But they also came to live and work near other smart, entrepreneurial people. The presence of top talent attracted more talent. The critical mass of talent made both cities more attractive to entertainment and cultural institutions — which grew and expanded, thus making Austin and San Diego even more attractive to high-tech and biotech talent.

"I think that the fact that there's venture capital, management talent, and entrepreneurial attitude here in San Diego, coupled with the fact that you have these major research institutions within three square miles supports the whole reason that this cluster is here. Additionally, the networking here through the programs such as (UCSD's) Connect and BIOCOM have created a situation where starting a company is like falling off a log. The network is so in place for not just the money, but the facilities and the legal support,both corporate and patent, the lab supplies, you name it. Everything is here, easily available."

– Howard Birndorf, Hybritech co-founder. Interview, April 16, 2004. Milken Institute, 2004.

Proximity Can Build a Competitive Advantage

Despite being both a university city and a state capital, Austin was a "small town" where it was easy for leaders from different domains to get together and talk. But business and civic leaders also went out of their way to connect regional assets that had great potential but were not being used well – a university, a state government, an entrepreneurial climate. In San Diego, the city deliberately created what might be called an innovation district by providing land and opportunities for several major biotech institutions to reside in close proximity to each other. The clustering of major institutions — principally UCSD, Scripps Institute and Salk Institute — promoted an "open innovation" atmosphere where ideas were swapped back and forth, constantly adding to the innovation pyramid.

Strategic Bold Moves

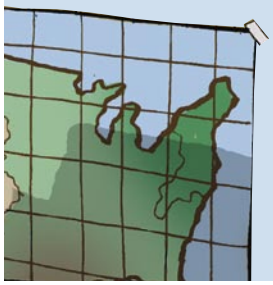
Finally, it should be emphasized that these cities chose to reinvent their economy. In both cases, regional leaders – civic, business, academic, political – understood how to position their cities for the next wave of economic innovation and committed themselves to both short- and long-term steps that helped create success. Austin wasn't content to be dominated by an oil and gas mind-set. Nor did it want to be the university and government town it had always been, with a few branch technology plants. Regional leaders decided, instead, to move up the economic hierarchy, crafting a strategy based on the following premises:

>> Information technology would serve as the economic engine of the United States.

>> Austin had the characteristics necessary to move from a branch-plant economy to a leading creative player in the information technology industry.

Location Matters

"A location may be favorable for other reasons (such as offering low manufacturing costs or access to key markets) but unfavorable for innovation. Managers must make R&D locational choices strategically, recognizing that there tends to be only a few true innovation clusters in each industry… R&D locational choices are particularly important for companies that aspire to global strategies."



– Michael E. Porter, Harvard Business School *Innovation: Location Matters*, 2001.

>> Once Austin became a leading player, it would serve as a magnet for more companies in the industry.

>> While attracting activity may be important initially, entrepreneurship would ultimately determine the level of Austin's success.

>> Quality of life was increasingly important to economic success, as knowledge workers would have great latitude in choosing where they would like to live *(EDA, 2003)*.

A decade later, to catch the biotech wave and reinvent its economy, San Diego leaders made decisions and moves like Austin. The table on the next page shows the similarities.

Austin and San Diego: The Power of Strategic Moves, Knowledge, Networks and Proximity

Created Assets	Austin	San Diego
Top Universities	University of Texas (UT) Built strong (top 10) electrical engineering and computer science schools	University of California, San Diego (UCSD) Built UCSD in 1960s, and added a medical school and new management school to the campus within four decades
Research Centers	MCC, SEMATECH City pro actively attracted the nation's first industry research consortia	Scripps, Salk Institutes A 1960 city gift of 27 acres of ocean-facing property on Torrey Pines bluff kicked off the location of several new research institutes
Talented People	High percentage of college educated 32 new endowed faculty chairs; part of the package to lure MCC University and research consortia drew top engineer and computer talent Companies followed the consortia: Allied Materials, Cypress Semiconductors, Samsung	High percentage of college educated Research Institutes attract top biomed researchers: Scripps gained immunologist Frank Dixon and his team from Pittsburgh; Jonas Salk attracted Francis Crick, one of the discoverers of the "double helix" structure of DNA UCSD attracted two scientists from Stanford that later founded Hybritech
Entrepreneurial Culture	High entrepreneurship Former dean of UT business school, George Kozmetsky, co-founded Teledyne, Innovation Creativity and Capital Institute, and developed "technopolis framework" as a guide to tech-based economic development Hundreds of high-tech companies started up; among the better known are Dell Computers, National Instruments, Tracor	High entrepreneurship Hybritech, which spawned 50 firms, seeded the region's biomed cluster Salk scientists developed over 20 companies and 250 patents UCSD medical school spun out over 65 companies
Networks	Strong networks Austin Chamber linked up government, industry and university 360 Network: connected young entrepreneurs to the region	Strong networks UCSD CONNECT – bridged academia and industry BIOCOM – one of the strongest formal industry networks in US
Proximity	Research Consortia Consortia are largely about co-location of 10-15 national firms and top researchers Creative downtown: "creatives" in technology and music converged in Downtown Austin	Research District Torrey Pines Mesa, a two-mile stretch of Meds and Eds institutes and talent Major players were within a five mile radius of each other – could meet in 10 minutes
Inherited Assets		
Geography **Climate** **Population**	Central location Mild climate Growing population	West Coast location Mild climate Growing population
Results		
Wealth Creation	In 1990s, per capita income rose dramatically relative to the rest of the nation	Average real annual wages for science and technology clusters increased from $57,000 in 1995 to $71,000 in 2002
Diversified Economy	Rankings on science and technology industry and talent lists rose dramatically	Transformed from defense and tourism region to a leader in biotechnology

Sources for Austin and San Diego case studies include: Milken Institute, *America's Biotech and Life Science Clusters: San Diego's Position and Economic Contribution*, 2004. *San Diego: Rise of a high-tech cluster,* Nature Vol. 426, December 11, 2003. *Economic Development Administration*, US Department of Commerce, *Strategic Planning in the Technology-Driven World: A Guidebook for Innovation-led Development*, 2001. Council of Competitiveness, *San Diego: Clusters of Innovation Initiative*, 2001. Collaborative Economics Inc, *Civic Revolutionaries: Igniting the Passion for Change in Communities*, 2004.

A STRATEGIC FRAMEWORK: THINKING ABOUT HEALTH — AND ECONOMIC DEVELOPMENT—DIFFERENTLY

The lessons learned from San Diego and Austin, combined with the Five Realities covered earlier in this report, provide a solid framework for assessing Arizona's position and prospects. The building blocks of success are innovation-oriented assets, entrepreneurial cultural, exceptional talent and collaboration.

Arizona has a strong foundation in some of these areas – or, at least, important building blocks that can be used. The state has laid a lot on the line with its "Three Big Bets" – more research dollars for its universities, attraction of TGen/IGC headquarters and bioscience researchers, and recent focus on innovation-based industry clusters. The state also has a "road map" for the biosciences, thanks to the work of Battelle and the Flinn Foundation.

But as we all know, Arizona is not currently a top-tier state in the Meds and Eds race, and there remain significant holes and gaps in important assets. More "big bets" are required for Arizona to leap ahead. And while much collaboration exists today, it's not clear everyone has the same end game in mind.

To become the team to beat in the biology century, Arizona has to think differently about health care and economic development. The state has long had a habit of casting health as a social issue — focusing on access for low-income families. That view will remain important — but it is not enough. Arizona also needs to focus on health as a major economic driver of the state economy. Progress was made with the Battelle Bioscience Road map and efforts to attract TGen and IGC. Nevertheless, the view of health as a major economic driver — and the Meds and Eds combo in particular — needs to be more deeply embedded in Arizona economic development, workforce and legislative strategies.

Arizona has long had a narrow interpretation of medical and education institutional purposes — basically hospitals treat illness and universities teach students. That view needs to expand. Arizona needs to start thinking of Meds and Eds not only as "treating" and "teaching" institutions but also as the collective assets that can help Arizona discover new cures and improve patient care. In other words, these are assets that will help Arizona leapfrog ahead in the 21st century.

But most of all, Arizona has the potential to build a very different future — if it focuses its efforts and leverages its Meds and Eds assets to lead the nation in the integration of health science discoveries and health care innovations.

Arizona's "Three Big Bets" on an Innovation Future

Big Bet No. 1

The Arizona University System: Proposition 301, a sales tax increase which citizens approved in 2000, earmarks $1 billion over 20 years, distributed among the state's three universities to expand funding for university research, technology transfer and new business development. Citizens have recognized that top-tier universities are a critical infrastructure for the 21st century. In 2003, the Arizona Legislature approved $440 million in research facilities at the state's public universities.

Big Bet No. 2

Genomics: $90 million was raised in 2002 to "jump-start" the bioscience industry by, among other things, bringing star genomics researchers to the state and creating new not-for-profit research institutes, particularly TGen and IGC. The state has also developed a road map to scale-up Arizona's efforts and activities over the next five years in three areas of existing or emerging strengths — cancer therapeutics, neurological sciences and bioengineering.

Big Bet No. 3

Industry Clusters: The state's new economic strategy targets technology-oriented, knowledge-intensive clusters to build strengths in: high technology, software, biomedical, aerospace, optical sciences and advanced business services — all sectors that compete on innovation, can deliver high income jobs and propel other development.

Source: *Which Way Scottsdale?*, Morrison Institute for Public Policy, 2003.

To encourage Arizona to think differently about health sciences and health services and to think strategically about its goals in the 21st century, we have developed a Strategic Framework (on page 25). As the framework reveals, there is a world of opportunity — economic opportunity — in the intersection between health research and health care.

As Regina Herzlinger points out in *Harvard Business Review*, the health sciences revolution will permit health care providers to revolutionize patient care through the emergence of three dramatic innovations:

>> Focused "factories" of health care that provide patients with integrated treatment of complex diseases, rather than continuing the fragmentation that impedes better health care and drives up costs.

>> Integrated information records that bring together dispersed medical records for each patient.

>> Personalized medicine — depicted at the very center of the Strategic Framework chart — which uses the combination of integrated patient records, integrated health care providers, and genomic breakthroughs in drugs, tests, and devices to provide more comprehensive patient care. All these efficiencies can also reduce costs *(Herzlinger, 2002)*.

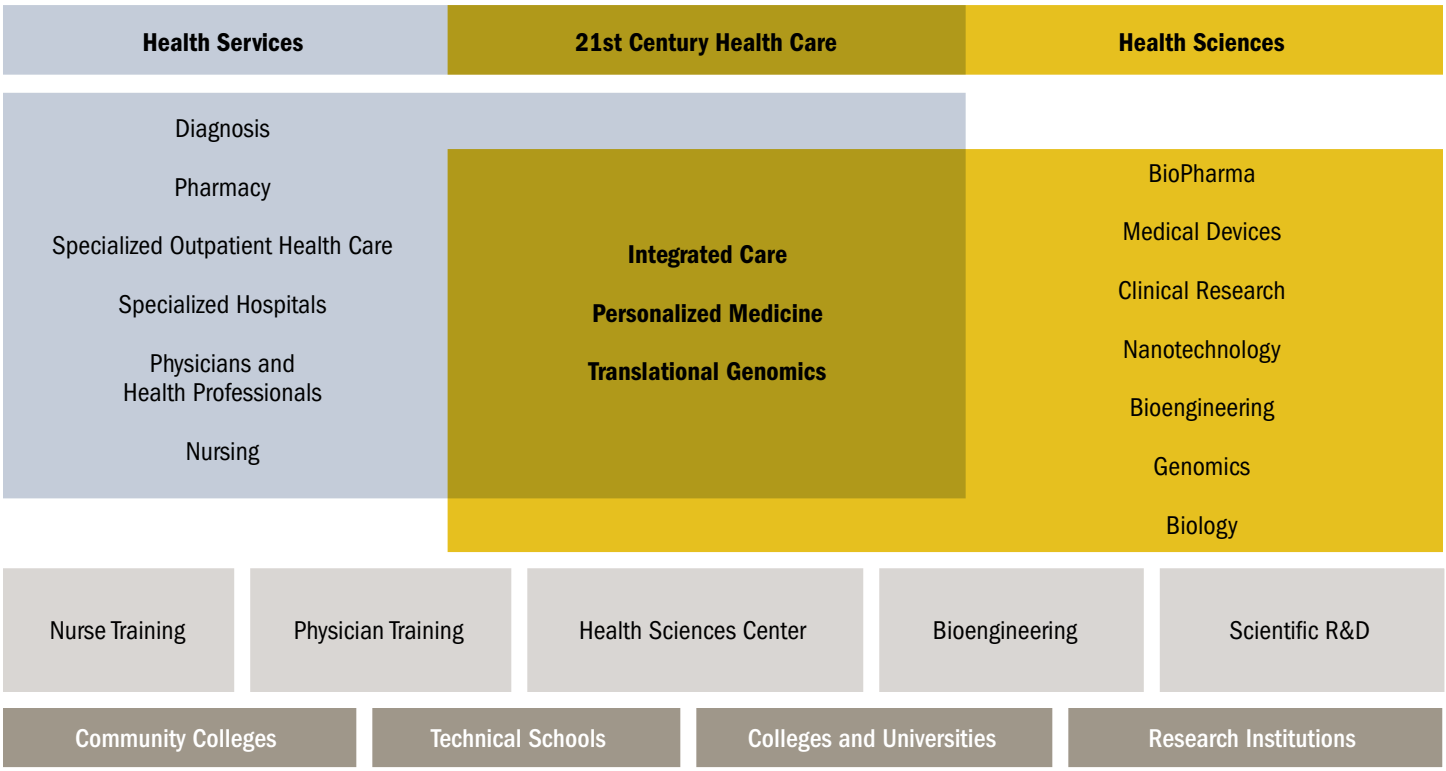
Arizona is perfectly situated to take advantage of these trends and leapfrog ahead. But as the Strategic Framework chart shows, the role of educational and medical institutions is crucial here. Take these assets away, and the significance of health to economic growth could collapse. These institutions are vital for talent — nurses, doctors, scientists, researchers — and patient care. But they are golden assets for at least three other reasons:

>> The Meds and Eds are critical sources of innovation. As the prestigious Council on Competitiveness has said, "universities and specialized research centers are the driving force behind innovation in nearly every region" *(Clusters of Innovation, 2004)*.

>> They are collectors of talent — or a "growth pole," as Creative Class guru Richard Florida notes, "that attracts eminent scientists and engineers, who attract energetic graduate students, who create spin-off companies, which encourages other companies to locate nearby" *(Florida, 2003)*.

>> They are embedded institutions that are generators of sophisticated jobs *(Federal Reserve Bank of Dallas, 2004)*.

A Strategic Framework for Arizona's Future, Built on Meds and Eds



So, to even play in the biology century, Arizona must excel at creating Meds and Eds institutions — nurturing them — staffing them — and ensuring that they continue to thrive. Perhaps most important to leap ahead, Arizona must be especially successful in linking these institution's agendas together, in synchronizing their resources and priorities with local technology enterprises, and in building the interconnections that foster knowledge transfer, collaboration and support that can't be easily replicated by other regions.

HOW WELL-POSITIONED IS ARIZONA?

Arizona has made tremendous strides in the past few years, largely in pursuit of the "Three Big Bets." Even a short list of the state's recent Meds and Eds triumphs seems enough to show general trajectory.

But Arizona still has significant gaps in important assets and lags in important outcomes. The state must stay focused — and make more "big bets" to get the job done.

From the Headlines

Anyone that pays attention to local news will quickly learn that Arizona is deliberately sharpening its innovation edge. For example, in recent years, Arizona has gained:

New Research Institutions

>> New bioscience institutes are under construction at ASU (Arizona Biodesign Institute at ASU and UA (BIO5). Another is planned at NAU.

>> These institutes are, in large part, the result of Proposition 301 funds. But they are also the result of Arizona legislation in 2003 that funded the development of 12 new research facilities at the state's public universities.

>> Arizona has secured the funding to establish the Translational Genomics Research Institute (TGen). Its mission is to make and translate genomic discoveries into advances in human health. The challenge attracted Dr. Jeffrey Trent, Scientific Director of the National Human Genome Research Institute at the National Institutes of Health, to accept the leadership position.

>> The International Genomics Consortium (IGC), a non-profit medical research organization, is expanding upon the discoveries of the Human Genome Project and other systemic sequencing efforts by combining world-class genomics research, bioinformatics, and diagnostic technologies in the global fight against cancer and other complex genetic diseases. The consortium was conceived on a cocktail napkin in 1999 by Phoenix attorney Dick Mallery, cancer physician Daniel Von Hoff and genetic researcher Jeffrey Trent.

>> All three state universities have adopted bold new strategies as a result of the Arizona Board of Regents Changing Directions initiative. In response to the Regents' challenge to think big, each president outlined truly bold and challenging missions that would set a national standard. All three universities are focused not just on generally strengthening education but on strengthening in a concerted or strategic way the state's science and technology research, talent and entrepreneurial base.

>> University of Arizona secures $8 million to establish The Critical Path Institute, a partnership among the University, US Food and Drug Administration, and SRI International for a first-of-its-kind FDA-affiliated institute to explore ways to accelerate the drug-approval process through new testing approaches and technologies.

New and More Talent

>> The Maricopa Community College District has embarked on a five-year $1.5 million initiative to train workers in biotechnology.

>> Pima Community College launches a new degree program in histology, the study of human and animal tissues for medical diagnosis.

>> Renowned biosciences leader George Poste was named director of ASU's Biodesign Institute.

>> TGen has hired 170 employees, 70 with advanced degrees. Richard Love, Elizabeth Montemayor, Daniel Von Hoff, Michael Berens, Mary Ann Guerra, Ellen Feigal are among the well-known scientists, researchers and administrators joining TGen.

>> Though they attract less public attention, the state also has a strong network of private colleges and universities, including Ottawa University and Western International, with four campuses in Greater Phoenix. Midwestern University has a medical school for osteopathic physicians. An additional osteopathic medical school, which trains only third and fourth year students is the Arizona School of Health Sciences (ASHS), is located in Mesa. Both Midwestern and ASHS also train physician assistants. Midwestern also has a pharmacy school.

Entrepreneurial Culture

>> ASU launches Technopolis, a new economic development initiative that will stimulate entrepreneurship by drawing upon the University's vast expertise to provide local technology and life science innovators with business plans and management assistance.

>> UA Science and Technology Park opens the Arizona Center for Innovation to provide space and assistance for Tucson's emerging technology companies.

>> Acenta Discovery, Inc., a Washington, D.C. based medicinal chemistry company specializing in chemical services and technology to biopharmaceutical businesses, moves to the UA Science and Technology Park.

>> Scottsdale and ASU partner to purchase the Los Arcos Mall site for $41.5 million to be the future home of the ASU Scottsdale Center for New Technology and Innovation.

>> ASU and TGen are in early stages of developing a spin-off company, NanoBiomics Inc., to create a product that can detect early stages of disease and biowarfare agents.

>> Beyond TGen and IGC, 12 bioscience firms located or expanded in Arizona in 2003. These firms are expected to create up to 800 jobs over the next three years.

>> Arizona Technology Enterprises (AzTE) partners with the ASU Research Park and the university to launch the ASU Innovation Fund to help researchers bring their innovations to market.

Grand Collaborations

>> Arizona Board of Regents decides to build the Phoenix Biomedical Campus in downtown Phoenix that will co-locate an extension of UA College of Medicine and College of Pharmacy and ASU College of Nursing and some biomedical research efforts.

>> A Memorandum of Understanding (MOU) is orchestrated by Gary Stuart in his role as Arizona Board of Regents president, signed by ASU President Crow and UA President Likins, and approved by the Regents. The MOU establishes collaborative principles for expanding the UA College of Medicine's presence on the Phoenix Biomedical Campus. This is a historic document, as it represents a turning point in the long struggle for a strategy that would realistically produce a research-based college of medicine for Greater Phoenix.

>> Arizona's three universities form the Arizona Biomedical Collaborative (ABC) to plan and coordinate joint efforts on education, research and health policy.

>> Ground is broken for the Mayo Clinic Collaborative Research Building, a new biomedical research facility on Mayo Clinic's Scottsdale Campus, to house research laboratories for TGen, Mayo Clinic and other biomedical research entities. City of Scottsdale provides $3 million to support Mayo's Research Building.

>> TGen enters into multiple research collaborations: Children's Memorial Institute for Education and Research of Chicago for cutting-edge genomic research into childhood illnesses and better defining their relationship to adult diseases; Southwest Autism Research & Resource Center (SARRC) for a comprehensive patient-driven genomic studies of autistic disorders in the world; Consortium for the National Institute of Genomic Medicine in Mexico (INMEGEN) to conduct joint research into diseases with major regional significance.

Beyond the Headlines

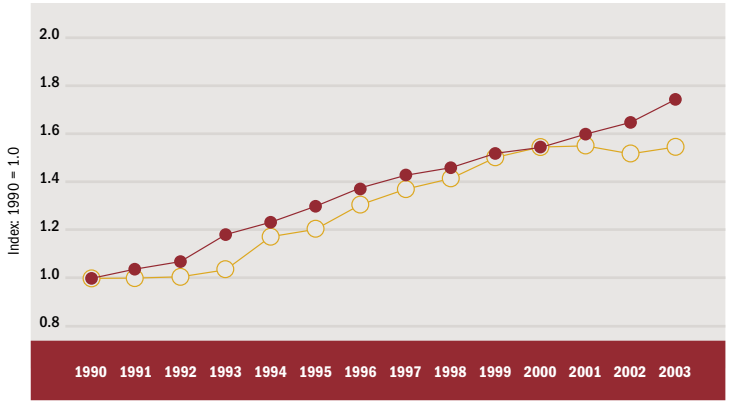
Beyond the headlines, a number of important indicators confirm that health is a strong economic driver for Arizona and that recent moves to boost the state's capture of better talent, more grants and biosciences jobs are beginning to pay off. The good news includes:

Health Jobs Are Big in Arizona

As the Strategic Framework chart on page 25 suggests, the health care system is the integration of economic activities in the health services (such as offices and clinics of medical doctors, outpatient health care, and nursing and residential care facilities) with the economic activities in the health sciences. Health science activities include research and development, laboratory facilities and basic research in the life sciences.

Strong Employment Growth

Health-related employment growth in Arizona compared to total employment growth across Arizona, 1990-2003.



Source: Economy.com; Collaborative Economics.
*Private sector only.

Together, health sciences and health services are a major driver of job growth in Arizona. The health system employed about 265,000 Arizonans in 2003, representing about 14 percent of the state's 1.9 million jobs. And the health system is producing jobs faster than the rest of the Arizona economy. As the graph shows, job growth in the health system has outstripped job growth overall since 1990. Health employment grew 4.3 percent annually during this period, compared to only 3.5 percent overall.

And this trend is accelerating. Since 2000, health employment has grown 4 percent annually, while total employment has remained virtually flat. Only construction jobs grew faster than health jobs in Arizona.

In addition to producing a large number of jobs, Arizona's health system is producing a cross-section of jobs across the income scale, including many high wage jobs. The average health wage is slightly higher than the state average (currently about $34,000), while 43 percent of health system jobs pay more than $63,500 per year.

Because health jobs are big in Arizona, the Maricopa Community College District plans to put $100 million of its total successful bond drive in 2004 towards future facilities and equipment to expand biosciences and health care training programs.

A Picture of Strong Economic Impact

Arizona's health care system employs 265,000 people, which equals 14 percent of the state's employment.

Sophisticated Work
Where people work.

Excellent Pay
Average wage is $36,524, which is about the same as Arizona's average wage of $36,131.

Fast Growth
Health employment grew from 153,321 jobs in 1990 to 265,148 in 2003, a 73 percent change.

Arizona Health System *Where people work*	**Pay 2003** *Average annual salary*	**Employment 1990**	**Employment 2003**	**Employment Change 1990-2003**	**Employment Percent Change 1990-2003**
Offices of Physicians, Dentists and other providers	$43,468	32,577	64,589	32,012	98%
Other Social and Health-related Assistance	$22,465	17,726	33,889	16,163	91%
Scientific R&D	$35,816	13,927	29,865	15,938	114%
Nursing and Residential Care Facilities	$35,698	18,222	34,150	15,928	87%
Hospitals	$42,462	47,279	58,605	11,326	24%
Home and Ambulatory Care	$22,220	3,507	10,435	6,928	198%
Outpatient Care Centers	$34,782	4,207	9,967	5,760	137%
Health Consumer Goods	$28,576	10,665	14,958	4,293	40%
Medical and Diagnostic Labs	$30,622	1,916	4,155	2,239	117%
Medical Equipment and Supplies	$41,513	2,539	3,883	1,344	53%
Pharmaceuticals	$67,316	756	652	-104	-14%
Health System Total	$36,524	153,321	265,148	111,827	73%
Arizona (all employment)	$36,131	1,223,692	1,894,725	671,033	55%
Health Share of AZ*		12.5%	14%	17%	

Source: Economy.com.
*AZTPNF = Arizona Total Private Employment Non-Farm.

The Multiplier Effect

For every dollar of additional business activity in these health sectors in Arizona, an additional $2 is added to the local economy.

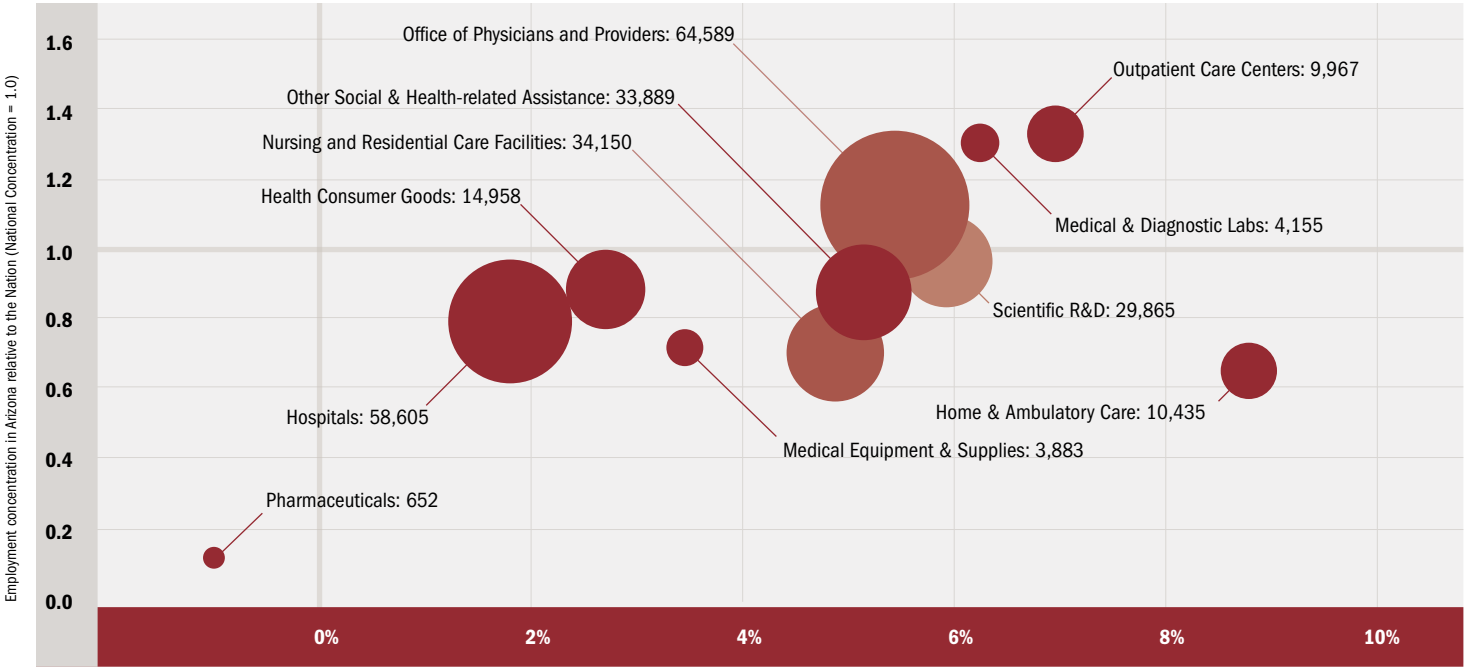
	Business Activity (In US dollars)			
Health Services	**Direct**	**Indirect**	**Induced**	**Total**
Pharmaceutical and medicine manufacturing	$1,000,000	$361,414	$766,560	$2,127,975
Laboratory apparatus and furniture manufacturing	$1,000,000	$426,832	$739,341	$2,166,173
Surgical and medical instrument manufacturing	$1,000,000	$383,621	$920,462	$2,304,083
Surgical appliance and supplies manufacturing	$1,000,000	$372,841	$861,856	$2,234,697
Dental equipment and supplies manufacturing	$1,000,000	$399,461	$782,833	$2,182,294
Ophthalmic goods manufacturing	$1,000,000	$345,497	$942,373	$2,287,870
Dental laboratories	$1,000,000	$215,811	$982,931	$2,198,742
Home health care services	$1,000,000	$311,594	$1,117,945	$2,429,539
Offices of physicians, dentists and other health practitioners	$1,000,000	$200,027	$1,154,832	$2,354,859
Other ambulatory health care services	$1,000,000	$488,361	$857,648	$2,346,009
Hospitals	$1,000,000	$460,442	$908,815	$2,369,257
Nursing and residential care facilities	$1,000,000	$282,640	$1,104,234	$2,386,874

Source: 2001 IMPIAN data, L. William Seidman Research Institute, W.P. Carey School of Business, ASU.

Arizona's Health System is becoming more Research Focused

The Portfolio of Arizona Health Sectors below shows more detail for 11 segments of the health system by average annual employment growth from 1990 to 2003 (horizontal axis), employment concentration relative to the United States (vertical axis) and employment size (size of circle). This chart shows growth in research capability beyond academic research. For example, the health sectors medical and diagnostic labs and scientific R&D employment grew at about 6 percent annually between 1990 and 2003. Relative to the United States, Arizona's medical and diagnostic lab employment grew nearly 20 percent more concentrated, rising from an employment concentration of 1.11 in 1990 to 1.32 by 2003. Scientific R&D employment became 5 percent more concentrated, rising from an employment concentration of .91 to .96 by 2003.

Portfolio of Arizona Health Sectors by Employment Size, Growth and Concentration



Source: Economy.com, Analysis: Collaborative Economics.

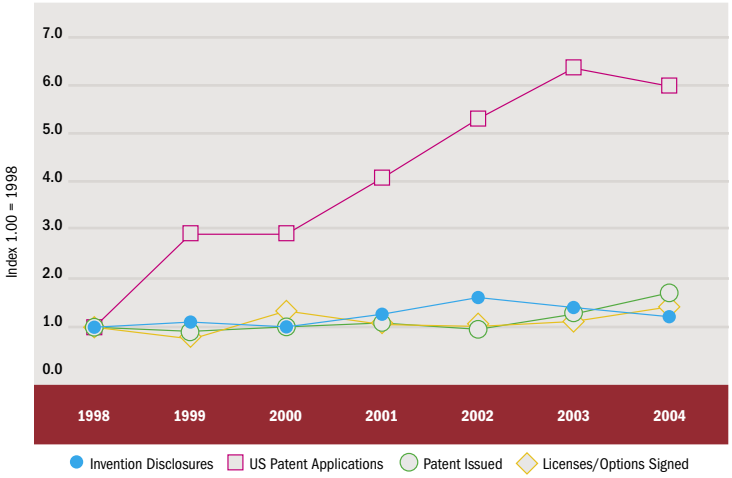
Notes: (1) Employment concentration is simply a measure of a particular sector's contribution to the overall employment base of a state or region. Sectors above the bold line on the chart are growing more concentrated; sectors below the bold line are growing less concentrated. (2) Size of circle and numeral beside name of the industry sector is total employment, 2003.

University Patents are Increasingly Focused in the Health Sciences

Arizona won't be rich in innovation and scientific progress without more private enterprises spurring innovation. But Arizona must also count on its universities and medical centers to spur innovation.

Patents are considered an indicator of innovation, and the number of patent applications from researchers in Arizona universities increased more than six times between 1998 and 2004. However, Arizona's universities have not seen such a large increase in the number of patents issued (or awarded). The number of patents awarded during the same period went from 22 in 1998 up to 37 in 2004. The number of licenses and options executed increased from 25 in 1998 to 46 in 2004 and the number of invention disclosures increased 36 percent from 141 in 1998 to 192 in 2004.

Growth in Arizona University System Inventions and Patents, 1998-2004



Source: Arizona Board of Regents, 2005.
F Y= Fiscal Year.
Notes: (1) Invention disclosures (IDEs) are usually the first step individual inventors take to formally disclose innovations to their sponsoring institutions to initiate the complex process towards patent protection. The next step is patent application to the US Patent and Trademark Office. So IDEs and patent applications reflect the initial ideas with commercial potential. (2) Licenses/options signed provide a vehicle for the transfer of intellectual property from universities to companies that will commercialize the technology. (3) Graph is for ASU, UA and NAU combined. NAU did not begin reporting patents until F Y 2001.

Arizona University System Net Revenue from Licenses and Options (ASU and UA Combined)

The fact that firms and new companies are willing to pay these fees is a clear indicator of the value of the innovations created at Arizona Universities.

Year	Dollar Amount	Licensing Revenue
2004	$2.4 million	
2003	$2.2 million	
2002	$2.5 million	
2001	$2.6 million	
2000	$1.8 million	
1999	$1.3 million	
1998	$470,000	

Source: Arizona Board of Regents, 2005.

The tables on this page show the breakdown of patent activity by discipline at Arizona State University and University of Arizona. At ASU, the largest share of inventions were disclosed by engineering researchers who made up 36 percent of all invention disclosures. This was followed by 20 percent in bioengineering. The UA has a large share of engineering invention disclosures, but its portfolio of medical and bioscience disclosures is larger.

Patents reflect the initial discovery and registration of innovative ideas.

Strong patent activity usually reflects significant conduct of R&D with potential commercial relevance.

Arizona State University Patent Activity by Discipline Area in 2004

At ASU, patent activity in the biosciences is on the rise, although it still lags behind engineering.

Department	Invention Disclosures	Provisional Patents Filed	Patents Issued	US only Patents
Bioengineering	19	16	2	2
School of Life Science	6	5	0	0
Cancer Research Institute	3	5	19	2
Chemistry/Biochemistry	14	12	1	0
Communications/Business	4	4	0	0
Fulton School of Engineering	35	39	22	10
School of Construction	1	1	0	0
Applied Bioscience	2	2	0	0
Physics/Astronomy	6	5	5	3
ASU East Engineering	5	4	1	1
Total	95	93	50	18

Source: Arizona Board of Regents, 2005.

University of Arizona Disclosures by Major Academic and Research Units, 2004

At UA, patent activity is largely in medicine and biosciences.

Academic or Research Unit	Invention Disclosures	Provisional Patents Filed	Patents Filed (US)
Arizona Cancer Center	6	2	2
Arizona Research Labs	3	1	0
BIO5	3	1	0
College of Agriculture & Life Sciences	16	4	2
College of Engineering	22	9	1
College of Fine Arts	1	0	0
College of Management	1	1	0
College of Medicine	21	5	1
College of Nursing	1	0	0
College of Pharmacy	12	4	0
College of Science	7	6	0
College of Social & Behavioral Sciences	3	0	0
Units Under the VP for Research	1	1	0
Optical Sciences	11	3	2
School of Health Professions	3	1	0
Total	111	38	8

Source: Arizona Board of Regents, 2005.
Note: Numbers were not reported for UA patents issued.

Arizona's take of Federal Research Funds is Shifting to Health

Between 1993 and 2002, health-related federal research funds awarded to Arizona institutions almost doubled, from $94 million to $176 million. This increase means that health research is now almost as important as defense research to the Arizona economy. In 1993, defense research accounted for 57 percent of all federal research funds to Arizona, compared to only 20 percent for health. By 2002, the numbers had shifted to 47 percent for defense and 36 percent for health. (The ratio may be different today, as Arizona universities and companies have successfully competed for new defense and national security grants after 9/11.)

Most health research funds flow to the state's universities, while most defense research funds flow to private contractors. In 2002, Arizona received about $500 million in federal research funds of all kinds. As the Federal R&D Funding table shows, federal research dollars are primarily divided between research universities and private industry: ASU, UA — including the College of Medicine and NAU — captured about 44 percent of all federal dollars. About 55 percent went to private companies such as Raytheon and McDonnell Douglas Helicopter.

Although allocations of funds change from year to year, Arizona gets 75 percent of its health research funding from the National Institutes of Health (NIH). NIH funds about 36 percent of medical and health research in United States, while private industry pays for 57 percent and nonprofit organizations pay for 7 percent. 84 percent of NIH funds goes towards research in universities, medical centers and research institutions in the United States and globally *(The Pfizer Journal, 2003)*. Capturing more of NIH funds and industry funds will be a critical factor in determining Arizona's success in the biology century.

The state's trajectory is good. As NIH Awards table shows, Arizona captured about $153 million in 2003, up from $136 million in 2002 and $118 million in 2001, representing a 29.7 percent increase. This percentage increase virtually mirrors that of the top 10 states.

Federal R&D funding to Arizona, 2002

Performer Name	F Y 2002 Total Amount (in millions)	Share
University of Arizona (Includes UA College of Medicine)	$165	33%
Raytheon Systems Corporation	$107	22%
McDonnell Douglas Helicopter Corporation	$69	14%
All Other*	$58	12%
Arizona State University	$45	9%
Orbital Sciences Corporation	$14	3%
General Dynamics Decision Systems	$12	2%
Northern Arizona University	$8	2%
Materials and Electrochemical Research Corp.	$5	1%
Lockheed Martin Corporation	$4	1%
Arizona Dept. of Agriculture, Maricopa	$3	1%
Dynamic Science Inc.	$3	1%
League for Innovation	$3	1%
Total	$496	

Source: RAND, 2004.
*All Other: is the sum of about 200 other individual companies and entities that were added together because for each of them, their share of all funding was less than .05 percent. Included in this group are Sun Health Research Institute, St. Joseph's Hospital and Medical Center, Mayo Clinic and Samaritan Health Services.
F Y= Fiscal Year

NIH Awards in 2003, 2002, and 2001

	US		Top 10 States		Arizona	
All Awards	Grants (#)	Funds	Grants (#)	Funds	Grants (#)	Funds
FY 2003	51,942	$22 billion	3,299	$1.4 billion	451	$153 million
FY 2002	49,716	$19 billion	3,116	$1.3 billion	419	$136 million
FY 2001	46,453	$17 billion	2,954	$1.1 billion	393	$118 million
% Growth	11.8%	29.4%	11.7 %	29.9%	14.8%	29.7%

Source: Battelle, 2004.

Arizona has Pockets of Medical Specialties and Talent

Rankings are often used as signals of expertise, and the often-cited *US News & World Report* ranks Arizona in a number of medical specialties. As the chart below suggests, University Medical Center in Tucson is recognized among medical centers in the nation in several critical areas. In Greater Phoenix, St. Joseph's Hospital and Medical Center, the Mayo Clinic, and Thunderbird Samaritan Medical Center each garner national ranking in their areas of specialty.

How Arizona's Health Centers Rank Nationally in 17 Areas of Specialization

Ranking of top 50 US Hospitals in Specialty	University Medical Center, Tucson	Mayo Clinic Hospital, Phoenix	Thunderbird Samaritan Medical Center, Glendale	St. Joseph's Hospital & Medical Center, Phoenix
Cancer	20			
Digestive Disorders				
Ear, Nose and Throat	34			
Geriatrics	31			
Gynecology	48			
Heart and Heart Surgery	22			
Hormonal Disorders				
Kidney	46			
Neurology and Neurosurgery	22		48	9
Opthamology				
Orthopedics	35			
Pediatrics				
Psychiatry				
Rehabilitation				
Respiratory	26	30		
Rheumatology				
Urology				

Source: *US News & World Report*, 2004.

Across the US, more than 2,100 centers were evaluated and compared, based on the number of procedures performed in their specialty area. Centers are ranked on the basis of professional reputation, mortality ratio and care-related factors, such as nursing and patient services. (For more details, see the 2004 *US News & World Report* rankings at www.usnews.com/usnews/health/hosptl/methodology.htm).

There is Always a But

Despite all this, there are lots of gaps and risks that could trip up Arizona. These include:

Still Not Enough Gains to Lead

Although Arizona is rapidly increasing its health research capability, innovation output, and research talent and reputation, it still lags behind other states.

As the following charts show, Arizona was ranked 27th among states in university life sciences R&D. The state ranked 28th nationally in National Institutes of Health support to institutions. Arizona ranked 28th in higher education degrees in biological sciences and 21st in biological scientists in the workforce.

University R&D Expenditures, FY 2002

	Arizona	US	Rank
Total	$531 million	$36 billion	21
Life Sciences R&D	$253 million	$21 billion	27
Life Sciences as percent of total R&D	48%	59%	
Life Sciences Per Capita	$46.38	$74.06	
Change in Life Sciences (FY 1996-2002)	59%	69%	

NIH Support to Institutions, FY 2002

	Arizona	US	Rank
Total	$136 million	$19 billion	28
Per Capita 2002 Expenditures	$24.89	$65.49	
Change in Expenditures (FY 1997-2002)	76%	82%	

Higher Education Degrees, 2002

	Arizona	US	Rank
Higher Education Degrees Biological Sciences, AY 2002	1,426	107,803	28
Biological Scientists in the Workforce (FY 2000-2002 Avg.)	7,350	461,973	21

Source: BIO - Biotechnology Industry Organization/Battelle Technology Partnership Practice and SSTI.
AY= Academic Year. FY= Fiscal Year

Arizona is beginning to produce more graduates in bioscience-related disciplines, especially biology. According to a 2003 Bioscience workforce study by Battelle, Arizona institutions awarded more than 1,700 biosciences degrees in 2001-2002, including almost 900 in basic sciences biology programs — the core degree in the biosciences. Biology degrees were up 20 percent in the previous five years — an encouraging trend considering that the national trend was flat.

Amid this encouraging undergraduate news, there is bad news for graduate degrees. Arizona has recorded a sharp decline in Ph.D. and master's graduates in biosciences. Significantly, this decline comes just as the demand for postdoctoral scientists in Arizona is expected to soar in the next several years *(Battelle, 2003)*.

Serious Shortages in Talent Key to Patient Care

In most critical areas — especially in clinical health care — Arizona is simply neither producing nor attracting the number of trained workers required to leapfrog ahead.

The shortage of nurses has been well-documented — 90 percent of all trained nurses are in the workforce and there's still a 15 percent vacancy rate in the industry. Based on the latest data available, there are only 605 registered nurses for every 100,000 residents in Arizona, compared to 784 nationwide. These shortages are partly the result of a lack of educational capacity — not enough space and professors to teach future nurses — but also a lack of financial resources to support prospective students. Last year, nearly 1,000 qualified applicants for nursing programs at Arizona universities and community colleges were denied enrollment in the semester in which they applied, according to a consultant for the Arizona State Board of Nursing.

A state law, SB 1260, calls for a doubling of nursing enrollment in state schools by 2007. Currently the state graduates about 1,200 RNs per year.

But nurses are only one part of the story. In many key clinical areas, Arizona is also suffering from labor shortages. And even in areas where Arizona is doing better — for example, physicians — a crisis is looming. Arizona has 195 doctors for every 100,000 population — a figure well below the national average of 253. Furthermore, the pool of physicians practicing in Arizona is aging rapidly, and the 200-250 physicians per year graduating is barely enough to keep up with the growing population. The most ominous weakness of all, however, may be a growing problem of recruiting and retaining good physicians.

More Nurses, Doctors and Technicians Needed

Average Annual Job Openings in Arizona

	Average Annual Job Openings		
Professions	**Openings Due to Industry Growth**	**Openings Due to Retirement or Other Workforce Separations**	**Total**
Registered Nurses	1,978	714	2,692
Physicians and Surgeons	110	44	154
Health Technologists and Technicians	1,925	710	2,634

Source: www.workforce.az.gov; 2003-2013, Arizona Statewide Occupational Projections.

There are many different reasons why physicians are choosing not to practice medicine in Arizona — and why other health care providers such as hospitals are struggling. The increasing burden of escalating malpractice premiums, the penetration of managed care and low reimbursement rates, and the high cost of new startups are driving many current physicians out of practice – and causing others not to consider Arizona as their practice site. Furthermore, despite expansion of coverage of children through KidsCare, a very high percentage of Arizona's residents are uninsured or insured through Medicare, HMOs and other entities that make practicing medicine less financially attractive. According to Arizona Hospital and Healthcare Association (AzHHA), either Medicare or AHCCCS (Arizona's Medicaid) covers more than 60 percent of patient hospital days. What's even worse for hospitals and physicians, though, is that the outstanding payments in Arizona medicine total a half-billion dollars at any given time *(AzHHA, 2001)*.

These worker shortages have a real impact on health care services. According to the AzHHA Healthcare Institute, in 2001, virtually all hospitals in the state experienced severe problems in dealing with overcrowding and capacity — a vastly different picture than the rest of the nation, as the hospital capacity table shows. Emergency department capacity problems are largely a function of personnel rather than facilities limitations. Arizona also sees a lot of inappropriate use of ER for non-emergent problems.

Percent of Hospitals Reporting Capacity Problems

		Percentage (%)
Exceeding 90% Census*	US	42%
	AZ	73%
Emergency Department Overcrowding	US	41%
	AZ	91%
Emergency Department Diversion	US	26%
	AZ	82%

Source: Arizona Hospital and Healthcare Association, 2001.
*Census in this graph means percentage of staffed beds that are occupied by patients.

Missing Key Building Blocks

Furthermore, the lack of a fully developed major medical school and academic medical center in Phoenix has been an enormous gap in the state's Meds and Eds infrastructure. Metropolitan Phoenix was the 14th largest metropolitan area in the nation in the 2000 census — and it is by far the largest metro area in the nation without a four-year allopathic medical school and major academic medical center.

There is little question that academic medical centers will play a central role in the biology century. They serve as the bridge between the world of biosciences research, where new treatments and therapies are developed, and the world of clinical treatment, where these innovations are applied. And, there is ample evidence that academic medical schools — those producing research-oriented physicians — show a strong relationship with successful NIH funding.

The Phoenix Biomedical Campus, which is the proposed location for an expanded UA College of Medicine and UA College of Pharmacy campus, and a relocation of the ASU College of Nursing, is an innovative solution. As envisioned, the new Phoenix Biomedical Campus will fill Arizona's need for more health care professionals and make Arizona much more competitive on a national level for health-related research funding.

Growing Fragmentation

The current trend in Arizona — which is perhaps stronger than in the rest of the country — is for physicians and other clinical practitioners to remove themselves from hospitals and other institutions and set themselves up as entrepreneurs and specialists.

The circle diagram of Arizona's health services and health sciences cluster presented on page 31 shows the 11 segments of the health system by average annual employment growth from 1990-2003 (horizontal axis), employment concentration relative to the United States (vertical axis) and employment size (size of circle). In this diagram, the health sectors associated with "free agents" are growing much faster than traditional sectors. For example, outpatient care centers are growing at close to 7 percent per year, while traditional hospital employment grew by only 1.7 percent per year.

Meanwhile, employment is becoming more concentrated in health sectors associated with specialization, and less concentrated in traditional health sectors. In fact, Arizona leads the nation in specialty hospitals, according one expert.

There is little doubt that this shift in the structure of health care employment in Arizona is due to competitive pressures between physicians and hospitals. The Center for Studying Health System Change says that, at least in metropolitan Phoenix, "physicians are aggressively pursuing strategies to improve their financial situations" by devoting more time to "their own ambulatory treatment and surgery centers or specialty hospitals in which they have equity interests." The drawback, the Center adds, "is that the growth of specialty facilities threatens traditional hospitals with the loss of profitable services" *(www.hschange.org)*.

Arizona's Health Care System is Evolving

Question is, Can it Get to Integrated Medicine?

	FROM: General Practice	TO: Outsourced Specialization	TOWARDS: Integrated Medicine
Focus	Hospital	Outsource Services	Personalized Medicine
Driver	General Practitioner	Disease Specialist	Health Professionals/Free Agents
Mode	Whole Patient	Pieces/Parts	Integrated System
Method	High-Touch	High-Tech	High-Touch and High-Tech
Function	Silo, Solo Doctor	Small Groups	Interprofessional Education

Source: Collaborative Economics, 2004.

The Center's report also notes that, at the same time, "Hospitals are increasing investment in freestanding specialty hospitals in response to the continued growth of physician-owned specialty hospitals."

This explains why today's health care system is not geared toward the integrated treatment of complex diseases. It's increasingly organized around individual doctors and discrete episodes of care rather than around the comprehensive needs of patients. Our providers can be excellent — indeed, their specialization may foster expertise that is a great asset to the region. But the fragmentation of health care can lead to devastating results, as debilitated victims of chronic diseases vainly struggle to patch together an expensive and poorly coordinated system of care.

Few would quarrel with the view that more hospital-doctor-insurer collaboration and more inter-professional teams working with patients are critical to better care and lower costs. At this point, Arizona's trajectory is in the opposite way — more fragmentation and less integration.

Is this Arizona's Leap year?

ARIZONA THE BOLD?

For Arizona, the challenge is clear: Many of the building blocks for leadership in this century are already in place in Arizona. But unless the state can overcome most of the deficiencies discussed in this report – and excel in the must-haves for innovation – Arizona will not be able to leapfrog ahead into the race for leadership.

For Arizona, the opportunity is also clear: Prosperity and quality of life will depend, in large part, on the ability of a state or region to take advantage of opportunities to combine cutting-edge research and cutting-edge medical practice into a new economic driver and new quality of life amenity.

One other thing is clear as well, this is the time to decide: Are we going to be "Arizona the Bold?"

Here are five bold things Arizona can do to leapfrog ahead.

1. Set some BHAGs (Bee-Hags) – Big Hairy Audacious Goals

BHAG No. 1 Invented here. Discovered here. Started here. From just those three phrases, Arizona has the beginnings of a BHAG to guide it into the 21st century. Taken together, these phrases say Arizona plans to be home to those people, companies, and institutions striving to fully explore the new frontiers of science and technology and looking to develop globally competitive enterprises based on new ideas and new discoveries. The phrases also say that Arizona recognizes the natural limits of the "cheaper here" and "warmer here" model of economic development. It worked for Arizona in the past, but now it mainly works for developing economies, not advanced economies. Arizona will lose the "cheaper here, warmer here" competition in the future.

BHAG No. 2 follows from the first: Set the standard for quality health care. As the 21st century gets underway, Arizona has to look ahead to decide where to compete and to invest. Looking ahead then, as we have in this report, there will be no more powerful idea — in terms of both prosperity and quality of life — than bringing together cutting-edge research and cutting-edge medical practice in one location. Researchers and clinicians will be able to communicate back and forth about evidence-based treatments and new technology; individuals will benefit rapidly not only from new drugs, technology and practices but also from customized health plans. The results will be high value research and treatments that will be exported all over the world but also deliver exceptional medical care for Arizonans.

Working towards these two goals will provide focus, motivation and momentum. Yet the trick is to get there faster than anyone else. Bottom line, the best way to predict the future of health care is to invent it. So **BHAG No. 3** has to be: Leapfrog. It's a motto that says: Look ahead 20 years, but get there in 10. It certainly seems to fit the strategy Microsoft followed years ago. When Microsoft challenged IBM for high-tech supremacy, success didn't come by catching up — building a better mainframe. It came by leapfrogging over IBM and betting on software for the personal computer. And it is exactly the kind of mind-set that drove the aggressive investments Austin and San Diego made to build a new path to regional prosperity by capturing more talent, research funds, and science and technology-oriented jobs in a relatively short period of time – less than a decade.

These three BHAGs can guide Arizona's choices in public policy in the future. Private enterprises will surely drive Arizona's technology future — we'll be a smart, innovative place and a leader in health care revolutions largely if we have a critical mass of smart, innovative companies in knowledge-intensive industries. At the same time, however, if Arizona doesn't have the right foundations and right caliber of talent, its future can fall apart like a house of cards. Location is an extremely important consideration in a firm's competitiveness. Globally-oriented businesses are looking for places that can provide the assets, collaborative institutions and mindset that support innovation — many of which can be built and shaped by local and state public policy.

How Badly does Arizona Want to be a Smart, Innovative Place?

Innovation is Not a Term Most Associate with Arizona

When asked to describe Greater Phoenix, three national groups said: good place to retire and vacation.

	National Business Media	Business Executives	Site Selection Consultants
Describe Greater Phoenix	1. Retirement 2. Vacation/Touristy 3. Sprawling 4. Too Hot 5. Good Place for Golf 6. No Water	1. Retirement 2. Vacation/Touristy 3. Too Hot	1. Retirement 2. Vacation/Touristy 3. Sprawling 4. Too Hot 5. Techno-Advanced
Industries Associated with Greater Phoenix	1. Retirement 2. Tourism	1. Retirement 2. Tourism	1. Electronics 2. Financial Services 3. Retirement 4. Tourism 5. High Technology

Source: Greater Phoenix Economic Council, 2003.

After Studying the Must-Haves for Headquarters and R&D Operations, Austin and San Diego took Bold Steps to Transform Their Economy and Their Identity

Business Function	Location Priorities	Sensitivity to Cost
Headquarters	Accessible international air service High-end hotels, restaurants, entertainment, cultural events, major league sports to facilitate heavy inter-company face-to-face interaction Professional support services; good choice of office space or availability of land to build-to-suit Diverse professional employee base Attractive housing for executives, affordable housing for managers and support staff within reasonable commute Strong educational system for employees' children and continuing adult education	Cost sensitivity *(within a normal range)* is less important than availability of key requirements.
Research and Development	Proximity to concentration of universities Clusters of highly educated workers, or alternatively, lifestyle amenities that are attractive to this pool of talent	Cost sensitivity is less important than the availability of talent and other requirements *(although R&D may be more sensitive to cost than headquarters)*
Back Office	State-of-the-art telecommunications capacity Affordable housing costs Good schools for employee recruitment and their children On-going available adult education and training	Sensitivity to cost: real estate, telecommunications, housing, taxes
Manufacturing and Distribution	Good transportation system; near major interstates Strong utility systems: electric, water, wastewater, gas Well-educated workforce; strong specialized training programs	Sensitivity to housing costs; taxes, utility rates

Source: Cohen, N. *Business Location Decision-Making and the Cities: Bringing Companies Back,* April 2000.

BLUE Note of urgency for Arizona. BOLD Bold move made by other states or cities to address similar challenge.

2. Get the "Right People on the Bus"

This bit of wisdom comes from *Good to Great* author Jim Collins, who advises companies that are seeking the path to greatness to have one priority above all others: acquire as many of the best people as you can. Something similar can be said for a state, and it has particular relevance to a state such as Arizona that has pinned its hopes on capturing a big chunk of the emerging bioscience economy.

Essentially, Arizona won't lead in medical discoveries unless universities and research institutions are loaded with top talent and research dollars. And it won't lead in patient care unless its hospitals and clinics are loaded with plenty of well-trained doctors and nurses.

The question is how to do it. It's not enough to say Arizona has to capture more federal research dollars, especially National Institutes of Health (NIH) grants. While that's important, the truth is, total federal research dollars are flat, NIH money is going mostly to a few regions, and nearly every biotech wannabe in the nation has that game plan. Arizona does have Proposition 301 dollars for university research and workforce, but that $44 million per year is looking more like jump-start money and less like leapfrog money. Leapfrog money looks like $3 billion for "California Stem Cell Research and Cures Act," which Californians approved in November to support cutting-edge life sciences research and top talent (see Bold Standard on page 45).

Arizona could take a dramatic step forward and establish an Arizona Science and Technology Foundation to support cutting-edge health researchers and research consortia.

Time and again we have seen how a transforming philanthropy gift or big grant helps a university, research institute or academic center attract high-profile scholars, who raise the level of scholarship and research within the school or institute. This enhanced reputation helps to attract the finest students and more dollars from the NIH, industry, alumni, foundations and other donors. There's a domino effect of sorts, and it's a big reason for the Georgia Legislature's support of some $375 million investments in Georgia Research Alliance and Eminent Scholars and University of Southern California's new $100 million for 100 new faculty so it can leap into the top ten private research colleges in the country by the end of this decade.

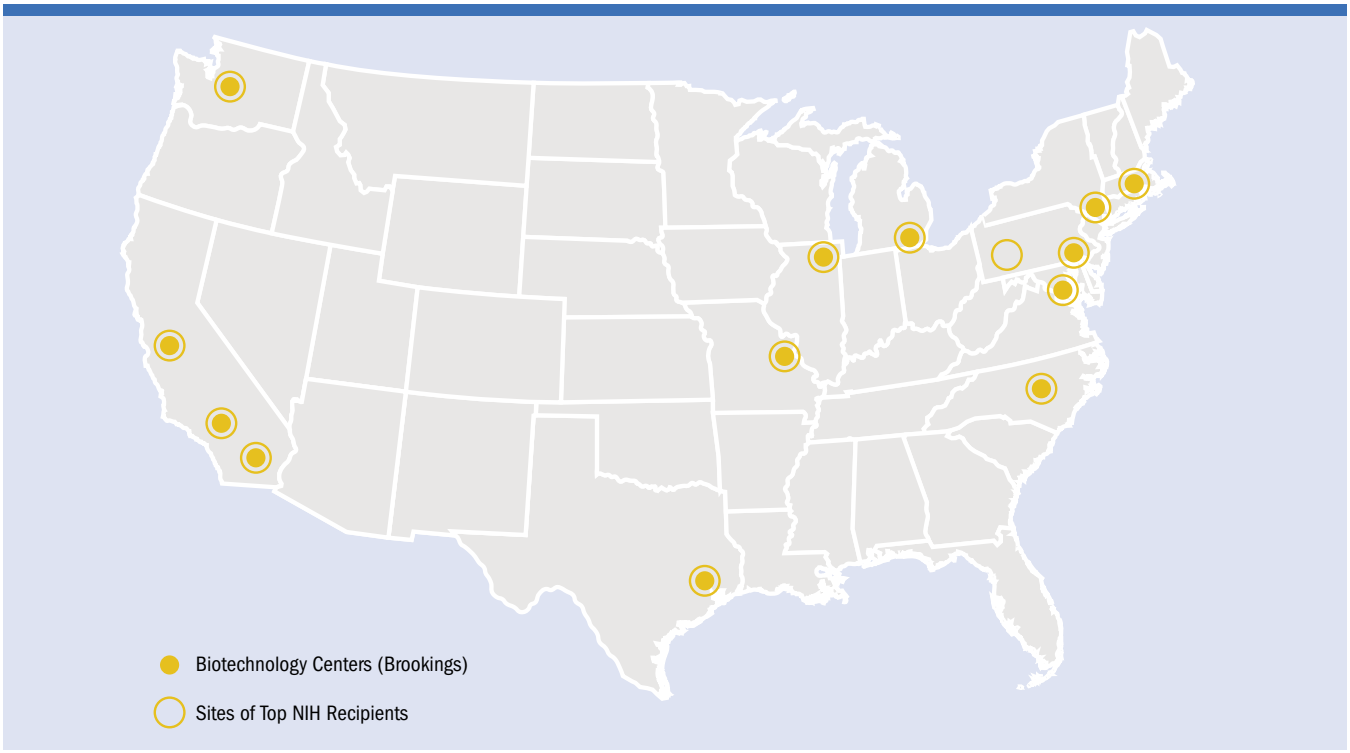
Most recently we have seen how a state-sponsored research "war chest" can transform not only a university but help transform an economy. In California, a recent analysis of the 8 year-old University of California Discovery Grants program — a $60 million per year fund, coming from the state, UC and industry — finds that UC's contribution to California's R&D-intensive industry sectors includes UC scientists founding one in six communications firms and one in three biotechnology firms in California.

Are Arizonans ready to make a "Fourth Big Bet" on top-tier Meds and Eds? That's a key question because generating leapfrog dollars for Nobel Prize-level science and top-caliber talent probably means another voter-approved proposition like Proposition 301 to create Arizona's own research fund.

Look for more and more States to Create their Own Mega-Research Funds

It's not enough to say Arizona has to capture more federal research dollars. Nearly every biotech wannabe has the same game plan, and the few regions that already receive the lion's share of NIH money are not waiting for Arizona and other states to catch up.

Federal Research Dollars Flow Mostly to a Few Regions



Even though California scores well on federal research dollars, it has created its own research fund – not once, but three times.

1 **In 1996, the University of California (UC) created a $3 million university-industry cooperative research program.** Today it is roughly a $60 million a year fund, coming from state appropriations, UC and industry.

2 **Four years later, in 2000, a bold plan was launched to create four California Institutes for Science and Innovation at UC.** These institutes are a three-way partnership between the state, California industry, and UC. Each institute focuses on a research field key to the future of California's economy, bringing together the best and brightest UC scientists and students with industry in an unmatched research enterprise. Taken together, these four institutes represent a billion-dollar effort to focus resources and expertise on research areas critical to sustaining California's economic growth and its competitiveness in the global marketplace.

3 **Another four years later in 2004 — voters solidly backed a jaw-dropping $3 billion over 10 years — or an average of $300 million a year — to fund research that could offer treatments and cures for serious diseases** such as diabetes, Alzheimer's and Parkinson's. No state has ever raised that much money for a specific type of research. This may sound risky to some people, but many more believe that this is one of the savviest moves of all time to capture top researchers and innovative companies.

BLUE Note of urgency for Arizona. BOLD Bold move made by other states or cities to address similar challenge.

3. Create the Assets You Need

Arizona has known for some time now that its health care system is short on nurses, physicians, faculty and medical schools and that these shortages could jeopardize its biotech status. Yet its response has been weak to non-existent. Arizona legislation (SB 1260), for example, mandates doubling of the number of nurses by 2007, but it does not provide any resources to meet that goal, leaving the universities, community colleges and hospitals scrambling to respond. All past initiatives to build a full-scale medical school in Phoenix have been "dead on arrival." It's no accident, in sum, that Arizona faces these gaps in its building blocks. The stories of Austin and San Diego remind us that talent and medical institutions are "buildable" assets and that they can be had by a state or region that puts its collective mind to it. The question is how.

Two factors could provide hope for resolution of these long missing Meds and Eds building blocks:

>> Revisit SB 1260 in 2005 and fund the mandate to double the nurses, which will cost at least $40 million, not counting major capital investments that are needed. But long term, there needs to be an on-going method of identifying high-demand fields and programs based on student and employer needs and then an on-going method of funding universities and community colleges so they can respond.

>> Support the Arizona Board of Regents' decision and the city of Phoenix's plans to bring the University of Arizona Colleges of Medicine and Pharmacy to downtown Phoenix. By insisting that the medical school develop in a "collaborative way" with both ASU and UA, the Board of Regents broke a historic log-jam in Meds and Eds in Arizona.

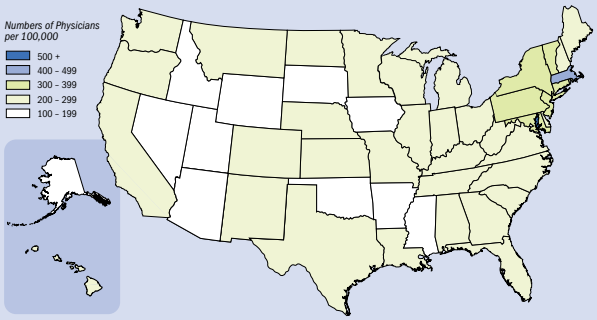
The reasons for the first initiative are straight forward: Arizona can't expect to have quality health care without nurses — nurses for emergency rooms and hospitals, nurses for clinical trials, and nurses for home health care. Furthermore, investments in nurses are likely to remain in Arizona because these are among the jobs least likely to go overseas.

The reasons for supporting Arizona Board of Regents' and Phoenix's plans to establish a medical school are even more compelling. It will be a pipeline for more home grown physicians and researchers. It will be an asset for attracting those translation-oriented researchers and innovation-oriented physicians that desire faculty appointments with medical schools. But most important perhaps, it will give Arizona the chance to build a "new era" medical school and to leap ahead on so many fronts — the first medical school jointly developed by two universities will be among the first medical schools to focus on training the 21st century physicians and the first medical school to weave health science and health care into one curriculum. The opportunity, in short, is priceless.

Call it the Shortage that will not Quit

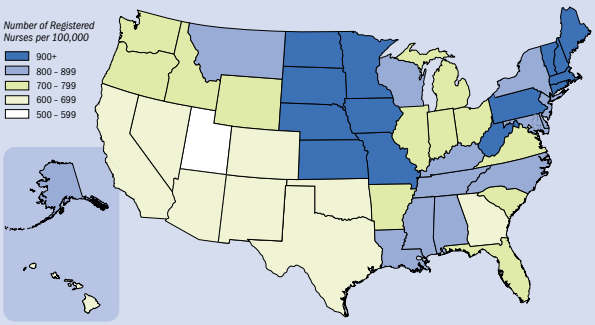
Arizona has Among the Lowest Number of Working Nurses and Physicians per Capita

Comparison of Physicians and Population



US Average 253.
Source: US Census Bureau Statistical Abstract of the US: 2002, active non-federal physicians.
Not including District of Columbia.

Comparison of Registered Nurses and Population

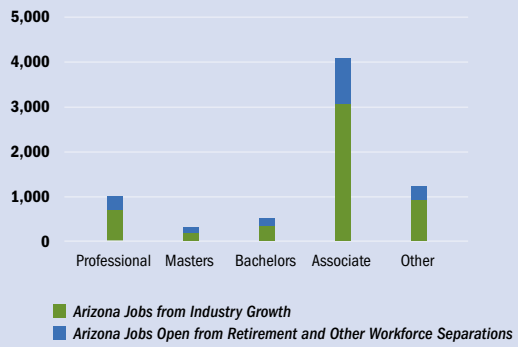


US Average 784.
Sources: Population - US Census Bureau.
Nurses - US Bureau of Labor Statistics, www.bis.gov/oes/current/oessrcst.htm

Workforce issues face all industries. But the challenges take on new intensity in occupations critical to patient care, where the issue isn't simply supply and demand. It's a factor in whether people live or die.

Most Health Care Job Openings will Require Education

Annual Job Openings in Arizona by Education Level



Florida and Indiana are Loading Up on Talent in New Ways

Meds: Foreign Educated MD to RN Program. A constellation of hospitals, med schools and governments have organized to create a program at the Florida International University School of Nursing to help turn foreign-educated physicians in the United States into nurses if they are unable to transfer their doctor's licenses. The program helps Florida face a critical shortage of nurses and offers opportunities for Cuban physicians with legal immigration status and English proficiency get health care jobs, many of whom would otherwise be consigned to low-skill, low-wage employment outside the medical field.

Eds: Lilly Endowment, a private philanthropic foundation, gives $100 million to Indiana universities to lure the best and brightest talent to Indiana. Because faculty salaries are almost 7 percent less than the national average, and the universities and colleges do not rank highly in National Merit Scholars or in competition for federal research grants, they can use the money to upgrade research facilities, pay star researchers and faculty, and attract top students.

BLUE Note of urgency for Arizona. BOLD Bold move made by other states or cities to address similar challenge.

4. Use Proximity to Our Advantage

Proximity will play a key role in shaping success in the 21st century. Co-location of the Meds and Eds combo was a success factor in San Diego and elsewhere as well — and it becomes even more compelling for the health research and health care linkages that are pivotal for specific activities such as clinical trials.

Traditionally, Arizona has not scored well on the proximity issue. Arizona's major research universities — the University of Arizona in Tucson and Arizona State University in Tempe — aren't clustered together the way they are in Massachusetts and Pennsylvania. The major medical institutions in the Valley of the Sun are scattered throughout the region. The Mayo Clinic, for example, is in north Scottsdale and Phoenix.

Innovation districts can reserve land in downtown Phoenix and along the light rail route between downtown Phoenix and Tempe for those uses that benefit most from close proximity to universities, medical centers, TGen and IGC.

But Arizona is starting to see the beginnings of biotech/health care clusters — downtown Phoenix, around the University of Arizona in Tucson, and around the Mayo Clinic in North Scottsdale. It's a good time to make proximity part of city and state land use and economic development policy. Possible steps include:

>> Create innovation districts in downtown Phoenix and elsewhere to focus development.

>> Expand Arizona's urban development toolbox to focus on bioscience innovation.

Instead of remaining ruggedly against Tax Increment Financing (TIF) and other redevelopment tools, Arizona could enable cities to create innovation districts. These districts can serve several purposes. An innovation overlay can help preserve land along the light rail line between downtown Phoenix and Tempe, land in close proximity to universities, academic medical centers, TGen and IGC in downtown Phoenix, and land surrounding Mayo Clinic for those uses that benefit most from proximity. An innovation district with TIF or other such arrangements can help pay for some of Arizona's new Meds and Eds infrastructure.

Using Place as an Asset In the Age of "Open Innovation"

Easy to See Why San Diego is "The Place To Be" for Companies and Venture Capitalists Seeking to be Near Top-Calibre Talent and Nobel-Prize Level Science

UCSD: Indicators of Bioscience Strengths

Since its founding in 1961, University of California San Diego (UCSD) has risen to become one of the world's leading universities for life science research. The following illustrates various dimensions of its talent and new ideas.

Nobel Laureates. Ten UCSD faculty have been awarded the Nobel Prize. Current faculty members who won awards relevant to the life sciences are Francis Crick (prize awarded in 1962 for discovery of the double helix structure of DNA), George Palade (1974, structural and functional organization of the cell) and Renato Dulbecco (1975, tumor viruses).

National Medal of Science. Considered the nation's highest scientific honor, eight UCSD faculty have been recipients, including Nobel Laureate George Palade (1986) and Yuan-Chen Fung (2000), professor emeritus of bioengineering.

MacArthur Foundation Awards. Popularly known as the "Genius Awards," 11 UCSD faculty have been recipients, including Russell Lande in biology.

National Academy of Sciences. UCSD ranks 7th in the nation in the number of faculty elected to the NAS, America's premier society for the scientific community. (The top 10, in descending order are: Harvard, UC Berkeley, Stanford, MIT, Yale, CalTech, UCSD, Princeton, Chicago and Cornell.)

***Nature* Magazine.** The leading scholarly journal of the life sciences, *Nature*, in its "Yearbook of Science and Technology" has ranked UCSD as "one of the 10 most powerful research universities in the United States."

Cited Research. The Institute for Scientific Information has ranked UCSD 5th in the world in terms of the most cited molecular biology and genetic research papers. UCSD pharmacology professor Michael Karin ranks 1st worldwide.

Source: Milken Institute, *America's Biotech and Life Science Clusters*, June 2004 and UC San Diego.

Pennsylvania Decides to Build Innovation Zones

Since the San Diego success, other states have begun to adapt traditional redevelopment tools to foster innovation proximity. Pennsylvania recently created the Keystone Innovation Zone – a new concept that permits communities with universities and research institutions to obtain a state designation designed to encourage Meds and Eds style innovation. Keystone Innovation Zones qualify for state funding for operational costs, and businesses located within the zones can compete for a statewide pool of $25 million in tax revenue.

Already, Pittsburgh – one of the leading health and science centers in the nation – has qualified for a Keystone Innovation Zone by having private businesses and institutions around Carnegie Mellon and the University of Pittsburgh provide matching funds. Seeing competition from San Diego and others, Pittsburgh is not resting on its laurels, but rather using new tools to maintain its lead.

BLUE Note of urgency for Arizona. BOLD Bold move made by other states or cities to address similar challenge.

5. Trump the Competition with Arizona's "Collaborative Gene"

Arizona has already shown that it has the "collaborative gene." This can be the state's trump card — especially in a century that requires collaboration like never before.

Arizona: "We are the epicenter of gene-based research in the world. We have become a national model…When people ask me, "How did this happen in Arizona?" I reply, "We're Westerners. We believe individuals can make a difference and can solve problems when we work together."
Richard Mallery, a leader in attracting TGen to Phoenix

Boston: "If collaboration is the key, you cannot expect Boston to lead. It's too busy being an important place. Don't get me wrong, it **is** an important place. But the docs are too busy and the game of grabbing research dollars is the whole deal."
Former US Senator David Durenberger, now a national consultant on health care policy (Boston Unbound, 2004)

Hidebound places like Boston can't use collaboration the way Arizona can — too many silos, too many degrees of separation. So Arizona can take steps to use the collaborative gene as the final strategy that will ensure the success of the leapfrog approach. Obvious steps include:

>> Create a permanent organization of CEOs and other leaders in the Meds and Eds field — universities, community colleges, government agencies, hospitals and health care providers, biotech business leaders — so that Arizona will stay on course.

Priorities? How About:

> Top Ten Meds and Eds by 2015. In a world in which everyone is searching for top talent and new ideas, and in which success breeds success, top stature for Arizona's medical school, hospitals and research universities is critical.

>> Create a network that includes not just universities and research institutions but also hospitals and health care practitioners, so that traditional health care providers and emerging free agents can collaborate in pursuing three dramatic innovations:

> focused "factories" of providers that work together to better treat specific diseases or patient groups,

> integrated information records that consolidate currently dispersed patient information, and

> personalized medical technologies that enable treatments to be designed for individuals.

>> Create funding mechanisms for fueling multi-institutional, state-wide consortia that work to realize the potential of personalized medicine.

This could be part of an Arizona Science and Technology Foundation initiative, discussed earlier, or it could be established as a grant program like California's Discovery Grant program.

A Different View – to the Collaborator Goes the Spoils

Silo, Solo is Passé

Meds: "The clinical researcher today is really no longer a lone physician-scholar in a white coat who returns to the lab to putter around after a day of diagnosing and treating patients…Clinical research today is more often a team effort in which physicians, pharmacologists, research nurses, basic scientists, data managers, statisticians and others all work together."

Source: The Pfizer Journal, 2003.

Eds: "Despite the popular image of the inventor as a lone agent, invention is a deeply collaborative process."

Source: Report of the Committee for Study of Invention, sponsored by the Lemelson-MIT Program and the National Science Foundation, April, 2004.

Pittsburgh Collaborates to Achieve Perfect Patient Care — and Captures National and International Attention for It.

Perfect Patient Care in Pittsburgh

The Pittsburgh Regional Healthcare Initiative (PRHI), a nonprofit, was formed under the leadership of former US Treasury Secretary and Alcoa Chairman, Paul O'Neill. PRHI is a consortium of hundreds of clinicians, 42 hospitals, four major insurers, dozens of major and small-business health care purchasers, corporate and civic leaders, and elected officials, whose goals are:

>> Achieving the world's best patient outcomes by
>> Creating a superior health care system, by
>> Identifying and solving problems at the point of care

This effort has also distinguished itself by applying the lessons learned from the Toyota production system to the health care system to reach these goals. Two of those Toyota lessons will be music to any patient's ears: "mistake-proofing" and "no problem should be left unsolved" *(www.prhi.org)*.

BLUE Note of urgency for Arizona. BOLD Bold move made by other states or cities to address similar challenge.

CONCLUSION

Perhaps no other state is as well positioned as Arizona to move so far ahead so quickly in the health era. Because Arizona is still a young state with a relatively small pool of leaders, it is possible to reach a consensus on how to move forward. Because Arizona is creating wealth quickly, it is a state that can afford to invest in the right things. And because Arizona has already taken important steps – Bioscience roadmap, TGen, Proposition 301, University Partnerships, and Research Facility Funding – it is possible to build on a solid foundation.

But once again, simply playing catch-up isn't good enough. The whole goal of Arizona's Meds and Eds effort must be to leapfrog ahead of the competition – to leverage a wide variety of assets (new institutions, the existing health care system, climate, and strong urban areas) to blow past other regions and states that are also seeking to position themselves for the biology century.

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Is this Arizona's leap year?

The 21st Century has been dubbed the "Biology Century." It's a century driven by innovation, with a big focus on innovation to improve health. Arizona is more than capable of playing a leading role in this century. But it's going to take:

New Era Thinking. Most people think "Cheaper in Arizona" and "Warmer in Arizona." While that identity has served Arizona well so far, it's time to move on to new ambitions: "Invented in Arizona." "Discovered in Arizona." "Started in Arizona."

Sustained, Resolute Effort. These new ambitions will not be realized unless they serve as long-term guides for important public policy. Private companies will surely drive Arizona's future — but there is much Arizona can do to build the foundations that support and cultivate innovation. Top of the list is to build a dynamic combo of top-rated "Meds and Eds," because success in the biology century will require intense interaction among research institutions, universities, entrepreneurs and hospitals in order to yield the big medical breakthroughs and better patient care.

Exceptional People. There is no substitute for talent — it's the path to greatness. Arizona has to have "star talent" to be known for its top-notch medical care, its Nobel-Prize level science, and its path-breaking companies. But it can all fall apart if the state doesn't also create a great pipeline so that the "line jobs"— physician's assistants, bioengineers — are filled with high-quality, educated workers.

The Collaborative Gene. No more silos. Faster cures and better patient care require collaboration. So does bold public policy. Leaders must cut across all sectors and all institutional barriers so that government, business, universities, research institutions and clinical institutions all work together to leap ahead in areas that matter most in the 21st century.