MAKING ARIZONA COMPETITIVE IN SCIENCE, ENGINEERING AND MEDICAL RESEARCH AND INNOVATION

Understanding the Pathway to Success

Greater Phoenix Leadership
Southern Arizona Leadership Council
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INTRODUCTION

The purpose of this document is to help Arizonans understand the importance and value of Arizona becoming competitive in science, engineering and medical research and what it will take to achieve that goal.

In the past five years or so, Arizona has made significant strides in its capabilities and capacity for conducting scientific research. Hundreds of millions of dollars have been invested by both public and private sources, considerable new talent has been attracted or developed, and dozens of reports have been issued on how the state could become a leader in the biosciences and related fields. Each of these efforts has added value to attaining a shared goal of enabling Arizona and its residents to benefit from the services, products and economic development that being competitive in scientific, engineering and medical research can produce. In a sense, the collective efforts have given Arizona its ticket for entering the much-heralded "knowledge" or "innovation" economy.

The confluence of research in science, engineering and medical fields presents an extraordinary opportunity. Becoming truly competitive in these areas would improve the quality of people's health and improve their job opportunities, too. Thus, to assist Arizona leaders and residents alike, this document presents a straightforward explanation of what it will take the state to become competitive in science, engineering and medical research. More specifically, it–

1. Simplifies content from a substantial number of reports on how to improve Arizona's capacity to compete in science, engineering, medical and bioscience research.
2. Presents a list of the most important actions from this body of work.
3. Identifies the organizations and institutions that have important, cooperative roles in carrying out those actions to make the state competitive.

THE AVERAGE HIGH TECH WAGE IN THE U.S. IS $63,687,
74% GREATER THAN THE PRIVATE SECTOR AVERAGE OF $36,646.

21ST CENTURY RESEARCH IN ARIZONA: THE OPPORTUNITY

Science, engineering and medicine constitute a vast landscape of opportunities, including research, development and commercial activities in biology, information and communication technology, engineering, chemistry, health care, agriculture and manufacturing. The convergence of these fields is especially exciting. Arizona becoming a competitor would yield very significant economic benefits to its residents.

Other cities, metropolitan areas, states and international competitors are well ahead of Arizona in industries in these fields, while some probably now lag too far behind to be serious contenders. Those still in the science and technology competition, including Arizona, need to compete especially hard.

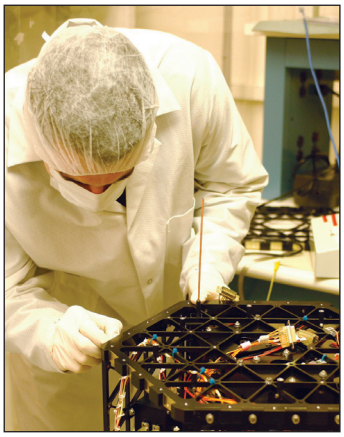
While Arizona is blessed with many qualities that attract people and businesses, historically many of the jobs created here have tended to be below the national average for wages and benefits. The state could improve the standard of living for its residents if it became truly competitive in science, engineering and medical research and in bioscience industries. This foundation would enable the state to expand its high tech economic clusters. Jobs in science, engineering and medical fields not only pay well and typically provide good employee benefits, they also generate additional good jobs. As Arizona faces the prospect of losing manufacturing and other jobs to the ubiquitous "off shoring" strategy now used by global businesses, it must be especially diligent at creating new, high paying jobs built on a well-educated workforce.

Here's the good news—Arizona has a lot going for it. The state's universities, hospitals and research institutes and its historic strengths in private sector electronics and engineering are very significant assets for making the discoveries that will spawn 21st Century industries and improve health care.

Perhaps the best news is the number of prominent Arizona leaders, businesses and institutions now working together to make Arizona a science, engineering and medical research competitor to be reckoned with. Since the initial path-breaking work a few years ago, numerous organizations and individuals around the state have gotten involved in a big way. But the challenge ahead is formidable: organize and focus numerous, diverse efforts that share a common purpose and then take decisive action. A dynamic, well-coordinated and patient effort can ensure that Arizona is competitive in the economy of the 21st Century.

BUILDING MOMENTUM

A successful statewide effort to become competitive in medical, science and engineering research requires vision, talent, institutional support, policy tools, investments, leadership and collaboration. Arizona simply will not get to play in the "big leagues" until critical mass in each of these areas has been reached and is well coordinated. Fortunately, the commitment to and assets supporting this goal have grown significantly in recent years. Thus, the state has considerable momentum.



SINCE 2000, MANY IMPORTANT MILESTONES[1] HAVE BEEN ACHIEVED—

- Proposition 301 initiated a significant, long-term state investment in research at the state's three universities
- Translational Genomics Research Institute, better known as TGEN, was established
- Mayo Clinic developed a master plan for expanding its Scottsdale and Phoenix campuses and cancer research facilities
- The $440 million "research infrastructure bill" was passed by the state legislature, enabling the universities to develop first-rate laboratories for bioscience research
- Flinn Foundation and Battelle identified Arizona's strengths in bioscience, its best opportunities for becoming a leader and provided a "roadmap"
- Arizona Bioscience Roadmap Steering Committee was formed to help implement Battelle's research
- ASU established the Biodesign Institute; U of A created BIO5; NAU initiated the Strategic Alliance for Bioscience Research (SABRE)
- Arizona Biomedical Collaborative was approved by the Arizona Board of Regents enabling a tri-university research operation

1 The aforementioned milestones and organizations are merely illustrative. Many others could have been included.

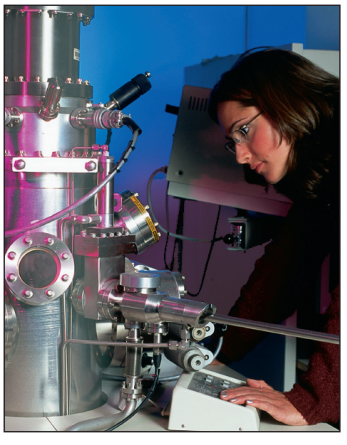
- Phoenix Biomedical Campus, an extension of the U of A College of Medicine, was approved
- Legislature passed a bill to stimulate "angel" investment in early-stage science and technology companies
- Arizona BioIndustry Association, a trade organization, was established
- Virginia G. Piper Charitable Trust committed $50 million to attracting world-class science research talent to Arizona
- Science Foundation Arizona was formed and funded by both public and private sources

In addition, numerous important reports on the biosciences, scientific research and technology commercialization in Arizona were issued in this timeframe by organizations including—

- Flinn Foundation and Battelle Memorial Institute
- Morrison Institute for Public Policy at Arizona State University
- Arizona Board of Regents
- Arizona Department of Commerce
- Maricopa Community College District
- Arizona Hospital Association
- Arizona Town Hall

COLLABORATIVE STEPS ON A PATHWAY TO SUCCESS

A movement of the magnitude required for Arizona to become truly competitive in science, engineering and medical research needs a compass. The vision statement presented in the 2002 Flinn-Battelle "Roadmap" report was just that. Given Arizona's progress in bioscience and scientific research since then, the challenges for 2006 and beyond are to achieve that original vision and also to expand the state's aspirations. The pathway below presents ten fundamental, collaborative steps for navigating toward this goal.



THE PATHWAY: TEN COLLABORATIVE STEPS TO SUCCESS

RESEARCH

1. Build science, engineering, medical and bioscience research facilities.
2. Develop new ways to collaborate on cutting edge research in strategic areas.

TALENT

3. Implement programs that increase instruction and motivate students in math and science.
4. Initiate programs that immediately enhance the composition of the science workforce.

COMMUNICATIONS

5. Communicate Arizona's achievements in science, engineering and medical research and innovation.
6. Inform Arizonans of the value of science, engineering and medical industries.

BUSINESS ENVIRONMENT

7. Develop economic policies and programs friendly to science and technology businesses.
8. Aggressively recruit national and international science, engineering, medical and bioscience enterprises to Arizona.

LEADERSHIP

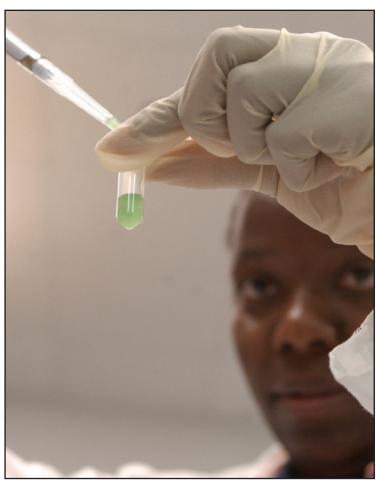
9. Develop a collaborative, coordinated effort among Arizona organizations and institutions that seek to make Arizona more competitive in science, engineering and medical research and innovation.

INVESTMENT

10. Develop and implement a long-term investment strategy

CONDUCT THE RESEARCH: DEVELOPING THE CAPACITY AND FOCUS TO COMPETE

To be a frontrunner in science, engineering and medical research, Arizona needs more capacity to conduct both basic research and applied research.



The starting point for research in most science, engineering and medical fields, including the biosciences, is *basic research*. Simply put, basic research advances scientific knowledge but does not always have specific immediate commercial or economic objectives. However, basic research certainly may be conducted in fields of present or potential commercial interest.[2] *Applied or use-inspired research* (which is often referred to as *translational research*), on the other hand, is "ideas, insights and discoveries generated through basic scientific inquiry that is *applied*"[3]. This type of research can lead to the development of treatments for health issues, for example, and seeks to find solutions to a wide array of problems in other areas.

As an illustration, use-inspired medical and scientific research moves basic research from the lab to the patient's bedside, turning basic research into commercial health-related processes or products. Use-inspired researchers in this field can seek to find preventions and cures for a particular disease or injury. In Arizona, special attention has been paid in this regard to Alzheimer's, Parkinson's, autism, asthma, and diabetes, among others. Any area of science, engineering and medical research and innovation can be *use-inspired*.

Although the public may not fully appreciate the importance of *basic and use-inspired* research, such research has led to cures for polio and tuberculosis, development of global positioning systems (GPS), high-impact plastics, cell phones and magnetic resonance imaging (MRIs) among a multitude of other innovations that improve health and create wealth.

Jerry Harper, City of Phoenix

PHOENIX BIOMEDICAL CAMPUS SITE

2 National Science Foundation, 1996; adapted.

3 Ontario Neurotrauma Foundation, http://www.onf.org/knowledge/glossary.htm; adapted.

Thus, such research is not only valuable to those who conduct it—scholars and scientists—it can lead to discoveries and applications that improve the quality of people's lives. Having the mission, capacity and wherewithal to conduct first-rate *basic research* in promising areas of science, engineering, medicine and the biosciences also increases a state's competitiveness for funding from the federal government, multinational corporations and major foundations. Such "external funding" brings money into a state and makes it attractive to companies—both large and small—that want to "translate" and apply research into commercial products. Thus, *basic and applied research* is a significant stimulus to economic development.

PATHWAY

STEP 1 Build science, engineering, medical and bioscience research facilities to make Arizona attractive to multinational and other knowledge-driven companies.

SUBTASKS

- Complete the University of Arizona Phoenix Medical School Campus and the Arizona Biomedical Collaborative as soon as possible
- Increase university and other institutional science and engineering research capacity

STEP 2 Develop new ways to collaborate on cutting edge research in strategic areas.

SUBTASKS

- Develop special support for Arizona's capabilities in areas such as imaging, informatics, bioengineering, semiconductors, sustainability and information technology
- Create incentives for researchers, institutions and businesses to share information, develop multi-institutional research and submit proposals for federal funding; improve common processes such as clinical trials

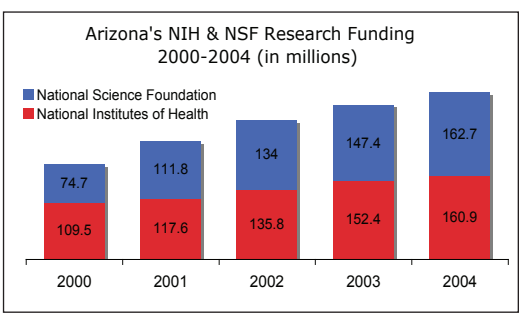
WHAT SUCCESS WOULD LOOK LIKE

Investments in research facilities and expansion of the medical school in Phoenix enable Arizona to conduct cutting edge research in science, engineering and medicine, especially in healthcare and life science fields. The state becomes a magnet for talented researchers and thus increases its capacity to train more doctors and nurses. Both multinational "knowledge companies" and smaller businesses relocate to and expand in the state to take advantage of the commercializable discoveries that emerge from a powerful combination of great researchers working in first-rate facilities with cutting edge equipment.

Photo Courtesy of Mayo Clinic

MAYO CLINIC COLLABORATIVE RESEARCH BUILDING

Collaboration becomes the norm among Arizona's public and private sector science, engineering and medical researchers. Such collaborations make Arizona scientists especially competitive for NIH and NSF funding. This results in steady increases in the number of research proposals submitted to federal government sources and the funding awarded to Arizona teams of scientists. The state develops NIH funded centers of excellence and routinely attracts top rate physicians, engineers and graduate students. Arizona becomes known as "the place to be" to conduct basic and translational research. These assets and the state's enhanced reputation lead to the creation of numerous science, engineering and medical business "spin outs" and strengthen established Arizona bioscience and science-driven businesses as well. Arizona experiences an economic development boom.



CREATE THE TALENT: RECRUITING AND EDUCATING THE RIGHT WORKFORCE

In knowledge-based industries, the quality of the work force determines success. Without outstanding talent, Arizona cannot compete. This means doing whatever it takes to ensure that the state has well-educated individuals and a steady pipeline of qualified workers to support its aspirations in science, engineering and medical research. This includes researchers, engineers, technicians, university and community college faculty, graduate students and entrepreneurs.

Even if Arizona creates state-of-the-art research facilities, it still won't be competitive without the right talent. Five aspects of education and workforce development are required:

Recruit	Arizona can't wait for a pipeline to mature. It needs to recruit the best and the brightest researchers and scientists now to increase research and commercialization activities.
Pipeline	Education throughout the P-20 system should especially provide students with the skills necessary to enter health care and science and engineering research fields.
Renewal	Adults who face skill and employment challenges or who simply want to change or upgrade their careers should have strong retraining opportunities with the sciences and health care fields in mind.
Incumbents	Continuing education and training of the state's medical, bioscience, science and engineering workers is necessary to keep them current.
Entrepreneurial	Education and training must be available to develop and inspire entrepreneurs who will lead and support business formation and growth based on scientific innovation.[4]

A reliable supply of flexible and highly trained workers, ready to initiate and staff Arizona's science, engineering and medical-related industries from top to bottom, will ensure that the state thrives in the long run.

4 Morrison Institute for Public Policy, March 2004. http://www.asu.edu/copp/morrison/CantStandStill.pdf

PATHWAY

STEP 3 Implement programs that substantially increase instruction and motivate Arizona's students to achieve in math and science at all levels.

SUBTASKS

- Develop and assess demanding K-12 learning objectives for science and math
- Continue aligning community college and university math, science and technology curricula to prepare students for emerging science, heath care and technology careers
- Create numerous opportunities for students to directly interact with medical, bioscience and engineering researchers

STEP 4 Initiate programs that immediately enhance the composition of the science workforce.

SUBTASKS

- Build on the recent philanthropic commitment to attract world leaders in personalized medicine by funding other "genius/scholar" programs
- Enhance training programs to improve worker and entrepreneurial skills

Big Job Growth in Biosciences/Technology

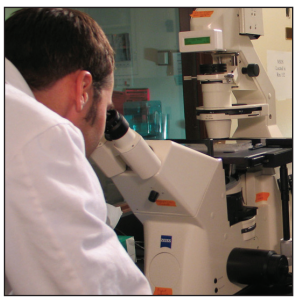
US employment projections 2004-2014

	Percentage Growth 2004-2014	2004 Median income
Computer software engineers	46.1	81,509
Forensic science technicians	36.4	44,010
Medical scientists	34.1	61,320
Healthcare support occupations	33.3	23,850
Computer specialists	31.4	67,100
Biomedical engineers	30.7	67,690
Registered nurses	29.4	52,330
Environmental Engineers & Technicians	29	62,543
Pharmacists	24.6	84,900
Physicians & surgeons	24.0	148,954
Health technologists & technicians	23.7	36,963
Biochemists and biophysicists	21	68,950
Source: Bureau of Labor Statistics Employment Projections		

WHAT SUCCESS WOULD LOOK LIKE

Arizona's K-12, community college, work force training and universities systems routinely produce students who are well qualified to work in or pursue further education in scientific and technology fields. The state has a strong pipeline of medical, health care, bioscience, science and engineering workers including lab technicians, nurses and world-class research scientists.

Training programs in science and health care fields are widely distributed throughout the state and readily available. Science and technology industries, in conjunction with Arizona's universities, establish career ladder programs to encourage employees to continue their education and enhance their skills so the state remains competitive. In addition, training and education programs in compatible fields such as entrepreneurship, engineering, technology and life science business management, and information technology are in demand.

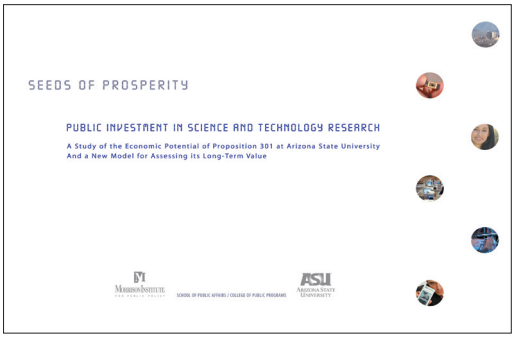


Arizona competes successfully when recruiting top research talent. It becomes nationally known that medical, bioscience and engineering industries here can count on the state's education and training pipeline to produce a sufficient number of quality workers. The former reputation that Arizona's K-12 system had for mediocre student achievement in math and science is erased. Now, both multinational corporate and small business leaders in Arizona praise its public education and work force training systems for producing people who are scientifically literate, highly motivated, entrepreneurial and ready to work.

COMMUNICATE THE MESSAGE: INFORMING DECISION MAKERS, GAINING PUBLIC SUPPORT

Arizona's effort to become more competitive in science, engineering and medical research would benefit significantly if the public had a better understanding of the economic and personal health benefits that accrue to states that lead these fields. In particular, Arizonans should be made aware of the investments, political will and patience required to succeed.

As the quest to become more capable and innovative in science research grows in Arizona and more institutions become involved in the effort, clarity-of-purpose will become especially important. An enduring marketing-communications-outreach campaign would create broad understanding of and support for Arizona's science, engineering and medical research initiatives, especially those in the biosciences. And, the public also needs to know Arizona's actual accomplishments in these areas. In short, the purpose, progress and payoffs of these efforts need to be regularly communicated in ways most people can easily understand.

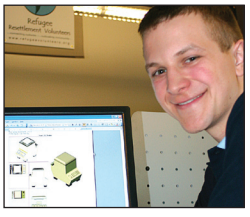


The good news is that Arizonans would be very receptive to these messages. According to a recent research report from the Morrison Institute[5], Arizonans are highly supportive of investments in science and technology research and feel that "Arizona becoming a leader in these fields" is very important. They believe they will personally benefit from the health discoveries and job opportunities that such research will yield.

Current communications from the Flinn Foundation, Arizona Bioindustry Association, Translational Genomics Research Institute (TGEN), Biodesign Institute at ASU, SABRE at NAU and BIO5 at the University of Arizona provide good examples of important outreach activities. A big challenge is to harmonize information from these Arizona organizations and others into a communications program that provides a clear yet comprehensive message to Arizonans. The Bioscience Roadmap Communications and Public Affairs Subcommittee has begun this work by laying out potential communications strategies. All of this work could someday become part of a statewide strategic plan to enhance Arizona's competitiveness and capacity to innovate.

5 "Arizonan's Attitudes Toward Science, Technology and their Effects on the Economy". Morrison Institute, ASU, June, 2006

In addition, as science "success stories" emerge in Arizona, they should be communicated beyond the state's borders. An essential ingredient in becoming an international competitor is letting the world know what you've accomplished. A comprehensive marketing and communications effort will also demonstrate good faith regarding public accountability.



ACTION ITEMS

STEP 5 Establish an Arizona identity that communicates prominence in science, engineering and medical research and innovation.

SUBTASKS

- Promote Arizona's achievements widely—to the state, the nation, the world
- Encourage Arizona's local, regional and state economic development organizations to promote a state identity in the sciences in their marketing and communications
- Recruit and nurture businesses that support Arizona's science identity

STEP 6 Inform Arizonans of the value of medical, science and engineering industries.

SUBTASKS

- Encourage the media to help deliver key messages
- Establish a website with a wide range of public information
- Host conferences and town hall meetings throughout the state

WHAT SUCCESS WOULD LOOK LIKE

Arizonans and out-of-state interests associate Arizona with science, engineering and medical industries the same way people associate Silicon Valley with the success of its information technology industry. A focused set of key messages, handouts and "elevator speeches" are readily available for public speakers and educators in Arizona with a commitment to scientific research as an economic development strategy. A statewide speakers' bureau is established and participants regularly present to all levels of government—that is, to Arizona's city, county and state officials and its federal delegation—as well as to business associations, students and the public. The Arizona media embrace the effort as a public service and promote Arizona's science identity, too. Conferences and town meetings are frequently held throughout the state, providing both residents and leaders with plentiful information about the state's science-related industries and their accomplishments. The public asks many questions and provides feedback to the speakers that enable them to sharpen the message and provide more responsive information. A special benefit of the outreach effort is that it stimulates Arizonans to seek careers in science and technology.

Arizonans—school age students, working adults, business leaders, elected officials and retirees—develop a good understanding of various science and technology industries, their economic potential and impact and the state's achievements in science and technology innovation.

CREATE THE RIGHT BUSINESS ENVIRONMENT: DEVELOPING A 21ST CENTURY ECONOMY

As stated earlier, science and technology innovation are huge economic opportunities for Arizona in the 21st Century. But the state will not get a significant piece of this pie without the right business environment. It's not enough to just have the best talent or to be able do the best research. Attracting and nurturing companies, venture capitalists and entrepreneurs that will help turn Arizona's science research into commercial products and services is necessary, too, and that will require a regulatory climate and economic development tools that encourage and support their activities. In particular, science and technology industries need tax policies that recognize the long development cycle and risks required to bring new science discoveries to the market, incentive policies that encourage innovation, and capital formation policies that substantially increase the availability of investment funds. Policies should be designed specifically to help established Arizona science, engineering, medical and bioscience businesses and to stimulate the formation of new ventures, as well. In return, the success of such businesses will create high-paying jobs and better health care prospects for Arizonans and will substantially increase state revenue.

Workgroups that emerged from pioneering efforts by the Flinn Foundation and Battelle restated the importance of having business policies and programs conducive to science and technology industries if Arizona wants to become competitive in bioscience. The Arizona Board of Regents' Health Sciences CEO Input Group published *Meds and Eds*, a report that called for such policies as well. The Governor's Council on Innovation and Technology has presented similar recommendations. These groups and others have consistently said the state needs to change past thinking and its approach to economic development if it wants to become competitive in science, engineering and medical research and development.

TGEN FACILITY IN DOWNTOWN PHOENIX

Creating the right business environment so that science-driven businesses can flourish in Arizona will be a challenge. The state has a history of avoiding

economic incentive policies, the very tools that give competitor states and countries an advantage in this field. Implementing the necessary policy changes will require Arizona's elected officials and private sector leaders to rethink the state's approach to taxes, business incentives and returns-on-investment.

Arizona cities and metropolitan regions have a critical role to play here, too. They will need to craft policies and incentives that encourage what economic developers call "preferred company environments." In other words, cities need to take action to become *places where science and technology companies want to be*. There are numerous ways to do this, including establishing "zones" or "corridors" where such businesses enjoy special treatment on taxation, financing, employee training and attention to their needs from local economic development professionals.

ACTION STEPS

STEP 7 Develop new economic policies and programs to attract and develop science, engineering and medical technology businesses.

SUBTASKS

- Determine and implement state economic policies to make Arizona attractive to medical, bioscience, science and engineering businesses, especially policies that focus on research and development tax credits and new sources of funding
- Provide entrepreneurial assistance programs to help such businesses plan and commercialize research
- Develop economic incentives for developing accelerator and incubator space for new and emerging science and technology-driven companies

STEP 8 Aggressively recruit national and international science, engineering, medical and bioscience enterprises to Arizona.

SUBTASKS

- Develop state, regional and city economic development programs to support the expansion and attraction of science-driven companies and supportive businesses
- Initiate a nationwide effort to market Arizona as a location for science, engineering and medical companies

WHAT SUCCESS WOULD LOOK LIKE

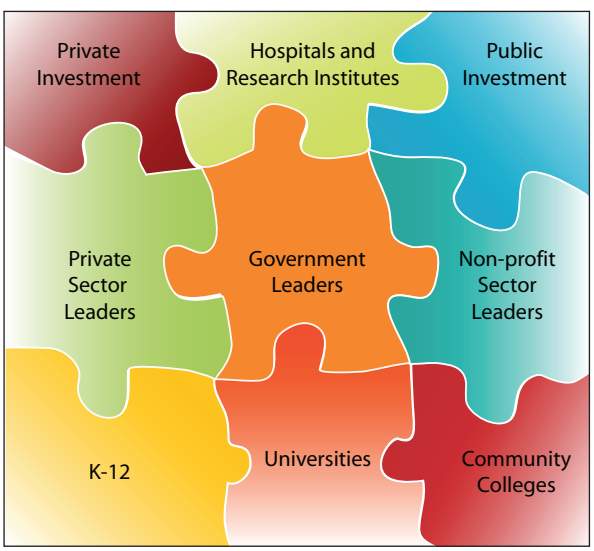
Numerous Arizona organizations and institutions collaborate to guide development and adoption of creative state and local economic policies that support Arizona's science industries. In response, the number of science, engineering, medical and bioscience start-up companies in Arizona increases dramatically and existing Arizona enterprises in these fields expand. The development of city and regional "corridors" designed precisely for such businesses becomes a major policy tool. Venture capital investments in the state's science and technology business sector increases, as well. The business and research climate attracts innovators

and businesses that want to commercialize their technologies here. Collectively, new and expanding firms create a significant number of jobs, ones that pay much higher-than-average wages for Arizonans and provide good employee benefits, too. The state's new incentive policies and programs for science and technology business development—ones with clear measures of expected return-on-investment—enable Arizona to compete with the same policy tools that other states have long offered. The growth of science-driven businesses and research capabilities increases the medical, bioscience and engineering products developed in and marketed from Arizona. More intellectual property is developed here than ever before. Thus, the state witnesses a major increase in licenses and patents of products and services. The thriving research and development environment also yields increases in scientific research publications generated by Arizonans.

All this activity puts Arizona in the spotlight. Its cities routinely find themselves featured in articles in national publications that describe them as significant competitors for expanding science industries. The buzz is that powerful clusters of science-based businesses have developed in Arizona as a result of its supportive state and local economic policies. As more science, engineering, medical and bioscience businesses and research talent arrives, even more businesses relocate to the state and more scientific discoveries are produced here. A vital cycle is created: success in the sciences leads to the desired state branding, significant economic growth and higher average wages.

ADVANCE THE EFFORT: COORDINATING ACTIVITIES, PROMOTING THE VISION

The action steps necessary for Arizona to become a competitor and innovator in science, engineering and medical research and development are challenging, yet straightforward. But those actions require both individual and institutional leadership and coordination to make the effort effective.



Completing the action steps presented in this document would yield the desired outcome—Arizona significantly increases its competitiveness in scientific research, development and application and enjoys the economic benefits thereof. However, completion of each step requires collaboration among numerous Arizona entities.

For example, the collaborative effort that led to establishing Science Foundation Arizona (SFAz) was a milestone in making Arizona more competitive in science, engineering and medical research. SFAz is modeled after the highly successful Science Foundation Ireland, a world leader in strategic investments in science and technology research that can impact economic development. According to its Articles of Incorporation, SFAz will: *(1) build and strength scientific, engineering and medical research programs and infrastructure in areas of greatest strategic value to Arizona's competitiveness in the global bioscience economy, and (2) actively engage scientific research, academic and medical institutions representing both the public and private sectors on a world wide basis.*

Many important Arizona institutions—both well-established and new—have essential roles to play in advancing Arizona's effort to become internationally competitive in science, engineering and medical research. Coordination and regular communication among their complementary activities is fundamental to success. In short, Arizona's research initiative needs outstanding, unselfish leadership that operates effectively in the context of rapid scientific and economic change and fierce global competition for the best talent.

ACTION STEP

STEP 9 Develop a truly collaborative, coordinated effort among Arizona organizations and institutions that seek to make Arizona more competitive in science, engineering and medical research and innovation.

WHAT SUCCESS WOULD LOOK LIKE

SFAz works closely with Arizona universities, hospitals, foundations, business associations, research institutions, public officials, economic development organizations, entrepreneurs and Arizona's Bioscience Roadmap Steering Committee to advance Arizona from a middle tier state to a top tier state in science, engineering and medical research and innovation. Together, these organizations and institutions enable implementation of the state's bioscience roadmap and connect it to complementary science, engineering and medical research and economic development activities. Collaborating organizations develop a new vision statement that expands upon the one put forth in the original "Roadmap" report—

> *Arizona will become internationally competitive in science, engineering, bioscience and medical research, development and application by 2012. As a result, the state will create substantial economic opportunities, improvements in the personal health of its residents and an international reputation for innovation.*

SFAz makes strategic investments that address gaps and seize opportunities. This substantially helps achieve the expanded vision. Public and private sector leaders "keep score" on Arizona's progress and shore-up gaps to improve the state's competitive position. The Arizona Legislature acknowledges the value of the return on the state's investment in SFAz and provides continued funding. Philanthropic and private entities contribute substantially to the effort, too. The Roadmap Steering Committee, Arizona economic development organizations and the media help Arizonans understand the importance of science and engineering to the state's social and economic prosperity. The leadership voices of Arizona's collaborative science, engineering and medical research and development efforts are many. They are highly sought as public speakers by cities, regions and other states that want to know how so many Arizona organizations, institutions and individuals were able to work together to achieve prominence in medical, bioscience and engineering research, application and commercialization.

MAKE THE INVESTMENT: FINDING THE MONEY, HAVING THE PATIENCE

Arizona is playing "catch-up". States with greater total financial capacity—such as California, Michigan and New York—have recently made very significant investments in their bioscience and other scientific research and economic endeavors. Arizona must do as much—or even more—to keep pace, let alone become competitive with such states.

In short, any effort to become truly competitive means Arizona has to think bigger, bolder and longer term with regard to its targeted economic development investments. The same is true for the state's private and philanthropic sectors.

Some of the broad areas and specific programs that will require substantial new investment include—

- Phoenix Biomedical Campus
- University research infrastructure
- University research faculty
- Private and non-profit research institutes
- Seed and venture capital
- K-12 education programs in math and science
- Business incubators and accelerators
- Entrepreneur training and mentoring
- Worker training and retraining
- Public education, marketing and branding

THE COMPETITION

- 40 STATES ARE SPECIFICALLY TARGETING THE BIOSCIENCE INDUSTRY
- 33 ARE PROVIDING FUNDING FOR BIOSCIENCE R&D FACILITIES
- 33 HAVE R&D TAX CREDITS
- 22 HAVE OR ARE DEVELOPING COMMERCIALIZATION FUNDS

Source: Laboratories of Innovation, Battelle, June 2004

If the state wants to gain on the leaders, the magnitude of new investment required is surely more than $1 billion over the next 5-10 years. This is indeed a far cry from what Arizona has previously invested in any targeted economic development strategy. But unless the state is prepared to sustain such a level of investment, it cannot realistically hope to compete.

Recent investments by competitors

State	Funding	Program
California	$3 billion over 10 years	Stem Cell funding
Florida	$510 million	Scripps Research Institute
Michigan	$400 million	21st Century Jobs Fund
Missouri	$160 million over 19 years	Life Sciences Trust Fund
Oregon	$500 million	Oregon Opportunity
New York	$435 million	Institute for Nanoelectronics Discovery and Exploration
Texas	$295 million	Texas Enterprise Fund
Wisconsin	$317 million	BioStar Program
Singapore	$4.6 billion over 5 years	Economic-oriented research & development
Source: Office of Economic Affairs, Arizona State University, February 2006		

ACTION STEPS

STEP 10 Develop and implement a long-term investment strategy.

SUBTASKS

- Determine the magnitude of the investment required for each action step
- Identify potential funding sources for each step
- Describe the expected return-on-investment regarding job growth, state revenue and federal awards for science, engineering and medical research

WHAT SUCCESS WOULD LOOK LIKE

Arizona becomes well known—throughout the nation and worldwide—as a state that puts its money where its mouth is when it comes to making investments to build its future. A powerful combination of public, philanthropic and private sources have made long-term commitments to various aspects of Arizona's efforts to increase its competitiveness in science research and development. Some organizations and institutions focus on attracting and retaining the best talent. Others, primarily the public sector, invest in creating top-notch research and medical facilities. Still others, mostly private firms, have substantially increased the capital available to entrepreneurs. These investments are a beacon that announces the state's long-term commitment to reaching the forefront in science and technology, with an emphasis on bioscience.

BIODESIGN INSTITUTE AT ASU

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ADVANCED RESEARCH AND DEVELOPMENT BUILDING AT NAU, OPENING DEC 2006

© C Robert Canfield, courtesy of ZGF

THOMAS W. KEATING BIORESEARCH BUILDING (BIO5 AT U OF A)

The expanded University of Arizona medical school in downtown Phoenix, along with its research partners Arizona State University, Northern Arizona University, TGEN, hospitals and others, ramps up quickly. The result: biomedical research funding from federal sources to Arizona institutions exponentially rises from 2010-2012, the state's patient-to-physician ratio falls and there is a sharp increase in the number of new, life science-focused companies in Phoenix, Tucson and other parts of the state. Arizona leads the nation in the percentage of new jobs created in science, engineering and medical industries and state revenues increase substantially as a result. Vibrant science, technology and innovation industries spur private developers to build additional research space. Public/private funding partnerships expand to facilitate innovation in emerging areas. Arizona's investment programs become models for programs in other states and cities around the world.

ACTION STEPS

Action Step	Subtasks
1. Build science, engineering, medical and bioscience research facilities.	• Complete the University of Arizona Phoenix Medical School Campus and the Arizona Biomedical Collaborative as soon as possible • Increase university and other institutional science and engineering research capacity
2. Develop new ways to collaborate on cutting edge research in strategic areas.	• Develop special support for Arizona's capabilities in areas such as imaging, informatics, bioengineering, semiconductors, sustainability and information technology • Create incentives for researchers, institutions and businesses to share information, develop multi-institutional research and submit proposals for federal funding; improve common processes such as clinical trials
3. Implement programs that increase instruction and motivate students in math and science.	• Develop and assess demanding K-12 learning objectives for science and math • Continue aligning community college and university math, science and technology curricula to prepare students for emerging science, health care and technology careers • Create numerous opportunities for students to directly interact with medical, bioscience and engineering researchers
4. Initiate programs that immediately enhance the composition of the science workforce.	• Build on recent philanthropic commitment to attract world leaders in personalized medicine by funding other "genius scholar" programs • Enhance training programs to improve worker and entrepreneurial skills
5. Establish an Arizona identity that communicates prominence in science, engineering and medical research and innovation.	• Promote Arizona's science and engineering achievements widely—to the state, the nation, the world • Encourage Arizona's local, regional and state economic development organizations to promote the state's achievements in their marketing and communications • Recruit and nurture businesses that support Arizona's science identity
6. Inform Arizonans of the value of science, engineering and medical industries.	• Encourage the media to help deliver key messages • Establish a website with a wide range of public information • Host conferences and town hall meetings throughout the state
7. Develop new economic policies and programs to attract and develop science and technology businesses.	• Determine and implement state economic development policies that would make Arizona attractive to medical, bioscience, science and engineering businesses, especially policies that focus on research and development tax credits and new sources of funding • Provide entrepreneurial assistance programs to help such businesses plan & commercialize research • Develop economic incentives for developing accelerator and incubator space for new and emerging bioscience, science and technology-driven companies
8. Aggressively recruit national and international science, engineering, medical and bioscience enterprises to Arizona.	• Develop state, regional and city economic development programs to support the expansion and attraction of science-driven companies and supportive businesses • Initiate a nationwide effort to market Arizona as a location for science, engineering and medical companies
9. Develop a collaborative, coordinated effort among Arizona organizations and institutions that seek to make Arizona competitive in science, engineering and medical research and innovation	• No subtask
10. Develop and implement a long-term investment strategy.	• Determine the magnitude of the investment required for each action step • Identify potential funding sources for each step • Describe the expected return-on-investment regarding job growth, state revenue and federal awards for science, engineering and medical research

SOME KEY ORGANIZATIONS ADVANCING SCIENCE, ENGINEERING AND MEDICAL RESEARCH AND INNOVATION IN ARIZONA*

Arizona Bioindustry Association
Arizona Hospital Association
Arizona Technology Council
Arizona Board of Regents
Arizona Department of Commerce
Arizona Department of Economic Security
Arizona Governor's Office
Arizona Legislature
Bioindustry Organization of Southern Arizona
Chambers of Commerce
Cities and towns throughout the state
Community Colleges
Economic development organizations throughout the state
Flagstaff 40
Flinn Foundation
Greater Flagstaff Economic Council
Greater Phoenix Economic Council
Greater Phoenix Leadership
Hospitals throughout the state
Local K-12 School Boards
Maricopa Biosciences Workforce Commission
Mayo Clinic
Municipal Leaders
Research Institutions
Science Foundation Arizona
Southern Arizona Leadership Council
Southern Arizona Technology Council
State Government
State Universities
Tucson Regional Economic Opportunities

* The aforementioned list of key organizations is not exhaustive. Other organizations are or should be involved.

SOME RECENT ARIZONA REPORTS AND INFORMATION RESOURCES*

- Arizona's Bioscience Roadmap, Battelle, December 2002.
- Arizonan's Attitudes Toward Science, Technology and their Effects on the Economy. Morrison Institute, June 2006.
- Bioengineering Research Platform Strategic Plan, Battelle, September 2003.
- Bioscience Future: Implementing Arizona's Bioscience Roadmap. PowerPoint by Flinn Foundation, April 2005.
- Bioscience Workforce Strategy: Preparing for the Future, Battelle, October 2003.
- Cancer Research Platform Strategic Plan, Battelle, September 2003.
- Capital Formation/Incentives Work Group Preliminary Recommendations, September 2003.
- Desired Outcomes, Communication Strategies, and Key Messages by Key Influencers, Bioscience Roadmap Communications and Public Affairs Subcommittee, December 2005.
- Economic Development via Science and Technology, Morrison Institute for Public Policy, June 2003.
- Economic Development Work Group Preliminary Recommendations, Battelle, October 2003.
- Entrepreneurial Assistance Work Group Preliminary Recommendations, Battelle, September 2003.
- Facilities Work Group Preliminary Recommendations, Battelle, September 2003.
- Faculty and Programs Identified Through Technology Platform Strategy Effort by Selected Niches for Development, Battelle, October 2004.
- Full Speed Ahead: Arizona's Bioscience Momentum, 2003 Progress Report by Flinn Foundation, January 2004.
- Investment Plan for Cross-Cutting Supportive Infrastructure Across Platform Areas, Battelle, September 2003.
- Maximizing Arizona's Opportunities in the Biosciences and Biotechnology, Eighty-Seventh Arizona Town Hall, October 30 – November 2, 2005, Background Report prepared by ASU.
- Meds & Eds: The Key to Arizona Leapfrogging Ahead in the 21st Century, March 2005.
- Moving Forward: 2005 Progress on Arizona's Bioscience Roadmap, Flinn Foundation, January 2006.
- National Center for Education Statistics, December 2004.
- Neurosciences Research Platform Strategic Plan, Battelle, September 2003.
- Overview of Technology Platform Strategies, Battelle, June 2004.
- Seeds of Prosperity: Public Investment in Science and Technology Research, Morrison Institute for Public Policy, April 2003.
- Strategic Plans for Developing Near-Term Technology Platform Areas of Cancer Research, Neurosciences and Bioengineering, Battelle, 2003.
- The Road Ahead, Collaborating on Arizona's Bioscience Future, 2004 progress report by Flinn Foundation, January 2005.

* The aforementioned list of key reports is not exhaustive. Many others could have been included.

Flagstaff Forty
leadership for action

Greater Phoenix Leadership

Southern Arizona Leadership Council