Morrison Institute
FOR PUBLIC POLICY

Economic Development Via Science and Technology

How Can Arizona Improve Its Standing?

Arizona State University

Economic Development Via Science and Technology:

How Can Arizona Improve Its Standing?

Prepared By

Rob Melnick
Suzanne Taylor
Nancy Welch
Morrison Institute for Public Policy

Jeff Chapman
John Stuart Hall
School of Public Affairs

Tim Hogan
Tom Rex
Dennis Hoffman
L. William Seidman Research Institute
W. P. Carey School of Business

Gail Howard
Arizona Office of the Governor

Morrison Institute for Public Policy • School of Public Affairs • College of Public Programs • Arizona State University
P. O. Box 874405; Tempe, Arizona 85287-4405 • (480) 965-4525 voice • (480) 965-9219 fax
www.asu.edu/copp/morrison or www.morrisoninstitute.org

June 2003

Economic Development Via Science and Technology: How Can Arizona Improve Its Standing?

Contents

Economic Development Via Science and Technology: How Can Arizona Improve Its Standing?

Executive Summary

Economic development leaders and public officials throughout the country are tending to the effects of a sour economy and huge state budget deficits when they would rather be creating quality jobs and new economy assets. According to the most prominent thinking on today's knowledge economy, locally developed and exported technology will be the primary economic differentiator between future winners and losers. Thus, with long-term fiscal and economic health at stake, the 50-state race is on for advantages and leadership in science and technology.

One of the most recent and talked about analyses of this nationwide contest is ***The State Technology and Science Index: Comparing and Contrasting California*** from the Milken Institute. This overview shows each state's readiness to benefit from new economic dynamics associated with science and technology. Milken's study argues for enhancing the infrastructure needed for gains in science and technology, including:

- Investing in technology research and development
- Preparing a workforce capable of carrying out such efforts
- Creating a "place" that will help attract and retain companies and individuals in these fields

For Arizona, the realities of economic development via science and technology raise 3 questions:

- What is Arizona's current standing in science and technology, especially in comparison to western competitor states?
- What have states that are leading in science and technology done to achieve their standing?
- What specific actions should Arizona take to improve its position in science and technology?

This report sheds light on these issues through an overview of Arizona's standing in science and technology today, short case studies of four competitors in the west, as well as Arizona, and ideas for Arizona's leaders to consider as they strive to give our state an edge.

Arizona's High Tech Status

Arizona ranks 18th in the Milken Institute's science and technology comparison. That sounds pretty good until one sees that 4 of Arizona's major competitors — California, Colorado, Utah, and Washington — placed 3rd, 2nd, 9th and 6th respectively and posted similar ranks in other studies of state standings in science and technology. These 4 are in a much better position than Arizona is to succeed in a technology-led economy.

Without question, high tech success is desirable. High tech industries offer much higher than average wages and generally provide full benefits to their workers. In Arizona, the 1999 wages for employees in high tech industries averaged $55,382, compared to just $28,807 for all sectors of the state economy and just $23,250 for the 12 industries that employed the largest numbers of Arizonans.

Comparisons Among Arizona and Four High Tech Leaders

Arizona lags behind California, Colorado, Utah, and Washington. Clearly there is room for improvement, but deciding where and how to focus is a multifaceted question. To better understand how California, Colorado, Washington, and Utah achieved their notable positions in science and technology and how Arizona compares, brief case studies were prepared for each of the 5 states. The case studies describe the:

- Context for economic development
- Current tax and fiscal trends
- Education system
- Special programs for high tech business development

Each of the 5 states has certain characteristics that contribute to their high tech standing.

A 5-State Overview

Arizona	California	Colorado	Utah	Washington
▪ High tech manufacturing ▪ Proposition 301 for university research funding ▪ Aerospace and electronics industries rooted in defense spending ▪ Rapid population and job growth	▪ History of risk taking ▪ Deeply rooted technology industries ▪ Commitment to higher education ▪ Federal R&D facilities	▪ High tech diversity ▪ Concentration of knowledge workers ▪ Quality of life ▪ Defense and space facilities	▪ High educational attainment and enrollment in higher education ▪ Record of entrepreneurship ▪ Youthful population ▪ Breakthrough tech products	▪ Political leaders on the national stage supporting development at home ▪ K-12 achievement ▪ Universities as federal research leaders ▪ Legacy of Bill Boeing and Bill Gates

Differences among Arizona, California, Colorado, Utah, and Washington are readily apparent. That these 4 competitor states rank as high tech leaders seems almost serendipitous. Yet, there are similarities that help to explain their status. All 4 benefitted mightily from large, sustained, multifaceted federal investments in defense and space that contributed to the formation of a significant concentration of knowledge workers. In turn, the presence of knowledge workers stimulated a positive cycle of higher education, training, socialization, and state preparation for high tech activities. Another similarity is the year-by-year development of major research universities and traditions of university-economic development connections and technology transfer.

The central lesson from this set of examples is that real strength in science and technology requires a momentous, sustained catalyst to ignite a change from old to new economy activities. To create a high tech fire, a place needs a flamethrower.

Unfortunately, research does not reveal simple cause-and-effect fiscal policies that result in this kind of development. All 4 do show the effects of sustained intergovernmental funding for human and capital infrastructure, which was matched by private investments, linked by catalytic events, and sustained by leadership. And, whether by chance or design, they benefitted from proximity to research institutions and good quality of life, both of which are powerful attractions for high tech businesses.

The Formative Phase of High Tech Development

In all states high tech development is highly sought after, complex, multifaceted, and synergistic. Hence smart, strategic public investments are important, along with the need to focus on particular R&D strengths, develop venture capital, encourage entrepreneurship, and craft an investment platform for a future that is unknowable, but will surely be different.

State and regional policymakers should play important roles in crafting and stimulating the relationships required to compete for a future that profits from science and technology. Investment with that in mind is prudent, yet the type of investment will vary. A few states, like the 4 high tech leaders considered here, will be smart investors if they use public investments to patch up holes in their high tech systems.

Catch-up states will need to develop a different logic of collective action. What is required in these states is larger, sustained multiyear investments to develop the culture, education, training, and socialization that have already occurred in leader states. States must not only invest, but must also "brand" and market their investments.

Strategies to Improve Arizona's Standing in Science and Technology

What would smart, sustained investment in a high tech future look like in Arizona? The examples of 4 competitor states suggest that Arizona needs:

- Lasting, enthusiastic leadership that recognizes the economic value of science and technology
- The right message and strategy to convey the urgency of this matter
- Investment in the creation and sustenance of first-tier research institutions
- More and better mechanisms to improve the transfer of ideas into the marketplace
- A belief that the state can be a leader in science and technology

States will not prosper from one-time actions. Instead they should involve leadership from all sectors and make smart investments from all sources. Tax and fiscal policy, in and of itself, is not the answer here, but it seems important in one respect — states need at least a certain level of public revenue to provide the education and physical infrastructure necessary to even be in the science and technology hunt.

Economic Development Via Science and Technology: How Can Arizona Improve Its Standing?

Economic development leaders and public officials throughout the country are tending to the effects of a sour economy and huge state budget deficits when they would rather be creating quality jobs and new economy assets. According to the most prominent thinking on today's knowledge economy, locally developed and exported technology will be the primary economic differentiator between future winners and losers. Thus, with long-term fiscal and economic health at stake, the 50-state race is on for advantages and leadership in science and technology.

One of the most recent and talked about analyses of this nationwide contest is ***The State Technology and Science Index: Comparing and Contrasting California*** from the Milken Institute. This overview of rankings on 73 indicators shows each state's readiness to benefit from new economic dynamics associated with science and technology. The publication makes a powerful case for these two areas as the best bets for developing state and regional economies. "Although high tech is not the only development strategy to pursue, it will be the key distinguishing feature of regional vitality in the 21st century," the report states. "States that recognize these changes and alter course quickly will be ahead in the economic development game."[1]

The Milken Institute study, along with others from such prominent institutions as the National Governors Association, Carnegie Mellon University, and the Southern Growth Policies Board, argues that, to get a share of the wealth generated by science and technology innovation, states and regions must pursue policies and programs that will enhance the appropriate infrastructure. These include:

- Investing in technology research and development
- Preparing a workforce capable of carrying out such efforts
- Creating a "place" that will help attract and retain companies and individuals in the science and technology fields

This widely repeated advice, though, conceals as much as it reveals. Unlike its manufacturing and services predecessor, the new economy is a more elusive, less understood "system." In fact, the Milken Institute describes the new economic dynamics as a "movement from a tangible asset to an intangible asset-based economy."[2] The authors write that "research, development, and innovation assets, the risk capital and entrepreneurial infrastructure, human capital capacity, the technology and science workforce, and ultimately, technology concentration and dynamism are the measures for states and regions in an intangible economy."[3] Most of these measures are new — or at least still mysterious — concepts to the majority of state and local leaders.

[1] DeVol Ross, *The State Technology and Science Index: Comparing and Contrasting California*, Milken institute 2002, p.5.
[2] *Ibid*. p.1.
[3] *Ibid*. p.1.

For Arizona, this situation gives rise to three broad questions:

- What is Arizona's current standing in science and technology, especially in comparison to western competitor states?
- What have states that are leading in science and technology done to achieve their standing?
- What specific actions should Arizona take to improve its position in science and technology?

The answers will affect Arizona's future since a state's prosperity is linked increasingly with its capacity to innovate, its technology infrastructure, and its pool of knowledge workers.

This report sheds light on these issues. It starts with an overview of Arizona's standing in science and technology, followed by short case studies of 4 competitor states in the west, as well as one on Arizona. ***Economic Development Via Science and Technology*** concludes with ideas for Arizona's leaders to consider as they strive to give our state an edge.

Arizona's High Tech Status

Arizona ranks 18th in the Milken Institute's state-by-state science and technology comparison. That sounds pretty good until one sees that 4 of Arizona's major competitors — California, Colorado, Utah, and Washington — placed 3rd, 2nd, 9th and 6th respectively. In short, these 4 states are in a better position than Arizona is to succeed in a technology-led economy. And, as a result, the difference in net wealth creation between our state and these others could be enormous. A look at Arizona's standing in high tech industries puts a fine point on the state's situation.

Arizona and Four Competitor States
Milken Institute State Science and Technology Rankings, 2002

California	3
Colorado	2
Utah	9
Washington	6
Arizona	18

Defining High Tech

The U.S. Bureau of Labor Statistics (BLS) defines "high tech intensive industries" as those which employ 5 times the average of all industries in research and development and technology-oriented professions.[4] This amounts to 15 employees in research and development per 1000 and 190 employees in technology-oriented occupations per 1000. Using this measure, the BLS identified 12 industries under the Standard Industrial Classification (SIC) system as "high tech intensive."

For its analysis the Milken Institute defined high tech industries as those that:

- Spend an above average amount of revenue on research and development
- Employ an above average proportion of workers in high tech functions
- Use high tech equipment in the production of the industry's goods and services

[4] As determined in the Occupational Employment Statistics survey, a major data collection program in the U. S. Bureau of Labor Statistics.

Fourteen SIC industries emerge as "high tech" under Milken's definition, while 12 industries appear on both the BLS and Milken Institute lists.

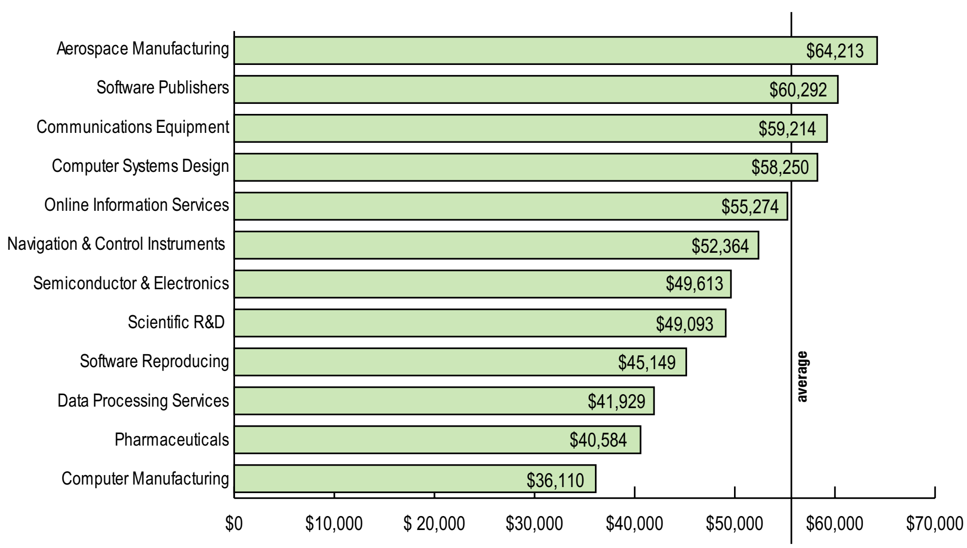
These 12 common industries include:

- Aerospace Products and Parts Manufacturing
- Communications Equipment Manufacturing
- Computer and Peripheral Equipment Manufacturing
- Computer Systems Design
- Data Processing Services
- Navigation, Measuring, Medical, and Control Instruments
- Online Information Services
- Pharmaceutical and Medicine Manufacturing
- Semiconductor and Other Electronic Component Manufacturing
- Scientific R&D Services
- Software Publishers
- Software Reproducing

These industries offer much higher than average wages (see Figure 1) and generally full benefits to the majority of their employees. In Arizona, the 1999 wages for employees in these industries averaged $55,382, and ranged from $36,110 for Computer and Peripheral Equipment Manufacturing to $64,213 for Aerospace Manufacturing.

Figure 1. High Wages Are Synonymous With High Tech

Average Wages in 12 High Tech Industries in Arizona, 1999



Source: U.S. Census Bureau, *County Business Patterns 1999*. Center for Business Research, Arizona State University.

Data from California further highlight the magnitude of the wage advantage provided by high tech employment. For example, 10% of all California jobs are in high tech industries, but these jobs provide 20% of all personal income in the state. Science and technology industries also have a significant "multiplier effect," which adds to the total pool of income generated throughout the state.

In comparison, the average 1999 wage for **all** sectors of the Arizona economy was just $28,807. As highlighted in Figure 2, average earnings in the 12 industries that employed the largest numbers of Arizonans stood at $23,250. Semiconductor and Other Electronic Component Manufacturing was the only high tech industry among these 12.

The areas that employed the largest numbers of Arizonans in 1999 were:

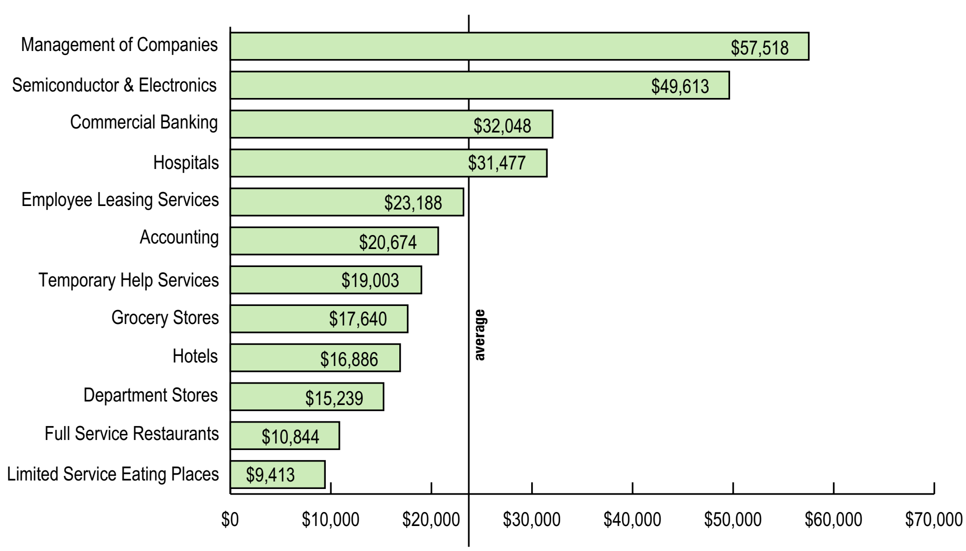
- Accounting, Tax Prep, Bookkeeping, and Payroll Services
- Commercial Banking
- Department Stores
- Employee Leasing Services
- Full Service Restaurants
- General Medical and Surgical Hospitals
- Semiconductor and Other Electronic Component Manufacturing
- Hotels and Motels
- Limited Service Eating Places
- Management of Companies
- Grocery Stores
- Temporary Help Services

Additionally, because of the prevalence of part-time and seasonal work in such areas as Full Service Restaurants and Hotels and Motels, many employees receive few or no benefits. These lower-wage industries are significantly less technology oriented, employ few technical professionals, and invest little in research and development.

It is axiomatic that science and technology businesses enhance state revenue and produce a variety of economic benefits. For example, the high-paying jobs in this sector result in increased income and sales taxes receipts (these levies account for 86% of Arizona's general fund revenue).

Figure 2. Only Management Occupations Exceed the Average Wages of High Tech Industries

Average Wages in Arizona Industries with the Largest Employment, 1999



Source: U.S. Census Bureau, *County Business Patterns 1999*. Center for Business Research, Arizona State University.

People employed in high tech industries are less likely to rely on the state for health care or other costly social services. Moreover because of their innovations, high tech companies tend to create new products and, in turn, spawn business startups. High tech companies can be players in international markets too — another important factor for local success in a global marketplace. Finally, the visibility of high tech industries can result in federal research and development monies for a locality and attract highly educated workers from other states.

Comparisons Among Arizona and Four High Tech Leaders

As indicated earlier, Arizona is above average in the Milken rankings of science and technology. However, Arizona lags behind western leaders California, Colorado, Utah, and Washington. Clearly there is room for improvement, but deciding where and how to focus is a multifaceted question.

To better understand how these 4 highly ranked competitor states — California, Colorado, Washington, and Utah — achieved their notable positions and how Arizona compares, brief case studies were prepared. These 4 states were chosen because they are in the top 10 on the Milken Institute index and have similar ratings in studies by the Corporation for Enterprise Development, the American Electronics Association, and the Progressive Policy Institute. The case studies describe each state's:

- Context for economic development
- Current tax and fiscal trends
- Education system (a surrogate for the capacity to develop knowledge workers)
- Special programs for high tech business development

Table 1 provides some background data of interest. Each study also presents 4 items "of note" in the state. These are compiled in an overview on page 23. In addition, details over time on state revenues and expenditures, K-12 and higher education spending, and the concentration of knowledge workers are included in the Comparative Data section, which begins on page 26.

Table 1. Variety and Similarities Mark These States

Data for Comparisons

	Arizona	California	Colorado	Utah	Washington
Population, 1990	3,665,228	29,760,021	3,294,394	1,722,850	4,866,692
Population, 2000	5,130,632	33,871,648	4,301,261	2,233,169	5,894,121
Adults 25+ with B. A., 2000	15.2%	17.1%	21.6%	17.9%	18.4%
Adults 25+with more than B.A., 2000	8.4%	9.5%	11.1%	8.2%	9.3%
Per capita income, 2001	$25,872	$32,702	$33,470	$24,180	$32,025
White*/Hispanic**, 2000	64% / 25%	47% / 32%	75% / 17%	85% / 9%	79% / 8%

* White alone ** Of any race

Sources: National Center for Education Statistics Common Core of Data, 2000-2001, U.S. Census Bureau, U.S. Bureau of Economic Analysis.

Of Note in California —

- *History of risk taking*
- *Deeply rooted technology industries*
- *Commitment to higher education*
- *Federal R&D facilities*

CALIFORNIA

With the discovery of gold in 1848, this western "Eden" became a magnet for dreamers, schemers, and entrepreneurs. Few made the big strike, but the 49ers and those who followed them transformed California economically and socially. In addition the Gold Rush and its aftermath deeply affected California's business culture. Since that time, California has continued to attract people with a spirit of looking to do new things with the latest and greatest tools. In the early 1900s for example, the fledgling California motion picture industry used state-of-the-art technology, as the multifaceted entertainment industry does today. During World War II, aerospace industries put down roots in California, attracting engineers and scientists. In the 1960s, Silicon Valley began to flourish, in part because of the combined effects of Stanford University, the University of California at Berkeley, and San Jose State University. In economic importance, the California State Department of Finance refers to the development of Silicon Valley as another Gold Rush. In the 1980s, the San Diego region started to come into its own as a center for biotechnology.

Related to this environment was the 1960s Master Plan for higher education. Developed in part because of a tidal wave of incoming students and in part because of a general appreciation of the importance of postsecondary education to the state's economy, this plan ensured access to colleges and universities for all California citizens. It differentiated missions among the universities, state colleges, and community colleges and allowed universities to focus on high quality research. California's higher education system is still considered to be a major jewel, and state government continues to see postsecondary institutions as important players in economic growth generally and high tech development specifically.

Federal research and development facilities have a significant presence in California. In 1995, California's 48 federal R&D laboratories accounted for 18% of all federal lab spending or about $4.7 billion of $26.6 billion. The laboratories have programs in computing, plus electronics, lasers, communications, aerospace, robotics, biotechnology and medicine, energy, the environment, agriculture, and industry. These public institutions interact with private businesses in a variety of ways, including buying and selling services, issuing technology licenses, and cooperating on R&D projects.

Budget Downs and Ups: California's Tax and Fiscal Climate

California spent much of the 1980s and early 1990s dealing with the effects of Proposition 13 (which limited property tax rates and increases) and a rapidly expanding population. In particular because of Proposition 13 and related initiatives, school finance became far more of a state responsibility. As a result, state spending expanded during the 1980s, with most discretionary funding directed to K-12 education.

As elsewhere in the nation, the 1990s began in California with a major recession, which led to a series of budget crises. The state remedied a shortfall in 1991-1992 by raising $9 billion in taxes, cutting expenditures by about $3 billion, and shifting $1.6 billion in costs to local governments. These actions were augmented in 1992-1993 by a variety of other techniques, including revenue accelerations, loans from special funds, debt restructuring, and a property tax shift from local governments to schools. This process of budget adjustment continued through 1995-1996. At this time, the state's economy began to grow, and it continued to expand until about 2000.

Beginning in 1996-1997, the negative budget situation reversed. With more money available, lawmakers increased education spending at all levels, and reduced the major corporate tax. Policymakers decreased other specific taxes also, primarily vehicle license fees. From 1998-2000, state leaders reduced taxes by approximately $1.6 billion, while increasing spending on education, health, social services, and transportation.

Income, sales, and corporate taxes comprise the principal sources of revenue in California. Including federal dollars in the general fund, the importance of the income tax approximately doubled between 1972 and 1999; the sales tax increased by about one-third and the corporate tax fell. As a percentage of the general fund, revenue from the federal government has been essentially flat over the same period.

A Changing Population for Learning: Education Systems in California

Over the past two decades, California's school population has grown and changed. For example in 1981, 56% of K-12 students were White (non-Hispanic), 26% were Hispanic, and 18% were other ethnicities. By 2001, White students accounted for only 37% of enrollment, 43% were Hispanic and 20% were other ethnicities.

In 1990-1991, approximately 36% of general fund expenditures went to K-12 education; by 2000-2001, the proportion had risen to 41%. However, California's ranking among the states in expenditures per capita on K-12 and higher education fell between 1972 and 1999. The state now ranks about in the middle of the 50 states. California is also dropping among the states in the percentage of the population that has graduated from high school as well as the percentage with a bachelor's degree. Average SAT scores were essentially flat between 1987 and 2001, rising from 1008 to 1013. Californians have raised concerns about education quality and instituted a variety of improvement strategies. For example, in 1996, Republican governor Pete Wilson began to implement a plan to decrease class size in grades K-3 to bolster achievement. His initiative limited each class to a maximum of 20 students in the early grades.

In the midst of the 1991-1992 recession, Governor Pete Wilson's budget message called investment in higher education critical to the state's future and pronounced that social and economic well-being depended on an educated citizenry. Nearly 10 years later, Governor Davis's budget message echoed the same sentiment but with greater specificity. He argued that the products of higher education are powerful assets for the state's economic future and identified high technology, biotechnology research, and agriculture as fundamental for California's economic leadership. Despite these pronouncements, the percentage of the general fund spent on higher education fell from 14% in 1990 to 12.4% in 2000. Somewhat offsetting this was an increase in state financial aid to higher education students (for either public or private California universities) from approximately $282 million in 1990-1991 to $802 million in 1999-2000. In this latter year, about 70% of University of California students and 53% of California State University students received financial aid.

The University of California system with its 187,000 students is world renowned. Faculty members at the 9 campuses throughout the state have received 44 Noble Prizes, winning 12 in the past 6 years alone. Six of the system's institutions are ranked in the top 50 doctoral-granting universities by *U.S. News and World Report*. Among the public universities noted by *U.S. News and World Report*, the University of California, Berkeley placed 1st and University of California, Los Angeles was listed 3rd.

High Technology Support in California

The Office of the President of the University of California (UC) administers a relatively small state stimulus program for high tech development, which was established in 1981. Dubbed MICRO, the program combines UC funding with company contributions to undertake projects of mutual interest to the private and public sectors. Over 500 firms have participated in these projects, which typically total approximately $100,000 each.

In December 2000, Governor Davis announced an initiative for establishing the California Institutes for Science and Innovation. These 4 multicampus institutes are focused on bioengineering, biotechnology, and quantitative biomedical research; telecommunications and information technology; nanosystems; and information technology research. The state committed $300 million in funding over 4 years and mandated a 4-to-1 match from the private sector. The state and private sectors thus far have met their scheduled commitments.

In another example, the state, through its Technology, Trade, and Commerce Agency, runs the California Technology Investment Partnership (CalTIP), a matching grant program with 6 regional technology alliances, which began in 1993. CalTIP has made 237 awards averaging $200,000 each. These have been matched by $460 million in private sector and federal government funds. The awards are limited to small high tech companies, and the companies must also receive federal funding to qualify for the grant. CalTIP's internal evaluation claims that 1 out of every 3 projects results in the launch of a new product within 25 months of the project's start, and creates 5 sustainable jobs with an average salary of $63,000.

Few tax reduction instruments have been used to stimulate high tech industries generally. Throughout the 1990s, however, California aimed targeted tax relief at high tech, including a research and development credit and a manufacturer's research credit, which together totaled about $975 million in 2000.

Discussions with leaders in the Los Angeles and Silicon Valley areas revealed several common perspectives on state taxation policies related to high tech: the policies are either below the horizon or, at best, affect high tech development only at the margin. They agreed that the technological environment is far more important — and that this environment is defined by such public infrastructure as good airports, world-class universities, and agglomeration effects, so that high tech entrepreneurs and workers can move easily from job to job. One respondent noted that tax cuts might have helped some of the larger companies, but generally did not serve small firms. The openness of the California culture had a much greater positive impact.

Finally, between 1995 and 1998, California science and technology companies recognized a $2 to $4 billion annual venture capital flow. Of this, 45% went to Silicon Valley industries, and 55% of the total dollars coming from California venture firms flowed to companies in the software and information communication industries. The Los Angeles Regional Technology Alliance, or LARTA, has raised over $1.5 billion in capital and has distributed $12 million in California through 88 seed investments in cutting-edge technologies.

Of Note in Colorado —

- *High tech diversity*
- *Concentration of knowledge workers*
- *Quality of life*
- *Defense and space facilities*

Colorado

Colorado is now recognized as a leader in income and quality of life and is reaping the benefits of economic seeds sown decades ago. During approximately 1940 to 1980, Colorado transformed from a resource-based economy to one based on high-value-added industries. Over these 4 decades, defense-related activities and growth in technology manufacturing surpassed agriculture and other traditional industries, although these remained important. Defense-related development included military facilities constructed during World War II, most of which were expanded during the postwar period. The Air Force Academy and the North American Defense Command were added to Colorado's defense base in the 1950s with the Consolidated Space Operation Center and the Air Force and U.S. Space Commands coming on line in the 1980s.

Besides an expansion of manufacturing, the defense buildup fostered a major shift in the products made and the materials and practices used. For example, electronics, aerospace, and other high tech manufacturing supplanted agricultural processing. IBM, Digital Equipment, Hewlett-Packard, Ampex, Honeywell, Litton Industries, Martin Marietta, Beech Aerospace, and other firms established significant Colorado operations during this period.

During the 1980s, research activity grew and further broadened and strengthened the existing tech-related manufacturing base. In particular, construction of the National Center for Atmospheric Research, the lab for the National Oceanic and Atmospheric Administration, and the Solar Energy Research Institute, as well as the expansion of the state's research universities, fueled this trend. Also during the mid-1980s, Colorado began to emphasize economic development initiatives, including the establishment of enterprise zones, job training programs, and state business development and international trade offices. Colorado, by FY 1991, was allocating $67 million annually to various economic development programs. In addition, leaders increased higher education funding in the late 1980s. At the same time and into the early 1990s, spending on public infrastructure projects increased as well — the most notable examples being the $3 billion Denver International Airport and several substantial highway projects.

The combination of defense and space installations, high tech manufacturing, and R&D activities during the 1980s provided the foundation for Colorado's current high tech economy. The high tech share of all nonfarm private establishments increased 38% between 1979 and 1989. In comparison, the high tech portion of the U.S. economy fell during this period. High tech in Colorado jumped a further 73% from 1989 to 1997. The state's employment in high tech industries rose from slightly less than 30 jobs per 1000 residents in 1979 to over 40 by 1989. Such employment remained at 40 jobs per 1000 residents throughout the 1990s.

A Lesser Burden: Colorado's Tax and Fiscal Climate

Income and sales taxes are the primary sources of revenue for the state.

Historically, Colorado's combined state and local expenditures have been less than the national average, although these have grown over time. With the constraining influence of spending restrictions instituted in the early 1990s, the average annual growth rate was 1.7% for fiscal years 1992-1999. By FY 1999, per capita state and local spending in Colorado had risen to 97% of the U.S. average.

Colorado's combined state and local tax burden, measured as a percent of state personal income, ranked 44th highest among the 50 states for FY 1999. For state taxes alone, Colorado's tax burden as a percent of personal income ranked 47th among the states.

Colorado's local tax burden relative to personal income is high — ranking 10th in the nation. Property and sales taxes are the major revenue sources for local governments.

Tax cuts figured prominently in Colorado during the 1990s. Corporate income tax rates were lowered several times by small amounts in the early 1990s, and both the corporate and individual rates were cut more substantially in 1999. While the base state sales tax rate remained the same, a number of exemptions have been added in recent years.

The adoption of a constitutional amendment known as the Taxpayers' Bill of Rights (TABOR) in 1992 signaled a profound change in the state's fiscal policy. TABOR applies to state and local governments and has two key provisions: 1) any tax increase requires voter approval and 2) the maximum increase in spending for a given fiscal year is limited to the sum of the rate of inflation plus the percent growth in population in the prior calendar year. TABOR requires that revenues in excess of the limit be refunded in the next fiscal year, unless voters agree to let governments keep the surplus. FY 1997 was the first year that revenues exceeded the spending limit. Over the FY 1997-FY 2001 period, refunds totaled more than $3 billion.

Seeking to Improve K-12: Education Systems in Colorado

As with total state and local government expenditures, funding for K-12 education generally has been less than the U.S. average. The distribution of state spending shifted markedly between FY 1980 and FY 1998. State allocations to K-12 education dropped from 28% of total appropriations in FY 1980 to 23% in FY 1998. The share devoted to higher education suffered an even bigger decline — from 27% in FY 1980 to 15% in FY 1998. A Legislative Council study in 2000 found that per pupil K-12 expenditures were 91% of the U.S. average, which ranked Colorado 32nd among the 50 states.

Colorado has not received high ratings in recent national comparative studies of the quality of K-12 education. The Legislative Council report notes that the ***Education Week*** "2000 Quality

Counts" study gave the state a "D" and ranked it 46th out of 50 states based on analysis of several categories deemed necessary for quality education.

In response to growing concerns about learning, Amendment 23 to the Colorado Constitution, which passed in November 2000, established a new funding mechanism for schools and mandated substantial increases in state spending for K-12 education. It requires that the amount of state dollars be boosted each year by at least the rate of inflation plus 1% for the first 10 years and at the rate of inflation thereafter. It is not subject to TABOR or other spending or appropriation limitations.

Higher education in Colorado does not have any specific earmarked funding sources. However when measured in either per capita or per dollar of personal income terms, state higher education spending is substantially above the national average. Notably, though, state and local government sources contribute only 4% of total R & D funding at Colorado universities.

Diversity in High Technology

Colorado's #2 ranking in the Milken index stems in part from strong performances in many areas. Consider, Colorado places:

- 1st in National Science Foundation funding per dollar of gross state product (GSP)
- 2nd in the share of computer and information scientists in the workforce
- 3rd in venture capital per dollar of GSP
- 4th in the percent of population with a doctorate

Colorado's technology community is more diverse than that of many other top high tech states. The state has large computer hardware, software, telecommunications, and aerospace sectors, and smaller, but significant, concentrations in biotech and photonics industries. Interviews with Colorado officials identified 3 primary factors that have led to Colorado's high tech success:

- **Ability to attract and retain thousands of knowledge workers** —The American Electronics Association reported in 2002 that Colorado had the highest concentration of high tech workers in the country. Colorado's higher education system produces relatively large numbers of the scientists, engineers, and other graduates desired by technology companies.
- **Perceived high quality of life** —This makes the state an appealing place for technology firms and a high quality workforce.
- **Federal labs, defense and space facilities, and high levels of R&D activity at the state's research universities** — Military, climate, and space facilities are clustered in Colorado.

Tax incentives and other economic development activities were deemed in interviews conducted for this report to have had effects only at the margin. They have not had near the impact of facilities, higher education investments, or quality of life.

Of Note in Utah —

- *High educational attainment and enrollment in higher education*
- *Record of entrepreneurship*
- *Youthful population*
- *Breakthrough tech products*

UTAH

The development of Utah as a high technology state is the result of a number of unique, complex and occasionally conflicting factors.

It is impossible to consider Utah without understanding the influence of the Church of Jesus Christ of Latter-day Saints (LDS) on the state. Mormon pioneers who were fleeing religious persecution settled in Utah in 1847. The area's isolation, climatic extremes, lack of natural resources, and rugged topography were seen as advantages by early settlers, who hoped those factors would keep others at bay.

Over the years, these characteristics have worked both to the advantage and disadvantage of Utah's economic development. The lack of natural resources has meant that the state has had to create its own assets; people and their brainpower were the only real resources available. At the same time, the isolation and small economic base have kept in-migration relatively low and the state's population small — only 2.1 million people. Its largest city, Salt Lake City, has approximately 182,000 people. As a result, the state has had to work to build a critical mass of people and companies to spur high tech development.

The LDS Church remains one of the primary factors influencing Utah. The state is the worldwide LDS headquarters, and more than 70% of the state's population is Mormon. The governor, all 5 members of the Congressional delegation, and 90% of the legislature are LDS. The LDS belief in large, strong families, self-reliance, and conservative government has affected policies and programs. Because of deep roots and family ties, residents who grow up in Utah or go to school there tend to stay.

Conservatism and Realism: Utah's Tax and Fiscal Climate

Utah is a conservative state that has been led for the last 10 years by Mike Leavitt, a moderate Republican. The state has had no tax increases in the past decade, but several tax cuts. Leavitt is considered a moderating force, balancing the state's public needs against a highly conservative legislature that would like to reduce government spending further.

Utah's major spending challenge is in education because of its large student population and small revenue base. The large percentage of the budget devoted to education has left policymakers with little flexibility to spend in other areas.

Both K-12 and higher education allocations come from the general fund. In K-12, the state has tried to accommodate uneven resources across districts by establishing a Uniform School Education Fund, as well as a separate fund for rapidly growing districts.

Infrastructure funding has suffered in the last decade and is becoming recognized as an issue that could adversely affect business growth. The governor has suggested that user fees be imposed for transportation and water infrastructure, a significant shift from previous policy. The state is also considering long term bonding for capital infrastructure, which has not been done before.

Many Students to Serve: Education Systems in Utah

Education policy and spending in Utah seem to be caught between two deeply held philosophies: the importance of education and fiscal conservatism. Spending on education on a per student basis is among the lowest in the country, yet the percentage of the overall budget spent on K-12 is relatively high (23% in 1999). The reason for this apparent paradox is the large number of students in the state in comparison to the total population. About one-third of the state's residents goes to school every day. As a result, a large portion of the budget is spent on education, but per pupil spending is low.

The state has a high rate of educational attainment. In 2000, 26% of adults had a bachelor's degree, the 19th highest level in the U.S., and 91% of adults had a high school diploma, 4th highest in the nation. It is generally believed that parental support and financial contributions through PTAs and other groups supplement the low per pupil public spending, although this is difficult to quantify. Another factor is the relatively homogeneous population in the state. There are few non-English speakers, for example, so spending for English instruction is low, especially compared to states like California and Arizona.

The state's higher education opportunities are generally considered to be one reason for the state's high tech standing. Several people interviewed called it "more important than tax breaks." Utah has about 100,000 university students and a large community college enrollment among a population of just over 2 million. Even more important is the amount of research dollars coming in — more than $400 million in 2000 to the 3 research universities (7th in the country in state academic research).

Collectively, Utah's universities have a national reputation in medicine, computer science, and entrepreneurialism. The first artificial heart was developed and implanted by researchers at the University of Utah in 1982. That event spurred specialization in artificial organs and prostheses and in materials research. Word Perfect, the first widely used word processing software was developed in Utah and in-state computer science professors revolutionized computer graphics. Silicon Graphics, Pixar Animation, Adobe Systems, and Atari all have roots in Utah.

More recently, the University of Utah was one of 13 global hubs for sequencing the human genome. The University of Utah has been a leader in genetics research, partly because of the LDS interest in genealogy, which has enabled researchers to track family genetic history and marry that social science to new medical breakthroughs.

The state devotes about 15% of its general expenditures to higher education, a relatively large percentage, and this figure has been consistent over the last 20 years.

High Technology Innovations and Dynamism

Utah can trace its roots as a high technology state to cultural characteristics and a series of significant technology advances and well known products.

Utah has a particularly strong track record in entrepreneurship. The National Commission on Entrepreneurship has ranked Utah as the #1 state in the nation in the formation of new businesses, in spite of the fact that the state has few programs dedicated to technology development. The Milken Institute's composite ranking on technology dynamism puts the state 7th in the nation.

While scientific breakthroughs and a history of entrepreneurship have inspired new technology companies, Utah has been less successful in retaining them. Many of the most well known firms with Utah roots have moved to California. Many in the technology field attribute this loss to two factors: 1) a lack of venture capital and 2) the small population base. The state has no public investment in venture capital, nor does it provide tax incentives or guarantees for venture capital investment.

The state's tendency toward fiscal conservatism and laissez-faire economics has meant few government-sponsored programs for technology business development. The state does have an Industrial Assistance Fund to provide incentives based on the number and quality of jobs, a fund for customized training, and a modest R&D tax credit. Few seem to believe these programs have brought more than marginal benefits to Utah companies.

The infrastructure for entrepreneurship is small but effective. The Wayne Brown Institute, founded in 1983, is one of the nation's most well known entrepreneurial institutes. The institute provides training for entrepreneurs and access to venture capital, and has been responsible for placing more than $1 billion in small Utah companies. The Utah Information Technology Association has about 120 members, and the Utah Life Sciences Association acts as a trade association for the biotech industry.

Realizing that the small population base is a hindrance to achieving a critical mass of scientists and engineers, Governor Leavitt recently began an initiative to double the number of engineering graduates in 5 years and triple the number in 10 years through targeted recruitment and retention programs.

Of Note in Washington —
- *Political leaders on the national stage supporting development at home*
- *K-12 achievement*
- *Universities as federal research leaders*
- *Legacy of Bill Boeing and Bill Gates*

WASHINGTON

Washington enjoys a prominent position on many high tech indices, and this stature is a source of pride and confidence in the state's future. Ironically, though, complacency is seen as the most significant long-term risk to the state remaining a high tech leader.

What is the most important event leading to Washington's high tech position? The short answer is "the birth of the Bills" — as in Boeing and Gates.

Bill Boeing's company grew into a national aviation and aerospace powerhouse during the 20^{th} century, employing over 80,000 in the Seattle area by 1970.

In 1979 Bill Gates and business partner Paul Allen planted their young Microsoft company in the Seattle suburb of Redmond, and the rest is high tech history.

Of Washington's 10 Fortune 500 firms, Boeing and Microsoft have had perhaps the greatest economic and social impact on the Seattle region and the state's high tech status. Their impacts have been direct and measurable as well as "almost incalculable spinoffs into other branches of technology such as computer gaming, internet software, and e-commerce." These enormously successful corporations provided the stimulus for developing a "core of expertise" in science and engineering and related high tech professions in the Seattle region.

The Seattle region's high tech boom had dramatic effects during the buoyant 1990s:

- A high tech workforce of 193,000 called the two Seattle region counties of King and Snohomish home as reported in 2001.
- Seattle area per capita income rose from 14% above the national average in 1990 to 24% above the average in 2002.
- High tech workers in Washington were the highest paid in the nation in 1998, with an average wage of $105,700 annually — almost double the national average.

While high tech growth has been dramatic in Washington, its many new economy developments are rooted in part in old patterns, including sustained federal support for the defense and high tech industries and a resulting appreciation of the state's engineering and science culture.

In particular, Senator Henry "Scoop" Jackson and Senator Warren Magnuson "brought home the bacon" for decades. Jackson and Magnuson were legendary national political leaders who provided an enormous one-two punch for the defense and aerospace sectors in Washington. Boeing and the University of Washington were among the big winners of federal favor, but they were not the only ones. The federal government's conversion of the Hanford Atomic Energy Works in eastern Washington from a plutonium production facility to a multifaceted center with numerous labs and R&D programs resulted in more long-term investments with significant high tech spinoffs.

A High Tax Burden on Business: Washington's Tax and Fiscal Climate

The most important difference in Washington's tax system compared to other states is that Washington does not have an income tax for businesses or individuals. Yet, according to a study conducted by the Washington Roundtable, the state of Washington has one of the highest tax burdens on businesses in the country.

The most significant business tax is the Business and Opportunity Tax (B&O), which was developed in 1935. It taxes a business' gross profits instead of its income.

In keeping with national trends, Washington's elected officials provided significant state tax relief during the boom times of the 1990s. For example:

- Tax-cutting measures in 1997, 1998, and 1999 resulted in $569 million in general tax reductions through June 30, 2001.
- B&O taxes were cut to pre-1993 levels, reducing business taxes by $333 million so far.
- Unemployment insurance taxes were reduced to save businesses $356 million by June 30, 2001.
- A voter-sponsored initiative reduced car licenses to a flat fee of $30, reducing state revenue by $750 million.

A K-12 Leader: Education Systems in Washington

Per student expenditures for K-12 education have been consistently higher in Washington than in California, Colorado, Utah, or Arizona. Interestingly, Washington ranked 16th among the states in 1972 for per capita K-12 spending, with Arizona at 15. By 1999, Washington's position on this measure was 14th while Arizona's had declined to 46th.

As a partial result of its sustained investment in K-12 education, the state had the nation's highest high school attainment level in 2001, one of the key factors leading to its "A" grade in the 2001 "Development Capacity Index" from the Corporation for Enterprise Development.

Yet recent budget shortfalls now challenge Washington's efforts in K-12 education. As a percentage of state operating expenditures from all funds, K-12 education has fallen from 30% in the 1987-1989 budget cycle to 26% in the 2001-2003 budget cycle, from a rank of 6th among the states in per capita K-12 spending in 1992 to 14th in 1999.

Despite the economic and fiscal challenges to the state's general support of public education, Washington has recently made important targeted investments, including:

- **$76 million in special state funding over 4 years for more learning assistance and individualized attention**
- **$85.7 million for smaller classes and extended learning opportunities in public schools**
  This funding keeps faith with a citizen initiative which makes an additional $393.3 million appropriation to school districts to further reduce class sizes and expand extended learning opportunities, as well as provide $77 million to build new schools.
- **A 3.7% increase in teacher salaries in 2001**
- **$61 million for the K-20 Educational Telecommunications Network**
  This network connects all levels of education, kindergarten through graduate school, offering Internet, intranet, satellite-delivered "distance learning" programs and videoconferencing capabilities.

Higher education clearly has played a pivotal role in Washington's high tech ascent. The University of Washington has been a national leader in federal research grants in recent years. But state support has not been targeted to high tech and, according to critics, must be improved to maintain the state's standing in high tech fields. In 2000 the National Science Foundation ranked Washington 35th in state funding support of research. As one observer put it: "While the University of Washington, the state's leading research institution, has been a leader in federal research grants, matching support from the state has been low."

Washington's current budget allots $56 million over 2 years for research and development at the state's 6 public universities and colleges. Overall, state support from the general fund for higher education has never been in the nation's top tier and has declined in recent years. In 1972 Washington per capita public spending for higher education was 13th highest among the states, by 1999 it had declined to 17th. Spending for higher education declined from about 12% of the state general fund in 1970 to 9% in 2000 and was a consistently lower percentage of the state general fund in Washington than in Arizona over a 30-year period.

As one expert said "...many of us knew all along that we have been seriously under investing in our research universities." Washington is 5th in the nation on the number of people in the workforce with bachelor's degrees in science and engineering, however, its public universities are 48th out of the 50 states with respect to the number of graduates completing those degrees.

A Research Leader in High Technology

One fact from the Milken study speaks volumes about relative investment in research and development in the state. In 1998, Washington placed 4th among the states in per capita industry R& D, 15th in federal R&D, and 20th in academic R&D. However, Washington's overall R&D rank declined from 8th in 1997 to 16th in 2001.

In an effort to create incentives for high tech businesses to locate in Washington and to prevent existing businesses from leaving the state, Washington developed two different tax credits related to R&D:

- **High Technology B&O Tax Credit** — Established in 1994, companies can claim up to $2 million in tax credits as long as the credit does not exceed the B&O tax due for that year.
- **High Technology Sales/Use Tax** — Also passed in 1994, the sales/use tax exemption applies to new research and development or pilot manufacturing facilities located in Washington.

With these two measures, Washington has attempted to account for disincentives inherent in the state tax system, but critics argue that the measures are far to small to have much impact on the decisions of high tech companies.

Washington also has taken specific, if relatively small, steps to link higher education and high tech:

- **The Advanced Technology Initiative at the University of Washington and Washington State University** brings investment to specific fields where a combination of cutting-edge research and education initiatives can create new industries or revitalize existing ones.
- **The University of Washington and Washington State University are now allowed to own and finance research facilities** and related equipment with dollars generated by research, and the universities can finance these facilities with revenue bonds.

The greatest threat to Washington's place in the high tech future is complacency, according to the executive director of the state's Technology Alliance. Founded in 1996 by Bill Gates, Sr. the Technology Alliance is a statewide consortium of leaders from technology-based businesses, research institutions, and technology organizations who are dedicated to Washington's economic success. And, with good reason, they are worried. An alliance report notes:

> *The state that was in 1999 flying high and the envy of many, has [in 2002] the unenviable distinction of having the highest unemployment rate in the country. Many states do not have the kind of technology assets Washington still enjoys — but that is not the point. The fact is that they [the report specifies Georgia, Michigan, and California as examples] are moving up.... They are investing in the future. Washington is not. In fact, we are doing a pretty good job of undermining everything that got us here.*

Of Note in Arizona —

- *High tech manufacturing*
- *Proposition 301 for university research funding*
- *Aerospace and electronics industries rooted in defense spending*
- *Rapid population and job growth*

ARIZONA

Arizona's record as a high technology state is mixed. The state fares relatively well in measures of the electronics and aerospace industries, but Arizona's overall performance is just slightly above average. Arizona is not in the top 10 by any ranking, and does no better than the national average on most indicators. In addition, by most measures, the state has not gained much ground in science and technology over the last 20 years.

Population growth — spurred by climate and job growth — has fueled the state's economy over the last 50 years. During World War II, an influx of military and defense-related activities, drawn in large part by the state's excellent weather for aviation, started this population boom. A small town in the 1940s, Phoenix was the country's 6th largest city in 2000.

Throughout the 1990s, the state had the nation's fastest or second-fastest population and job growth rate nearly every year. The slowdown at the end of the 1990s hit Arizona hard, however. By 2000 the state's job growth performance was anemic and the state was lagging the national recovery.

Although population and employment have grown at a breakneck pace, other indicators of economic progress have not done so well. Real per capita income, for example, fell further behind the national average from the early 1970s, when the state had 93% of the national average, to the 1990s, when Arizona's real per capita income had slipped to only 85% of the national average. Over the 1990s, when job growth was robust, real per capita income failed to improve. In short, by many people's measure, Arizona's economic growth has been more about quantity than quality.

Cuts and Supply-Side Economics: Arizona's Tax and Fiscal Climate

Arizona is a fiscally conservative state. In the last decade, Arizona leaders cut taxes for 9 straight years, a fact that has been touted by conservative legislators as having contributed to Arizona's rapid growth rate and high rate of job production. But such cuts substantially limited the state's revenue base. Today Arizona is facing its worst fiscal crisis since World War II and, on a relative basis, has one the largest deficits of any state in the country.

Some argue that Arizona has overspent for the last decade, and that the state's real fiscal problem is not tax cuts alone but the combination of tax cuts and increased spending. Others suggest that the state has reduced the size and scope of government in more subtle ways — by removing automatic cost-of-living increases, for example, and changing accounting procedures. By whatever means, according to the consistent methodology used by the legislature's budget arm, the state is spending less on its current operations than it did at the beginning of the 1990s, once inflation and population growth are taken into account.

The state's constitution requires a balanced budget. And, a super-majority is needed to approve an increase in taxes. In addition, the state has been faced with a variety of lawsuits on educational issues and voter-passed initiatives in education and health care that have resulted in increased state spending in these areas. The cumulative effect of these actions, combined with tax reductions that cut into the base, is very limited flexibility for the legislature. The vast majority of spending is mandated by federal programs, judicial decisions, or voter-approved initiatives. When budget crises hit, Arizona has only a few areas of discretionary spending, so these bear a disproportionate share of budget cuts. Finally, state general revenue is highly dependent on the sales tax, which accounts for about 50% of the total.

Not Keeping Pace: Education Systems in Arizona

The state's spending for K-12 and higher education did not keep pace with economic growth in the 1990s. Total education spending per capita in Arizona in 1972 was among the highest in the west and the highest among the 5 western high tech states considered in this paper. By 1999 per capita education spending had declined significantly and was the lowest among the same states. Higher education spending, measured in real dollars per student, follows the same pattern: high in the west in 1972, low by 1999.

Arizona is now relatively low in education rankings. Approximately 85% of the adult population had a high school degree or better in 2000, slightly below the national average and ranking the state 31st. The state ranked worse in 2000 than it had in 1990 for high school attainment. Approximately a quarter of the state's population has a bachelor's degree or more, ranking the state 24th in the country and just behind the national average.

Some observers attribute the state's lackluster educational record to its rapid growth rate. Rather than having to educate its own internal labor force, Arizona has been able to import educated workers from other states. As one analyst explained, as long as Michigan and Minnesota had good education systems, Arizona could reap the rewards.

Higher education receives a smaller percentage of the state's general fund than it did 20 years ago, and additional funding for higher education is an annual budget battle. The state provides relatively little in the way of financial aid to college students. However, in the late 1990s, Republican governor Jane Dee Hull asked the legislature to refer an initiative to the ballot to increase the sales tax to provide additional funding for K-12, with a percentage going to universities for the state's first-ever research fund. Proposition 301 passed in 2000 and provides a substantial 20-year dedicated funding stream for K-12 improvements and higher education research.

High Technology: Mostly Electronics and Aerospace Manufacturing

Arizona's claim to high tech fame has been primarily in electronics and aerospace, with optics also playing a strong role. The state's high technology emphasis has been in manufacturing, although there are also pockets of research. Arizona's major private employers are Honeywell, Intel, Motorola, Boeing, and Raytheon. Arizona State University's Engineering Excellence program — with solid ties to such players as Intel and Motorola — is considered an important reason for the strong concentration of electronics and aerospace firms in Phoenix. With the passage of Proposition 301, the universities have new resources dedicated to science and technology research. In year one, Arizona's three public universities received a total of approximately $50 million.

Total R&D in Arizona is below the national average and less than the 4 western high tech comparison states. That relatively low level is also a reality in R&D in federal, state and local, and industrial research.

Arizona was selected by *Inc. Magazine* as one of the nation's hot spots for entrepreneurship, boasting a high number of fast-growing "gazelle" companies. But the state has little indigenous venture capital and has not attracted a great deal of outside capital either. Arizona has no public programs to leverage or attract venture funding and makes no public investment in venture capital.

The state has few special programs for high technology, aside from a training fund that targets high tech workforce development. The infrastructure for entrepreneurship is more informal, although the Arizona Technology Council has been formed to advocate for the high tech community in central and northern Arizona in cooperation with the Southern Arizona Technology Council. The state also has a long history of cluster-based economic development and was one of the first states to adopt such a strategy. Several high technology industries have cluster organizations, some now affiliated with the technology councils, which provide networking, education, and advocacy for their industry. The cluster-based approach has brought national and international attention to Arizona.

The Logic of Collective Action: Strategies to Improve Arizona's Standing in Science and Technology

Differences among Arizona, California, Colorado, Utah, and Washington are readily apparent. That these 4 Arizona competitors rank as high tech leaders seems almost serendipitous. Such catalysts as the discovery of gold, the dominance of a homogeneous culture, the birth of 2 men, and the development of defense and space facilities seem to have little in common.

Table 2. Foundations for High Tech Success: Notable Features

A 5-State Overview

Arizona	California	Colorado	Utah	Washington
▪ High tech manufacturing ▪ Proposition 301 for university research funding ▪ Aerospace and electronics industries rooted in defense spending ▪ Rapid population and job growth	▪ History of risk taking ▪ Deeply rooted technology industries ▪ Commitment to higher education ▪ Federal R&D facilities	▪ High tech diversity ▪ Concentration of knowledge workers ▪ Quality of life ▪ Defense and space facilities	▪ High educational attainment and enrollment in higher education ▪ Record of entrepreneurship ▪ Youthful population ▪ Breakthrough tech products	▪ Political leaders on the national stage supporting development at home ▪ K-12 achievement ▪ Universities as federal research leaders ▪ Legacy of Bill Boeing and Bill Gates

Yet, there are similarities in the stories of these high tech achievers that help explain their status. All 4 comparison states benefitted mightily from large, sustained, multifaceted federal investments in defense and space that contributed to the formation of a significant concentration of knowledge workers. In turn, the presence of knowledge workers stimulated a positive cycle of higher education, training, socialization, and state preparation for high tech activities. Another similarity is the year-by-year development of major research universities and traditions of university-economic development connections and technology transfers. With these advantages, it appears to be a case of the rich getting richer, or at least a case of some places having head starts, which yielded varying degrees of high tech workforces and cultures.

Discussions of new economy indicators usually highlight entrepreneurial capacity, homegrown development, synergy resulting from the sprouting of small new firms, and so forth. But the central lesson of state high tech development from this set of examples is that real strength in science and technology requires a momentous, sustained catalyst to ignite a change from old to new economy activities. The catalyst does not necessarily have to be the same as described in these 4 competitor states. Georgia, for example, is using large, coherent state investments to move from old to new. To create a high tech fire, though, a place needs a flamethrower.

Unfortunately, research does not reveal simple cause-and-effect fiscal policies that result in this kind of development. The data in this paper reinforce an old lesson about the dangers of applying macro analysis to micro questions. Looking at total spending, total education spending, or even total university and K-12 spending biases outcomes in the "no significant difference" direction simply because of the size and complexity of these variables. Each state is a textbook case of long-term public-private partnership — plus historical events and rare people — that blossomed independently of state tax and spending policies.

All 4 show the effects of sustained intergovernmental funding (with heavy emphasis on federal dollars targeted to specific national priorities) supported by state and local human and capital infrastructure expenditures, which were matched by private investments and linked by catalytic events and strong leadership.

And, whether by chance or design, they had the good fortune to rank high on the factors that attract and retain high tech businesses. (See Table 3.)

Table 3. What Factors Attract and Sustain High Tech Industries?

Traditional Cost-of-Doing Business Measures	Specific to High Tech
▪ Tax Structure	▪ Access to Venture Capital
▪ Compensation Costs	▪ Educated Workforce
▪ Space Costs	▪ Proximity to Excellent Research Institutions
▪ Capital Costs	▪ Network of Suppliers
▪ Business Climate	▪ Technology Spillovers
	▪ Climate and Quality of Life

Source: *America's High Tech Economy*, Milken Institute, July 1999.

The Formative Phase of High Tech Development

A hundred years from now it is likely that the state of technology in 2002 will seem as elemental as the technology of 1900 does today. Hence the importance of smart, strategic public investments, the need to focus on particular R&D strengths, develop venture capital, encourage entrepreneurship, and generally craft an investment platform for a future that is unknowable, but surely will be different, is clear. In short, the policies and programs for the development of high technology that Arizona's government, nonprofit, and private leaders and institutions establish today could reap huge rewards in the future.

The logic of collective action suggests the following:

- Because this is the early stage of the new economy, high tech development is a highly competitive, volatile game with, at this point anyway, no absolute winners or losers.
- In all states high tech development is highly sought after, complex, multifaceted, and synergistic. Intergovernmental paths must be clear and open or a state will not be in this game. The many places where private and public interests and resources cross need to be obvious and useful as well.

State and regional policymakers must play important roles in crafting and stimulating the relationships required to compete for a future that profits from science and technology. Investment with that in mind is prudent, yet the type of investment will and must vary. A few states, like the 4 high tech leaders considered in this report, may be “Type A” states. They would be smart investors if they use public investments to patch up holes in their high tech systems. For example, Washington is still importing sizeable proportions of its high tech workforce and is slipping substantially in math and science education rankings, as well as support for its research universities.

The others, perhaps “Type B” catch-up states, need to develop a different logic of collective action, but they must act or be left in the dust. What is required for these places is larger, sustained multiyear investments to implant, or at least trigger, some of the culture, education, training, and socialization that have already occurred in Type A states. It is important in these states not only to invest, but to “brand” and market the investment too. The Research Triangle in North Carolina, Georgia’s Research Alliance and HOPE scholarship, and Michigan’s Life Sciences Corridor Initiative are examples of large investments with something more; they have created a critical level of “buzz” to help sustain support at home and draw national attention.

In this dynamic, competitive context, no state or region that expects science and technology to be part of its economic development equation can be complacent. That is underscored in Washington, where the executive director of the state’s powerful alliance of private and public high tech leaders concludes that, in essence, Washington is standing still or sliding backwards, while others states are striding ahead.

Strategies to Improve Arizona’s Standing in Science and Technology

What would smart, sustained investment in a high tech future look like in Arizona? The examples of 4 competitor states suggest that Arizona needs:

- Lasting, enthusiastic leadership that recognizes the economic value of science and technology
- The right message and strategy to convey the urgency of this matter
- Investment in the creation and sustenance of first-tier research institutions
- More and better mechanisms to improve the transfer of ideas into the market place
- A belief that the state can be a leader in science and technology

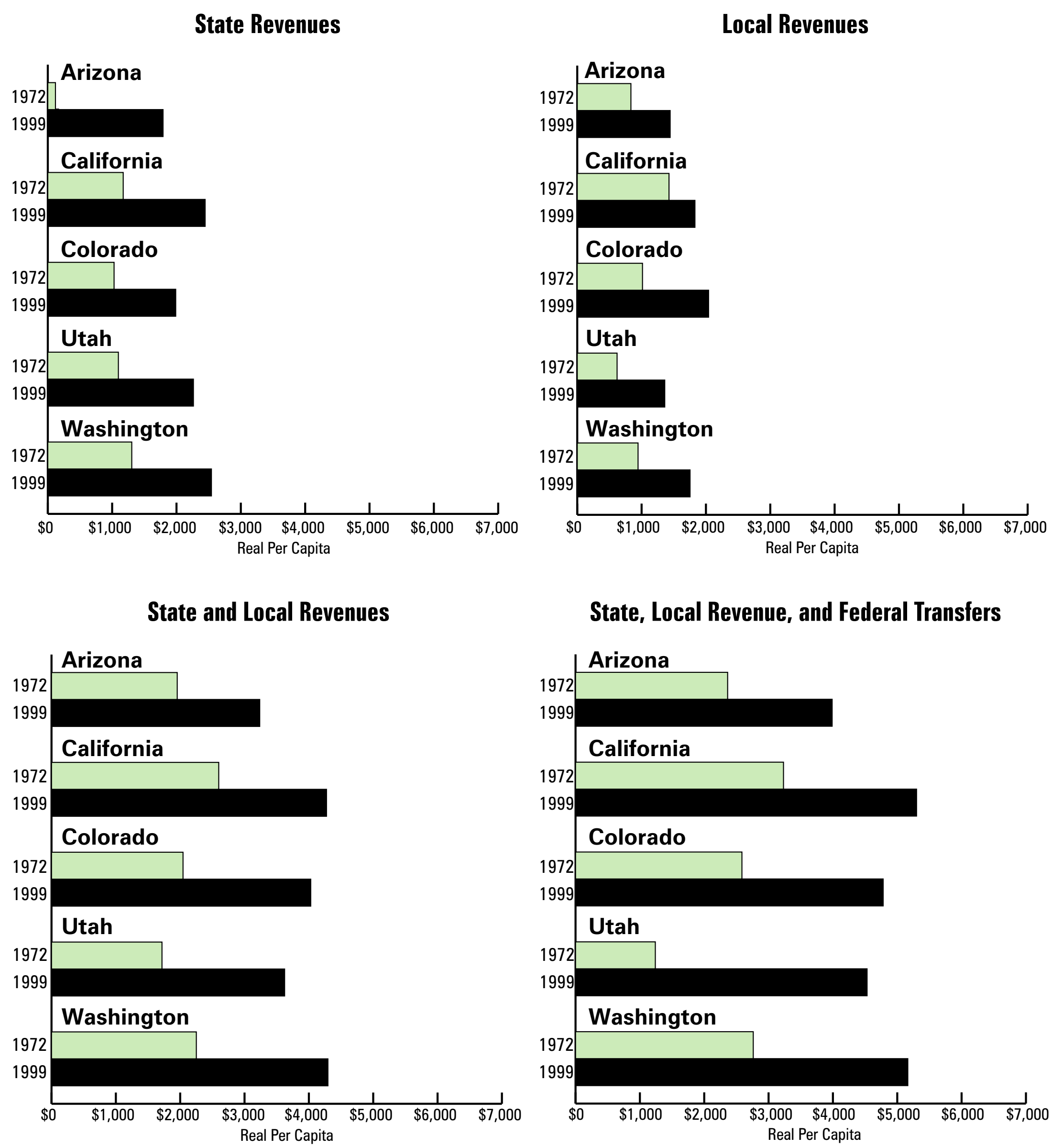
There are many variations on the formula for high tech success, but common elements are apparent. It is likely that states will prosper not from unilateral actions or single bullet solutions, but by involving leadership from all sectors and making smart investments from all sources. Tax and fiscal policy in and of itself is not the answer here, although it seems to be important in one respect — states need at least a certain level of public revenue to provide the education and physical infrastructure necessary to even be in the science and technology hunt. In the final analysis, though, states will improve and compete strongly if they make the partnerships needed to sustain and leverage investments and apply the logic of collective action to the task.

Comparative Data: Arizona, California, Colorado, Utah, and Washington

Figure 3.

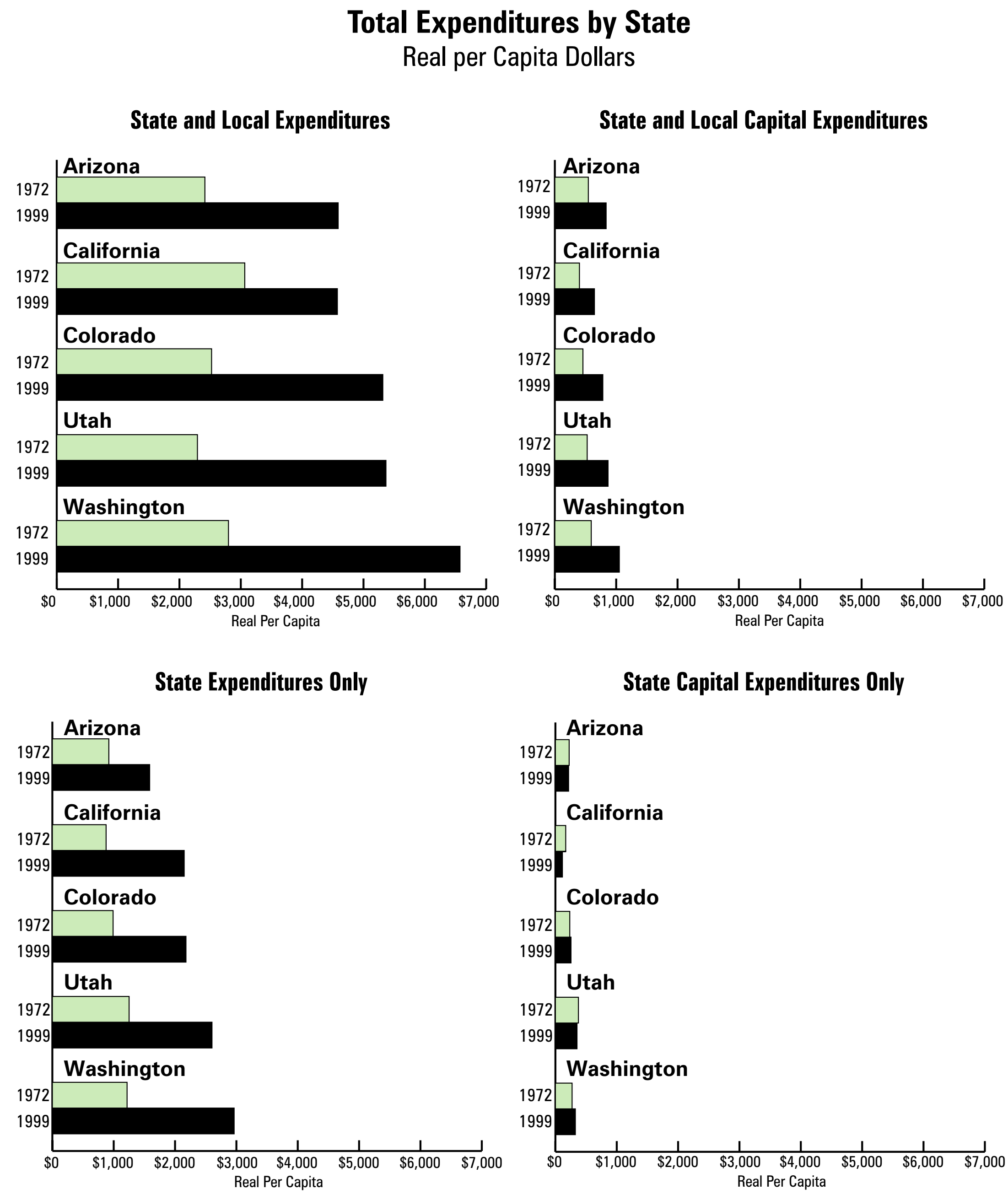
Total Revenues by State

Real per Capita Dollars



Source: U.S. Department of Commerce, Census Bureau.

Figure 4.



Source: U.S. Department of Commerce, Census Bureau.

Table 4. Per Capita Personal Income

Annual Average by National Economic Cycle*

Years	U.S.	Arizona	California	Colorado	Utah	Washington
			Real Per Capita Personal Income in 2001 $			
1971-1975	$16,563	$15,475	$19,024	$16,878	$13,827	$16,964
1976-1982	18,947	17,465	22,081	19,873	15,891	20,141
1983-1991	22,846	20,827	25,898	23,424	17,902	23,178
1992-2001	27,386	23,486	29,032	29,092	21,743	28,582
			Ratio to US Average			
1971-1975	NA	93.4%	114.9%	101.9%	83.5%	102.4%
1976-1982	NA	92.2%	116.5%	104.9%	83.9%	106.3%
1983-1991	NA	91.2%	113.4%	102.5%	78.4%	101.5%
1992-2001	NA	85.8%	106.0%	106.2%	79.4%	104.4%

* Each state follows a different cycle on this measure. Any given year could be unrepresentative for one or more states.

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Table 5. Average Wage

Annual Average by National Economic Cycle*

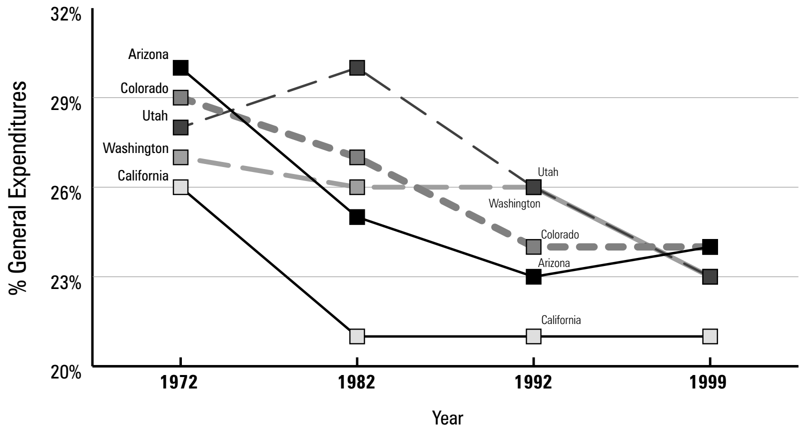
Years	U.S.	Arizona	California	Colorado	Utah	Washington
			Real Average Wage in 2001 $			
1971-1975	$26,620	$26,082	$29,090	$26,095	$23,522	$27,337
1976-1982	26,797	25,770	28,801	26,973	24,784	28,636
1983-1991	28,639	26,790	31,681	28,426	25,256	28,488
1992-2001	32,281	29,638	36,172	32,344	27,217	33,740
			Ratio to US Average			
1971-1975	NA	98.0%	109.3%	98.0%	88.4%	102.7%
1976-1982	NA	96.2%	107.5%	100.7%	92.5%	106.9%
1983-1991	NA	93.5%	110.6%	99.3%	88.2%	99.5%
1992-2001	NA	91.8%	112.1%	100.2%	84.3%	104.5%

* Each state follows a different cycle on this measure. Any given year could be unrepresentative for one or more states.

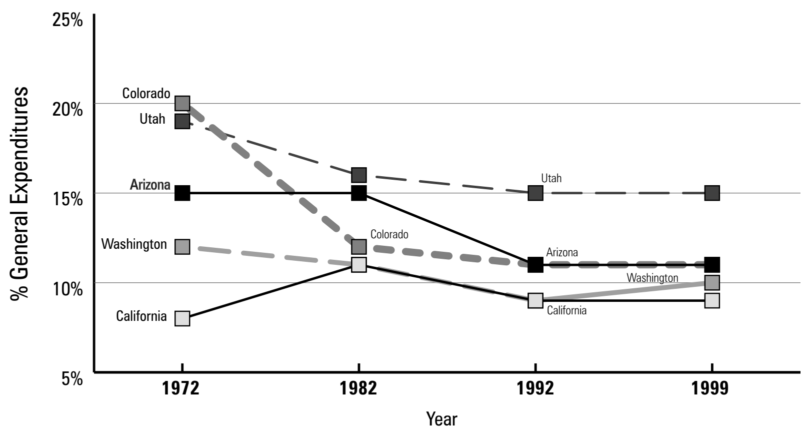
Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 5.

K-12 Education Expenditures by State



Higher Education Expenditures by State



Source: U.S. Department of Commerce, Census Bureau.

Table 6. Engineers/Scientists Per 100,000 Workers, 2000

	U.S. Median	Arizona	California	Colorado	Utah	Washington
Software Engineers						
Rank	—	12	5	2	19	3
Statistic	272	487	793	1,053	355	903
Hardware Engineers						
Rank	—	9	8	5	18	10
Statistic	23	62	72	81	30	54
Electrical Engineers						
Rank	—	4	5	3	45	13
Statistic	90	197	174	198	40	114
Electronics Engineers						
Rank	—	8	3	9	16	7
Statistic	58	118	160	118	96	119
Biomedical Engineers						
Rank	—	25	11	16	25	25
Statistic	0.0	0.0	5.6	3.4	0.0	0.0
Medical Scientists						
Rank	—	36	6	19	35	7
Statistic	6.5	0.0	39.4	10.6	0.0	34.3

Source: Milken Institute, *State Technology and Science Index*, September 2002, from U.S. Department of Labor, Bureau of Labor Statistics.

Sources

AeA. (2002). *Cyberstates 2002: A state-by state overview of the high tech industry*, June.

Bebchuk, L. & Cohen, A. (2002). "Firms decisions where to incorporate," Harvard Law School Discussion Paper No. 351. July.

Bird, M. (1993). "The economic development of Colorado in historical perspective," *Issue Paper 17-93*, Independent Institute, June.

Bock, C., Carino, V., & Schreiter, S. (2002). *The California Technology Investment Partnership (CalTIP) matching grant program: A survey of program effectiveness,* September.

California Department of Finance (2002). *Tax expenditure report, 2001-2002*.

California State Senate, Joint Committee to Develop a Master Plan for Education (n.d.).

Chapman, J. I. (1999). *The role of the state in research and development funding*, Sacramento, CA: California Council on Science and Technology.

Cheatham, L. (2001). "Technology and Its Role In Washington's Economy?" Testimony to Washington House of Representatives, Committee on Higher Education, January 17.

Colorado Legislative Council. (2000). *Tax handbook, research publication no. 471*, March.

Colorado Legislative Council. (2002). *Tax handbook, research publication no. 498*, March.

Colorado Legislative Staff. (2001). *Amendment 23: A brief overview*, February.

Cook, J. (2000). "State gets rich on Microsoft," *Seattle Post Intelligencer*, May 18.

Corporation for Enterprise Development. (2001) *Development report card for the states 2001*, November.

Devol, R., Koepp, R., & Fogelbach, F. (2002). *State technology and science index*, Milkin Institute.

Devol, R. (2002)," Institute View," *The Milken Institute Review.* (4)4: pp. 86-93.

Dunn, T. (2001). "How Colorado compares in state and local taxes," *Colorado Legislative Council Staff Issue Brief, No. 01-3*, May 7.

Eslinger, C. & Butler, J. (2001). "How Colorado compares in K-12 funding," *Colorado Legislative Council Staff Issue Brief, No. 00 - 1*, February 10.

Hall, B. H., & Wosinska, M. (1999), *Effectiveness of the California R&D tax credit*, Sacramento: CA: California Council on Science and Technology.

Hecker, D. E. (1999). "High technology employment: A broader view," *Monthly Labor Review*, June. p. 19-20.

Horvath, M. T. K. (1999). *California venture capital infrastructure study,* Sacramento, CA: California Council on Science and Technology.

http://www.dof.ca.gov/html/fs_data/historycaeconomy.

http://www.sen.ca.gov/ftp/sen/committee/joint?master_plan/_home/

League of Education Voters. (2003). "A brief history of school finance in Washington," http://www.education voters.org.

LeLoup, L. T. (2003). "Washington." In Robert Huefner (ed.), *Proceedings roundtable: State budgeting in the 13 western states,* University of Utah.

Mauer, M. R. (1998). "Appropriations growth by function," *Colorado Legislative Council Staff Issue Brief, No. 98-3,* January 23.

Morgan Quinto Press. (2002). Press Release — "Results of the 2002 Smartest State Award," September 26.

Poulson, B. (2001). *The TABOR amendment: Learning to live within Colorado's tax and spending limits, issue paper 9-2001*, Independence Institute, December.

Powell, L. (2002). "Biotech has been good to Washington: Now state needs to be good to it," *Seattle Times*, September 29.

Progressive Policy Institute. (2002) *The 2002 new economy index.* http://www.neweconomyindex.org

Rausch, L. M. (1998). "High-tech drives global economic activity." *National Science Foundation Issues Brief, NSF 98-319*. Arlington, AC, Division of Science Resources Studies, July 20.

Scott, A. (2002). "State faulted on high-tech front," *Seattle Times,* May 16.

Smith, R. (2001). "Technology-focused nonprofits join forces," *Puget Sound Business Journal,* August 17.

Technology Alliance. (2002). "Three case studies: How Georgia, Michigan, and California are building and sustaining innovation economies," draft, October 1.

Technology Alliance. (1999). *The Tax Environment*, January.

Trotter, A. (2000). "Washington initiative would skirt spending limits," *Education Week,* October 4.

U.S. Bureau of Labor Statistics. (2003). "Career Guide to Industries," http://www.bls.gov.

U.S. Department of Commerce, Bureau of Census. (1999). *County business patterns 1999*.

Washington Governor's Office, "Creating opportunity through technology: Washington's strategy for the innovation economy," http://www.wa.gov./innovation/strategy.htm.

Washington Roundtable. (2002). "Economic incentives: Keeping and attracting business," *WR,* September.

Washington State Department of Revenue. (2000). High tech R&D tax incentives study, http://www.dor.wa.gov/docs/reports.

Washington Technology Center, "Index of Innovation and Technology — Washington State 2001." http://www.watechcenter.org/techindex.

Windham, P. H. (1999). *An analysis of major federal laboratories in California, Vol. I*. Sacramento, CA: California Council on Science and Technology.

Zook, Amy. (2001). "State Funding for PK-12 Education," *Colorado Legislative Council Staff Issue Brief, No. 01 - 6*, June 8.