Competing

in an

Innovative World

An Oklahoma Academy Town Hall

October 14-17, 2001 @ Shangri-La, Oklahoma

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Introduction

The Academy Research Committee

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Introduction

The Research Committee & Research Team

This document was produced for the sole use of Academy Town Hall members. It is to be used by attendees to prepare themselves for extended debate and decision-making. Town Hall attendees are strongly encouraged to absorb this research and formulate relevant questions prior to the Town Hall ... discuss the issues and test ideas at the Town Hall ... and conclude the Town Hall by agreeing upon a recommended course of action for Oklahoma.

Academy Research Team

- Robert Dauffenbach, PhD, University of Oklahoma
- Tabitha Doescher, PhD, Stillwater
- Alexander Holmes, PhD, University of Oklahoma
- Tony Hutchison, Oklahoma Senate Staff
- Ryan Kiesel, Oklahoma Senate Staff
- Craig Knutson, E-conographic Consulting Services of Oklahoma, LLC
- Michael Lapolla, Oklahoma State University
- Mike Metzger, PhD, University of Central Oklahoma
- Kent Olson, PhD, Oklahoma State University
- Jeannie Bordelon-Parker, Oklahoma Senate Staff
- Steve Smith, Rose State College
- Larkin Warner, PhD, Oklahoma State University (Emeritus)

The Academy Research Committee

Alexander Holmes, University of Oklahoma; Tony Hutchison, Oklahoma Senate Staff; Craig Knutson, E-conographic Consulting Services of Oklahoma, LLC; Michael Lapolla, Oklahoma State University ; Mike Metzger, University of Central Oklahoma; Kent Olson, Oklahoma State University; Steve Smith, Rose State College ; David Walters, Walters Power International; Larkin Warner, Oklahoma State University (Emeritus)

Primary Contacts

The primary Academy contacts for this report are:

Julie Knutson
President/CEO
The Oklahoma Academy
120 East Sheridan #200
Oklahoma City, OK 73104
405-232-5828 (phone)
405-236-5268 (fax)
julie@okacademy.org

Michael Lapolla
Chairman, Research Committee
Oklahoma State University
2345 Southwest Boulevard
Tulsa, OK 74107
918-561-8381 (phone)
918-561-8372 (fax)
lapolla@osu-com.okstate.edu

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This Research

The Academy Research Committee

The theme of this Town Hall has evolved. We first considered the concepts of the New Economy and globalization. Then we changed to adding the concept of competitiveness. Then we felt that perhaps the term New Economy tends to be over-used and maybe not well understood. The same could be said for "global,, concepts. We finally felt comfortable with "Competing in an Innovative World,,. It is descriptive ... and may preclude pre-formed opinions. You will see the term New Economy used throughout this research, because it probably best describes our innovative world.

This research paper was prepared for a single purpose: to prepare Town Hall members for informed and elevated discussion, debate and brainstorming.

In Section 1, Craig Knutson and Steve Smith provide a concise and cogent presentation of the essential elements of the "innovative world,, ... and amplify how and why these elements are critical. They have provided us with a "thinking template,, to use at our Town Hall. It should occur to all of us that the six key elements they describe ... are the very same elements that define much of what we call our "Oklahoma culture,,. Other areas of the nation (and world) may react to the elements differently ... and create a competing culture . One will likely be more attractive than another as competition heats up in our innovative world.

THINK people, capital, research, policy, infrastructure and clusters. They will be a Town Hall mantra.

In Section 2, Dr. Larkin Warner provides a comprehensive overview of "how do we rate,, in the rankings of seven prestigious organizations. We need not micro-analyze these rankings and their comments. But we should not ignore the preponderance of their findings. We can safely conclude that we (Oklahoma) do not fare so well by most measurements ... and that we can do much better.

Section 3 was authored by Dr. Kent Olson and Dr. Tabitha Doescher. The intent was to explore two selected opportunities that may be available to Oklahoma. Our committee did not want to pre-select "winners,, when considering our opportunities. That said, it is likely that two of our many opportunities likely lie with Information Technology and Biotechnology. We present them in a case study format. For purposes of Town Hall discussion, feel free to discuss any of a score of economic/social ideas and themes. You may consider telecommunications, agriculture, energy, meteorology or others.

Section 4 was prepared by the Research Staff of the Oklahoma Senate. This section was intended to be a case study format. They analyzed the metro areas of Oklahoma and compared them to a carefully selected set of four "peer,, metro areas. We have also included interesting pieces on Oklahoma enterprises. And we have thrown in two countries ... Ireland and Singapore ... who have about the same population as our state.

Dr, Alexander Holmes was asked to anchor the team and write Section 5 in op-ed style. Those of us acquainted with Lex know him to be one of the most qualified Oklahomans to comment upon our strengths and weaknesses as a state. Dr. Holmes is a respected professor of economics; a former director of state Finance in the Bellmon administration; and one of the "founding fathers,, of the Academy. His words and thoughts carry weight.

This paper is a jumping off point toward vigorous Town Hall discussions built around your informed discussion questions.

So ... THINK people, capital, research, policy, infrastructure and clusters. And community and quality of life.

Let the Town Hall begin!

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Introduction

Using This Research

The Academy Research Committee

Most of success is due to proper preparation. The Army says "Preparation Prevents Poor Performance,, ... or something close to that. To ensure a successful Town Hall, it is essential that you absorb the essence of this document. It was assembled precisely to be used in your preparation for this Town Hall.

During the Town Hall there will be hours of discussion on dozens of topics. Bear in mind that most of us are good at problem identification. But identifying a problem doesn't get the job done. Our Town Hall expectations are way beyond problem identification. We need more than that from you.

This research document was crafted to help you do that. It offers a variety of didactic discussion and real-world case studies. It offers numerous tables, charts and illustrations. We suggest you do the following:

- Study the outline to understand the flow and construction of the information (see page7)
- Be aware of relevant historical Academy activity and recommendations (see pp 8-9)
- Be informed as to the current "state of the State,,, its shortcomings and its strengths

When offering discussion items for the Town Hall. And when you participate in the Town Hall it is imperative that the discussion be responsible and solution oriented. We suggest you consider the following:

- Set clearly measurable goals along with a definite deadline
- Determine which policies will best achieve those goals, carefully weighing all associated benefits and costs. Remember that nothing is free; sometimes the most significant cost of a policy is another opportunity that must be foregone to pursue it.
- Determine how best to effectively sell these ideas to Oklahoma citizens and decision-makers

We need to discuss BIG things at our Town Hall. We need to discuss efforts, approaches and ideas that are transformational. Millions of people work every day to effect incremental change, or even to protect the status quo. Why should we spend our valuable time doing the same?

If we are well prepared and participate in the Town Hall in a creative manner, it is likely we will collectively think of big, bold, and doable ideas that will permit every Oklahoman citizen and business to compete effectively in an increasingly complex and innovative economy. As Governor Nigh once said at an Academy Board meeting "we need to do the best we can ... with what we have ... where we are,,.

Where will we go from here?

Our Academy Implementation Committee, chaired by Greg Main, plans to convene a late Fall meeting with key legislators and appropriate Executive branch staff including the Governor. This will be our contemporary version of the Academy's Oklahoma Summit. They intend to present our Town Hall recommendations for their consideration. If our findings and recommendations make sense .. if they are intriguing, doable and compelling ... we expect to receive a favorable response.

With this goal in mind ... let's use this research to prepare for great discussion ... that will produce compelling and achievable ideas ... that our leaders can help put into motion.

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Introduction

Competing in an Innovative World

The Academy Recommended

We have explored Oklahoma issues and made public policy recommendations for 15 years. Many have borne fruit. Throughout this document you will see margin references that say: "The Academy Recommended,,. When you see that notation, turn to this section and review the specific recommendations made by the Academy. If these aggregated efforts have one overarching theme ... it would be to help make Oklahoma and its people become "more competitive in an innovative world,,. In Section 1, we describe the "key elements of an innovative world,,. They are people, capital, infrastructure, clustering, public policy and research. They are arrayed against the six key elements below. Use them to advance and elevate the Town hall discussions.

	People Education/Social Human Needs	Capital Venture Capital	Place Public Infrastructure	Clusters Critical Mass	Policy Policy and Regulation	R&D Research & Development
1985 **Oklahoma Revenue: Sources and Uses**						
Ad valorem tax reform	●	●			●	
State road/highway financing reform			●			
Broaden sales tax base	●		●			
Expand public revenue in K-12 schools	●					
Better define roles-higher education missions	●					
1986 **Economic Expansion**						
Create State Department of Commerce	●	●	●	●	●	●
Reform Worker's Compensation					●	
Increase K-12 funding	●					
Increase university research funding						●
Create university endowed chairs	●			●		●
1987 **Oklahoma s Future: Policy Options for 2005**						
Create Constitutional Study Commission					●	
Systemic restructuring of K-12 system	●					
Require / raise minimum ACT scores	●					
Fully fund university endowed chairs	●		●			●
1988 **K-12 Education: Will Oklahoma Pass or Fail**						
Form Statewide Education Task Force to:						
Develop improved statewide core curriculum	●					
Significantly increase statewide education funding	●					
Become national leader in use of educational technology	●					
Strengthen teacher preparation, performance & evaluation	●					
1989 **Developing Human Potential**						
Increase access to prenatal / perinatal care	●					
Promote strengthening of family / community values	●					
Study causes of death in youth	●					
Create and fund K-12 drug education task force	●					
1990 **Oklahoma s Future: Choice or Chance**						
Establish goal to fund education per "peer institutions,,	●					
Promote a major higher education Capital Bond Issue			●			
Build/support 21st Century telecommunications infrastructure			●	●	●	
Increase emphasis upon higher ed telecom networking	●			●		
Induce private telecommunications investment via incentives			●		●	

	People Education/Social Human Needs	Capital Venture Capital	Place Public Infrastructure	Clusters Critical Mass	Policy Policy and Regulation	R&D Research & Development
1991 **Oklahoma Policies: What Should They Be?**						
Task Force 2000 pursue the "school choice,, policy analysis	●					
State health care responsibilities - market/education focused	●					
1992 **Telecommunications: A Governor s Conference**						
The Oklahoma 2007 Vision should be pursued			●		●	
Governor should host a formal telecom policy retreat					●	
1993 **Today s Budget Decisions - Tomorrow s Priorities**						
Forward conference-developed budget balancing recommendations to the Governor, state legislative appropriations leadership and the Office of State Finance.					●	
1994 **Entrepreneurs & Small Business Development**						
Expand annual funding of OCAST by $3.5 million		●				●
Promote in-state investor tax incentives to generate risk capital		●			●	
Establish organization to formalize a network of risk capital		●				
Remove all barriers to University-based technology transfer		●		●	●	●
Establish "clearing house,, for entrepreneurial assistance				●		
1995 **Better Government Competition**						
Modify assessment testing of adult learners	●					
1996 **Building Safer Communities**						
Celebrate successful communities			●			
"Literacy prior to release,, philosophy	●					
Research church supported programs	●					
Public school curriculum enhancement	●					
1997 **Education & Training: The Key to a Richer Oklahoma**						
Maximize technology use and technology education	●		●		●	
Expand business involvement in education	●					
Develop a marketing campaign to promote lifelong learning	●					
1998-99 **TechnologyApplications:** **Accelerating Towards Prosperity**						
Maximize statewide physical connectivity	●		●	●	●	
Maximize statewide digital connectivity	●		●	●	●	
Provide the model for a redefined 21st century public education	●					
Reexamine the teacher preparation process	●				●	
Allow a state tax credit for family computer purchases	●		●			
Allow Constitutional amendments with a single vote					●	
Earmark the state sales tax to public (K-14) education and minimize reliance upon property tax	●				●	
Vigorously support State Questions 680 and 681				●	●	●
Create a Technology Entrepreneurial Institute.	●					
Invest a portion of state public pension funds in an Oklahoma Technology Venture Capital Fund		●				

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Section 1

Key Elements of an Innovative World

Steve Smith and Craig Knutson

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Section 1

Key Elements of an Innovative World

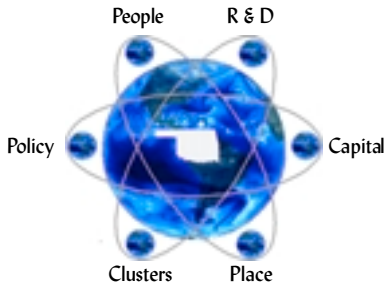
Steve Smith and Craig Knutson

Preface

In this section the authors establish the parameters for the Town Hall discussion. They discuss the six key elements of an innovative world: people, research, capital, infrastructure, clusters, and public policy. And they imply the overall importance of the elusive concept of community . The cited examples happen to mention the urban areas that have generated high-tech business in the last decade. This section does not mean to imply that smaller communities and non-metro areas cannot compete in an innovative world.

INTRODUCTION

During the 1990s, new regions of economic growth emerged around the country, e.g., Albuquerque, Austin, Boise, Colorado Springs, Dallas, Denver, Huntsville, Raleigh-Durham-Chapel-Hill and Phoenix. These new centers of economic activity not only were growing more rapidly than the U.S. economy, they were also generating a high standard of living and quality of life for their residents.



Consequently, these regions became the focus of researchers and policy makers wishing to determine the factors that were driving this economic expansion. These regions, known as the “high-tech,, or “new economy,, growth centers, share many characteristics that are fundamental to their growth.

The characteristics of the hi-tech or new economy do not represent a repeal of the basic economic laws or forces that drive a market economy, but rather, represent the consequences of applying new technology in the U.S. market orientated economy to address the fundamental issue satisfying human wants with limited resources.

As occurred with the Industrial Revolution over a century and a half ago the New Economy of the twenty-first century has created new opportunities for growth while at the same time reducing the growth potential in many sectors that previously provided the stimulus for expansion in the U.S. economy. This section of the report will identify the characteristics that a region or community must have to capture the growth potential of the hi-tech economy.

Generally, these New Economy communities have based their growth on the innovations derived from the explosion of knowledge and technology in the last thirty years. Education, science, technology and quality of life amenities have all contributed to the success of these new growth centers.

These characteristics are defining the high-tech growth regions in the United States. Consequently, metropolitan areas that do not have these characteristics may experience a lower rate of economic growth. This section will identify the characteristics of the hi-growth regions and explain why they are essential to the long-term growth of a region, such as Oklahoma.

Before examining the characteristics of high-tech growth centers a methodological caveat is in order. When scientifically examining the interrelationships between variables whether in physics, biology or economics, it is necessary to formulate mathematical models that can predict the impact of a change in one variable on the other variables.

Specifically, in economics, econometric models are used to predict, for example, the impact of increasing the expenditures in a school district on the value of housing in that district. Therefore, one approach to determining the factors that lead to the formation of high-growth centers would be to isolate these variables with the use a multiple-equation econometric model. For the purposes of this report, this approach has a technical and a practical constraint.

Technically, the causal relationship between technology and economic growth is very difficult to explain with such a model. The complex interrelationships between the variables tend to mask their influence upon each other. From a practical perspective, while an attempt to mathematically explain the economic determinants of high-tech growth sectors would

surely improve our understanding of what drives these regions, the time required to and the expense of developing such a model are beyond respective limitations of this report. It is recommended that, if the time and resources become available, such a study should be undertaken to assist in the understanding of the development of high-tech growth regions.

The methodology used to determine the characteristics of high-tech growth regions for this report was to review the technical literature on the New Economy and the high-tech growth sectors in the United States and identify the characteristics that were common to findings of these researchers.

We believe this technique does accurately identify the necessary characteristics that a region must have to become a high-tech growth center. However, it does not provide a measurement of the relative importance of each characteristic to the development of a high-tech region. Therefore, it is not possible to determine from this technique which characteristics should be given the highest priority.

While it would help determine these priorities, an econometric approach could also be very misleading. The relative importance of each characteristic, most likely, varies greatly from region to region. This variation occurs as a result of the unique technology base of each of these high-tech regions and circumstances that originally triggered the tech-related growth in a particular region.

In other words, high-tech regions are very heterogeneous, but share certain common characteristics that are identified in this report. These characteristics provide the basis for developing a strategy to establish a tech-based growth sector in a local economy. They are: people, research & development, venture capital, infrastructure, clusters, and public policy & regulation. Additionally, the concept of "community,, is an overarching element.

The Academy Recommended
The Oklahoma Academy s 1988, 1989, and 1997 Conferences focused solely upon people and their development and education

Key Element 1

People: Training & Education

The economic expansion that has driven the U.S. economy for the past decade has been concentrated in regions of the country where there is a high concentration of entrepreneurs and workers that have the unique skills required by technology-orientated businesses. In other words, regions, such as Oklahoma, with a modestly skilled labor force have not been and may not be competitive in the market for knowledge-based companies. Several authors writing on the New Economy have emphasized the importance of an appropriately trained workforce to the development of a high-tech sector. "The New Economy: A Guide for Arizona,, stated that, "People are the most important raw material.,,[1]

Jerry Jordan, President of the Cleveland Federal Reserve Bank, addresses the importance of education in the New Economy in a recent article by observing, "the labor market is churning, simultaneously creating new jobs and destroying existing ones ... human capital will depreciate quickly ... establishing policies that help accommodate change is essential.,, [2]

And Ross C. Devol of the Milken Institute suggests, "in terms of investment, providing a readily available labor pool is probably the best investment that a state and local government can make.,, [3] Finally, Edward Malecki notes that, "From a human standpoint, a well educated and skilled population will be best able to capitalize on new opportunities and take them in to the future,,. [4]

Because the New Economy places a much greater emphasis on a skilled labor force than ever before, all levels of a region's educational system are critical to the development of a hi-tech sector. The pre-K through secondary school system must provide a strong background in science and mathematics. Not only must these schools be wired with the latest technology, it is equally important that the faculty receive on-going training on the use of this technology.

While the preK-12 educational system provides the students with the knowledge foundation for a career in the New Economy, the state's tech centers, colleges and universities provide the specific skills in mathematics, science and engineering that technology-based companies require. Therefore, if a region is to develop a high-tech sector it must have a post-secondary educational system that provides world-class training in engineering, science and mathematics.

Also, workers will find it necessary to upgrade their skills to remain competitive in the New Economy workforce. Consequently, it is important that all levels of technical training provide state of the art instruction in fields of study that complement the technology-base of the region. In addressing this issue, the 2000 Economic Report of the President reported "high-technology manufacturers were less likely to report a difficulty in finding skilled labor in communities that had a community college than in those that did not.,, [5]

While the technology economy does provide opportunities for all workers with the appropriate skills, the biggest payoff occurs in higher education, especially in science and engineering. Metros with the highest ratio of workers aged 25 and above relative to the size of the population that hold at least a bachelor's degree, experienced higher rates of economic growth from 1980 through 1998. [6]

Today, college graduates earn 77 percent more than an average high school graduate, and the three fastest growing occupations are all computer-related and require at least a bachelor's degree. [7]

High-tech firms share the common denominator of a high-skilled workforce specialized in the sciences, mathematics and engineering. The regions that can supply this essential raw material will have the comparative advantage in New Economy of the 21st Century. Therefore, a well-educated workforce is possibly the single most important economic foundation, which a region can use to attract investment. [8]

Fr om a human standpoint, a well educated and skilled population will be best able to capitalize on new opportunities and take them in to the future. [4]

The Academy Recommended
The Oklahoma Academy s 1986, 1994, 1998 and 1999 Conferences focused specifically on research in Oklahoma.

Key Element 2

Research and Development

While many feel that human capital is the most important determinant of a region's ability to become a high-tech center, others feel research and development (R&D) is the critical factor. [9] A unique characteristic of innovative high-tech businesses is that they require access to highly specialized R&D to provide the scientific base for the development of the enterprise. The source of this R&D may be a federal research lab, such Los Alamos, a private research center, for example Bell Labs, the more traditional university based research, or an alliance of public and private institutions, as has occurred in Austin.

To successfully attract high-tech entrepreneurs the research and development activity must be world-class and focused on well-defined fields of study. [10] This means that policy makers in a region must determine which sector of the high-tech arena they want to pursue and then develop a R&D infrastructure that is specific to this high-tech sector. It is also very important that the R&D is accessible to all entrepreneurs who might be interested in developing a business related to the R&D focus. For example, some entrepreneurs may pursue an innovation that existing tech firms may utilize, while others may focus on inventing an entirely new high-tech product or service.

According to the Progressive Policy Institute's New Economy Index, the two states that are the farthest along the path to the New Economy are Massachusetts and California. [11] Both are quintessential high-tech states, which boast a concentration of software, hardware and biotech firms supported by world-class universities, such as MIT and Stanford.

One crucial element of the R&D activity in these states is that it is quite diversified. This enables many different types of high-tech firms to locate in these regions and utilize the spillover benefits of the R&D. This diverse high-tech economic base then tends to spin-off additional new ventures creating exponential regional economic growth. The technological innovations spawned over the past twenty years in these R&D centers have formed the foundation of the high-tech regions of the New Economy.

In summary, the high-tech regions that have developed over the last two decades have all been based on an existing R&D infrastructure that created the innovations utilized by existing and new technology-based businesses. The new high-tech regions of the future will also be driven by innovations from local R&D efforts, whether public, private or a consortium of the two.

The Academy Recommended
The Oklahoma Academy s 1994 and 1999 Conferences focused specifically on risk and venture capital in Oklahoma.

Key Element 3

Venture Capital

An additional characteristic shared by existing high-tech regions is a concentration of venture capital funding. There are five reasons that traditional funding techniques are not as well suited to the high-tech business model as the venture capital methodology. [12] The first is uncertainty over the number of outcomes that are possible from any project. The greater the number of potential outcomes the greater the uncertainty of the investment and the less suitable it is for traditional debt funding. This uncertainty reduces the willingness of investors to furnish capital, and suppliers to provide credit, and also places constraints on the managers.

The second issue is the complexity and timing of communication between the entrepreneurs of a high-tech startup and their investors, suppliers and partners. The presence of the venture capitalist in the management of the enterprise streamlines communication and therefore provides a more stable financing platform.

Third, information-technology based companies often do not have tangible assets to use as collateral. When the company's value is based on intellectual capital, it is difficult for managers of traditional sources of capital funding to assess the risk, and fund, a tech-based project.

T o achieve this goal they recommended investing a small percentage (1-3 percent) of state-controlled funds in venture capital pools and educating wealthy local investors about the advantages of pooling resources to develop angel funds.

Fourth, rapidly changing market conditions in the IT sector can make traditional financing problematic. This includes instability in the markets for the products being produced as well as capital market conditions and changing regulatory requirements. The personal involvement of the venture capitalist in each company and the flexibility they have adopted in their financing techniques are well suited to the unique needs of each entrepreneur.

Last, because high-tech start-ups are pursuing the commercialization of an idea that is based on leading-edge science, traditional funding sources may lack the technical expertise necessary to analyze the market potential of the proposed project. These characteristics of high-tech businesses provide the venture capitalist with an advantage over traditional funding techniques when investing in high-tech enterprises.

The Milken Institute has identified high-risk capital as a crucial component to the ability of the southwest to become a high-tech corridor. [13] According to this study, the availability of high-risk, or "angel,, financing, for high-tech start-ups is critical to attracting the established venture capitalist. To achieve this goal they recommended investing a small percentage (1-3 percent) of state-controlled funds in venture capital pools and educating wealthy local investors about the advantages of pooling resources to develop angel funds. The key to this strategy is to provide a bridge between the initial capital requirements of a high-tech startup and the funding provided by an established venture capitalist.

The Academy Recommended
The Oklahoma Academy s 1985, 1986, 1990, 1992 and 1998-99 Conferences focused specifically on infrastructure in Oklahoma.

Key Element 4

Infrastructure

The success of any economic development initiative, whether it is focused on manufacturing, tourism or high-tech growth, has been dependent upon creating a location that is uniquely suited to the focus of the economic development initiative. To create this unique location advantage requires investing in facilities, or infrastructure, that complement the businesses in the target industry.

For example, strategies to expand manufacturing activity in a region have included an infrastructure plan for the development of industrial sites, the construction of appropriate transportation links and providing electric and natural gas power. Likewise, a growth plan focused on the tourism industry would not be successful if it did not address the infrastructure required to attract people to the region, such as building an arena, theme park or enhancing other recreational activities.

However, as with training, R&D and financing, a high-tech economic development plan requires a new approach to infrastructure. Because of the global nature of high-tech industries, any region aspiring to develop and attract information-based businesses must be open to international markets. There must be a sophisticated logistics network within the region. This logistics network should provide a multimodal distribution system that can link the company to the world. In fact, the logistics management industry is, in essence, a high-tech industry itself, in that it has evolved in response to the demands of the global market place. Certainly, the region must be wired to provide the state-of-the-art communication services (bandwidth and switching) required by these New Economy companies.

In addition to these new twists to old infrastructure requirements, the New Economy players are also demanding a quality-of-life infrastructure. The quality-of-life characteristics focus on such factors as health, public safety, environment, culture, entertainment, community aesthetics, parks and recreational areas. Several studies have identified the importance of the quality-of-life infrastructure to the economic vitality of a region. [14]

These studies point out that the location of tech-based companies is not tied to a raw material or market, and therefore people are choosing locations that are appealing to them and then the companies follow. Since typical high-tech entrepreneurs are very skilled, well educated and earn high incomes, they seek locations that provide a high level of amenities. [15]

The Academy Recommended
The Oklahoma Academy s 1986, 1990, 1994, and 1998-99 Conferences focused specifically on clustering in Oklahoma.

Key Element 5

Industry Clusters

Long-range high-tech economic development strategies for Texas, Arizona, and a consortium of southwestern states have all recognized that the ability of a region to be successful in the high-tech arena is dependent on the creation of clusters. [16]

Is Oklahoma centrally located ... or simply centrally remote ?
Larkin Warner

The clusters are not an industry group, but rather many different industries that share technology, workers, suppliers and ideas. The companies in these clusters form alliances and networks with suppliers, research organizations, higher education and other training institutions and local agencies which enable these firms to lower their cost and speed up the innovation process by sharing technology, information, labor, infrastructure and other resources.

This means that place matters more than ever and the concept of a regional economy is at the heart of the New Economy. High-tech firms require the synergy provided by clustering to be successful. These clusters create a "tipping point,, where economic growth builds on itself as the benefits of these alliances expand exponentially over time. Once the tipping point has been reached, suppliers, labor and capital are attracted to the region to realize the benefits of the cluster. These clusters also reinforce the entrepreneurial activity that is also necessary for the expansion of the high-tech sector in a region. Well-known examples of these clusters include Boston, Silicon Valley, Denver, Dallas, Austin, Albuquerque, Los Angles and Raleigh-Durham-Chapel Hill.

The Academy Recommended
The Oklahoma Academy s 1987, 1990, 1991, 1993 and 1999 Conferences focused specifically on broad public policy and regulation in Oklahoma.

Key Element 6

Public Policy and Regulation

The spoils of the New Economy revolution will go to those communities and regions that adopt public policies to facilitate change and encourage the rapid assimilation of technology into their economies.

The Austin Chamber of Commerce Next Century Economy study recognized the role of public policy and regulation in the emergence of a high-tech sector when they stated "while a particular regulatory regime cannot create growth without other factors like a skilled workforce, it can alone deter it.,, [17]

Specifically, regulatory policy can enhance and accelerate the development of high-tech sectors by protecting intellectual property rights and providing for technology transfers and commercialization. It is important that researchers are able to license their findings to the private sector and work for private companies to assist them in developing commercial applications of their

science. Additionally, tax policy directed toward providing a substantial benefit at the startup phase of a new high-tech venture may provide the initial incentive necessary to jump-start the development of a high-tech cluster.

At the local level, it is important that requests for site plans and subdivision developments are not delayed by unnecessary regulation and review. New tech-based companies are very nimble and can usually choose from many acceptable locations and will, therefore, choose the site that minimizes the startup time and has a low cost regulatory environment.

One More Consideration: Communities

Community organization was not explicitly itemized in the research reviewed as an essential element to the development of a high-tech growth region. However, every report, without exception, implied that a unique community organization existed in every high-tech growth corridor and, therefore, indicated that this characteristic is assumed and may be the essential first step in the formation of a high-tech growth region.

While they each reached their goal by following different paths, each high-tech community created its path with a similar organizational structure. Each community created a team of civic, business, academic and political leaders to pursue the development of high-tech business in their region.

This team built a long-range strategy, based on thorough research, which could be used to build a consensus throughout the community. It was recognized that the realization of this goal would take decades and require a significant outlay of resources.

They understood they would be competing at world-class level when vying for high-tech business and would accordingly have to create world-class institutions to achieve their objective. The teams collectively shared a vision and a realistic understanding of what would be required to develop a high-tech sector in their region.

The complexities of high-tech enterprise and the interrelationships that exist in this sector require a well organized, focused, dedicated and completely supportive community organization to be successful.

Finally, there is the intangible community element called "quality of life,,. This measure is central to the strategic plan of the Southern Growth Policies Board (see Section 2) and other discussions of essential elements for progress (see Section 3).

CONCLUSION

All high-tech growth centers are based on innovations in science and technology and share the common characteristics of a highly skilled workforce, world-class educational institutions, an innovative research and development organization, the availability of venture capital funding, a high-tech infrastructure, the clustering of many different types of tech-related enterprises and a community culture that fosters an atmosphere of change.

These components occur in these regions because leaders from the community, business, and government collaborated to form alliances to make their region a high-tech growth center.

All of the alliances have combined public and private funds and other assets to achieve their goal. Also, without exception these growth centers did not spring up over night, but rather were the result of very focused long-range planning that, in all cases, did not bear the fruit of their effort for nearly two decades.

In developing these alliances and strategies, these leaders also recognized other more subtle issues that would influence their success. They were careful to focus on a plan that would create a diversified high-tech sector. This meant developing the fundamentals consistent with the New Economy and allowing the high-tech cluster to develop from this foundation.

They also were aware of the possibility of a digital divide, where less skilled workers in the region might not share in the bounty of the New Economy growth, and took steps to help ensure social equity.

Finally, there was the recognition that the planning process would never end. That it would be necessary to continue to foster flexible markets and respond to the churning that is inevitable in the rapidly changing high-tech sector.

Consequently, all of these regions continue to analyze the high-tech sector and develop new strategies to take advantage of the high-tech growth opportunities created by future innovations.

The challenge for Oklahoma policy makers is the develop a process to address each of these key elements of high-tech growth. This process must establish the priority for each element and measurable results for achieving the goals within each element.

Additionally, it should be noted, that in most cases these policy initiatives may require significant public expenditures, e.g., education or infrastructure or loss in tax revenue through subsidies, and therefore should be undertaken only if they are shown to be feasible with thorough cost-benefit analysis.

On the other hand, while many of the policy and regulatory changes may not appear to reduce tax revenue or increase public spending careful analysis of the direct and indirect effects of the policy action must be undertaken to avoid implementing policy that may bear significant costs to various sectors state's economy as has occurred in California with the deregulation of electricity.

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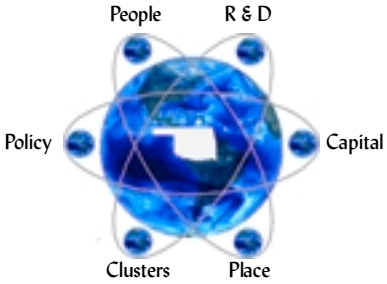
Section 2

Where Does Oklahoma Rate?

Larkin Warner, PhD and Robert Dauffenbach, PhD



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Section 2

Where Does Oklahoma Rate?

Larkin Warner, PhD and Robert Dauffenbach, PhD

Preface

In this section, Dr. Warner surveys the generally accepted models that rate states and communities in their presumed abilities to be competitive in an innovative world . Our Committee does not necessarily believe that we are good or bad based upon a single rating. In fact ... most committee members have a healthy skepticism for the methodologies, timeliness, motivations and validity of these ranking pr ojects. On the other hand, if five people tell you your shoe is untied ... you may want to look down. Dr. Warner has done an excellent job in reviewing the most credible rankings and interpreting our place among them. Use them as discussion guides ... but with some discretion.

INTRODUCTION

How does Oklahoma stack up as a New Economy state? The purpose of this section is to provide an introductory assessment based on a selection of frequently cited studies comparing U.S. states and metropolitan areas with respect to various characteristics related to high-technology driven economic growth. Studies which rate and/or rank states and areas are of interest to Oklahoma policymakers for two basic reasons.

First, frequently-cited studies help establish an image for the state which, whether fair and accurate or not, plays an important role in site-selection screening decisions of entrepreneurs otherwise unfamiliar with the state. In fact, state image is also important for existing business managers within Oklahoma who may determine that the grass is greener on the other side of the state line fence.

If it ain t broke, don t fix it. ... gets translated into acceptance of sub-par quality or if it ain t broke, don t fix it up.

Second, comparative studies suggest actual strengths and weaknesses in the state's economic environment. This provides a basis for attempting to remedy deficiencies. It also facilitates development strategies to expand sectors with an established record of comparative advantage. A practical motto often heard today in Oklahoma was probably derived from hard working farm folk: "If it ain't broke, don't fix it.,, Unfortunately, sometimes this gets translated into acceptance of sub-par quality or "if it ain't broke, don't fix it up.,, While interstate comparisons of New Economy status may not lead to a conclusion that major elements are seriously "broke,,, our current status and trends during the 1990s indicate that some things really need fixing up.

THE NEW ECONOMY PARADIGM SHIFT

As the period 1993-2000 developed, there were an increasing number of observers who asserted that a paradigm shift was occurring involving the basic structure of American economic growth. The U.S. economy was growing almost half again as fast as it had during 1973-93. The 2001 Economic Report of the President (the last of the Clinton administration) pointed to rapid productivity growth, low inflation and unemployment, federal budget surpluses and U.S. dominance among industrial economies as evidence of this paradigm shift. [1]

This improved performance was expected to be sustainable because of major structural shifts including computer-based technological change, deregulation of domestic business and liberalization of the international economy including the collapse of communism and hard-core socialism.[2]

There were, of course, dissenters who argued that what was being labeled a paradigm shift was nothing more than a burst of rapid development in a limited sphere of computer hardware, peripherals and telecommunications.[3] Developments during the early months of 2001 appeared to justify the proposition that there was excessive investment in these New Economy sectors.

There is, however, a wide consensus that the slowdown of 2001 is only temporary and that there will be a return to the growth patterns characterizing the economy during 1993-2000. Acceptance of this consensus is implicit throughout this report.

ANALYSIS OF NEW ECONOMY LEADING INDUSTRIES

Given the reality of the New Economy paradigm, what can be said specifically about the industries that are leading forces in this development? These are generally referred to as "high-technology,, industries, though there is certainly no uniformly accepted definition of high-tech, and some of the industries classified as high-tech are certainly not new. The use of computers and information technology, which are viewed as the bellwether components of the New Economy, are virtually ubiquitous throughout the nation's economy. Even "Old Economy,, industries, such as retailing and oil & gas production, are experiencing dramatic change due to computers and information technology. [4]

U.S Department of Labor

Bureau of Labor Statistics Approach to Analysis

Given the difficulties of specification, it is nevertheless useful to try to identify the New Economy by starting with an attempt to specify high-technology industries. One of the more widely cited sources of a high-technology definition is the U.S. Department of Labor's Bureau of Labor Statistics (BLS). [5]

The core of high-tech is identified by the BLS as consisting of a set of 29 industries, classified by their three-digit Standard Industrial Classification (SIC) codes.

The core of high-tech is identified by the BLS as consisting of a set of 29 industries, classified by their three-digit Standard Industrial Classification (SIC) codes. These industries have relatively high total shares of employment of persons in occupations classified as scientific, technical and engineering (STE). They also report relatively high proportions of employment involving STE personnel engaged in research and development. Industries are included if these two relative shares are at least twice the average share in all industries (Figure 2-1). A subset includes 10 industries, labeled "high-technology intensive,,, which have STE employment shares at least five times the national average.

The BLS estimated that total direct employment in high-tech industries in the U.S. in 1996 was 9.3 million. Another 7.1 million workers were estimated to be found in industries supplying the high-tech industries and in technology-oriented occupations not in high-tech industries or their suppliers. At 16.4 million employees, this generalized high-tech component accounted for 13.8 percent of total national employment in 1996, but was expected to account for 32 percent of employment growth between 1996 and 2006.

Not only is the New Economy, as specified by high-technology employment, responsible for an increasing share of economic activity, high-technology jobs are also high-income jobs (Figure 2-1). This reflects the productivity of high-technology workers and results indirectly from the extensive skill and educational levels of persons categorized as engineers; life and physical scientists; mathematical specialists; engineering and life sciences technicians; computer specialists; and engineering, scientific and computer managers. The workforces of high-technology industries typically embody substantial investment in human capital.

Table 2-1

High Technology Industries, Employment and Earnings, U.S., 1996-97

SIC Code	Industry	1996 Nonfarm Employment (000)	1997 Median Annual Wage
	Total Nonfarm Wage and Salary Employment	118,731	$22,734
	Total, High-Technology	16,366	
	High-Technology Industries	9,307	
	10 High-Technology Intensive Industries	4,549	
281,6	Industrial chemicals	263	$40,976
283	Drugs	259	31,886
357	Computer and office equipment	363	37,960
366	Communications equipment	269	29,494
367	Electronic components and accessories	610	26,187
372,6	Aerospace	550	38,292
381	Search and navigation equipment	161	42,661
382	Measuring and controlling devices	297	30,306
737	Computer and data processing services	1,208	40,602
873	Research, development, and testing services	569	34,882
	19 Other High-Technology Industries	4,758	
282	Plastic materials and synthetics	159	$34,320
284	Soaps, cleaners, and toilet goods	154	26,998
285	Paint and allied products	53	28,350
287	Agricultural chemicals	52	31,824
289	Miscellaneous chemical products	93	29,661
291	Petroleum refining	100	43,202
348	Ordnance and accessories	48	27,248
351	Engines and turbines	84	32,885
353	Construction and related machinery	232	27,248
355	Special industrial machinery	177	30,472
356	General industrial machinery	257	28,392
361	Electric distribution equipment	82	24,315
362	Electrical industrial apparatus	156	23,941
365	Household audio and video equipment	83	23,546
371	Motor vehicles and equipment	963	36,878
384	Medical equipment, instruments	268	26,562
386	Photographic equipment and supplies	85	31,658
871	Engineering and architectural services	839	38,210
874	Management and public relations services	873	31,970
	Employment in non high-technology industries generated by purchases of high-technology industries	4,856	Source: Daniel Hecker, "High-technology employment: a broader view," Monthly Labor Review, June 1999, p. 20.
	Employment in technology-oriented occupations, but not in high-tech industries or in generated employment	2,203	

Oklahoma s Employment in NE Industries

How does Oklahoma stack up as a high-technology state as defined by the SIC codes of Table 2-1? The County Business Patterns data prepared by the U.S. Census Bureau provides a source of detailed employment data for both the nation and for individual states. [6]

Using that data set for 1997, it is possible to identify the degree of technology intensiveness for Oklahoma and to specify the comparative extent of Oklahoma's participation in the various high-technology industries. Nationwide, 8.7 percent of total employment occurred directly in the high-technology industries identified by the SIC codes of Figure 2-1; the share for Oklahoma was 7.1 percent.

The gap between the national and the Oklahoma high-technology shares was almost entirely due to the fact that Oklahoma had relatively fewer jobs in the ten sectors identified by the BLS as "high-technology intensive.,, Nationally, those ten sectors accounted for 4.2 percent of total employment, while they accounted for only 2.8 percent in Oklahoma. The state's share in the 19 "other high technology,, sectors (4.4 percent) was virtually identical to their share nationally (4.5 percent).

Nationwide, 8.7% of total employment occurred directly in the high-tech industries ... the share for Oklahoma was 7.1%.

Economists, planners and geographers use the concept of location quotient to identify industries in a state that appear to be particularly strong and well-placed to export goods or provide services out of the region. Industries are identified with employment shares of total state employment that are above, equal to or below the comparable national employment share. The location quotient is simply the industry's percentage share of employment within the state divided by the percentage share of that industry nationally. A quotient greater than one indicates an industry likely to be exporting out of the state; a quotient less than one suggests that the state may be needing to import the product or service of that SIC category.

For example, in 1996, employment in communications equipment manufacturing (SIC 366) in Oklahoma accounted for 0.507 percent of total state employment, but only 0.249 percent nationally - resulting in a location quotient of 2.038. With nearly 5,000 employees in 1997, Lucent Technologies in Oklahoma City was a major reason for this high location quotient.[7] Additional high-technology Oklahoma industries with location quotients greater than one in 1997 were:

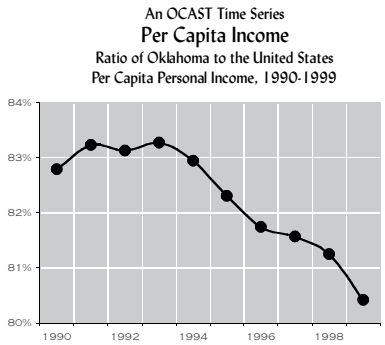
Aerospace	1.004
Agricultural chemicals	1.633
Petroleum refining	2.313
Ordnance and accessories	2.406
Engines and turbines	1.632
Construction machinery	3.612
General industrial machinery	2.054
Household audio and video equipment	1.682
Motor vehicles & equipment	1.053
Photographic equipment and supplies	1.410

These may be viewed tentatively as Oklahoma high-technology sectors that have exhibited comparative advantage, i.e. the state appears to offer a favorable environment in which to locate the industries' facilities.

The gap between the national and the Oklahoma high-technology shares was almost entirely due to the fact that Oklahoma had relatively fewer jobs in the sectors identified as high technology intensive.

Eighteen of the Oklahoma high-technology industries listed in Table 2-1 had 1997 location quotients less than one - indicating (again tentatively) a lack of comparative advantage. The quotients were particularly low (less than 0.5) for the following "high-technology intensive,, industries: industrial chemicals; drugs; electronics components and accessories; search and navigation equipment; and research, development and testing services, and for the following "other high-technology,, industries: plastic materials and synthetics; soaps, cleaners, and toilet goods; miscellaneous chemical products; and medical equipment, instruments.

In recent years, no single Oklahoma economic performance statistic has received as much emphasis as the state s relatively low per capita personal income (PCPI). Oklahoma s PCPI in 2000 was only 79 percent of the U.S. average, and gave evidence of having slipped somewhat since 1993. (see chart below)



Oklahoma Per Capita Personal Income (PCPI)

In recent years, no single Oklahoma economic performance statistic has received as much emphasis as the state's relatively low per capita personal income (PCPI). Oklahoma's PCPI in 2000 was only 79 percent of the U.S. average, and gave evidence of having slipped somewhat since 1993. One way of viewing this low PCPI is in the context of the New Economy paradigm. Although high-tech is not the only reason that a region may experience high income, the high-tech/ high pay relation suggests a syllogism for Oklahoma.

- A concentration of high-tech employment in a region will be associated with high PCPI.
- Oklahoma has relatively low PCPI.
- Therefore, Oklahoma's economic structure is not weighted heavily with high-tech activity.

In a 1998 study of the causes for Oklahoma's relatively low PCPI, researchers for Oklahoma 2000, Inc. compared the state with a set of 15 other states whose PCPIs were growing at least 5 percentage points more rapidly than the U.S. measure during 1980-95. Based on the BLS definition, 10 of these 15 states exhibited a higher relative share of direct high-tech employment than Oklahoma in 1996. [8] Oklahoma's PCPI performance would have been better if the high-tech sector had been more important.

Conclusions about the role of the New Economy in state development must be treated very tentatively. Five of the 15 rapid PCPI growth states had relatively smaller high-tech employment shares under the BLS definition than Oklahoma. This is a reminder that the three-digit SIC codes used to identify high-tech industries rely on average STE employment shares. Some state-level installations may fall into the appropriate high-tech SIC, but may involve production-only manufacturing or services which do not require many STE personnel at the site. Moreover, comparative analysis is sensitive to how high-tech is defined. Other systems of classification mean different sizes of state high-tech sectors.

NATIONAL ASSESSMENTS OF OKLAHOMA

Seven of the more widely cited nationwide and regional assessments of the status of states and metropolitan areas in the New Economy (high-tech) are reviewed. In each case, Oklahoma's most and least favorable attributes are indicated. The reports were prepared by the Office of Technology Policy, the Progressive Policy Institute, the American Electronics Association, the Center for Digital Government, the University of Minnesota's Hubert Humphrey Insitutet of Public Affairs, the Milken Institute, Southern Growth Policies Board and the . See Tables 2-3 through 2-5 for a graphical depiction of state ranking summaries

U.S. Department of Commerce [9]
In a study published in June 2000, the U.S. Department of Commerce, Office of Technology Policy provided information on state and regional technology infrastructure for the 50 states plus the District of Columbia and Puerto Rico ((See Figure 2-1). Researchers created rankings for 37 variables thought to measure important dimensions of technology infrastructure. The variables were classified as related to five major categories of funding in-flows: human resources, capital investment and business assistance, technology intensity of the business base and outcome measures. For those variables requiring a specification of high-tech industry, the study used an earlier version of the BLS industry codes discussed above.

No overall index of ratings was prepared. However, Oklahoma's performance in this rating system is indicated by noting the number of variables by rank quintile, with the highest rankings treated as the first quintile.

First quintile	2 variables
Second quintile	5 variables
Third quintile	12 variables
Fourth quintile	11 variables
Fifth quintile	6 variables

Although there is no way of weighting the variables, Oklahoma was ranked in the bottom two quintiles for 17 variables, while it ranked in the top two quintiles for only seven variables. (Oklahoma received no ranking for one of the variables for which data were not available, i.e. for National Assessment of Educational Progress in Science test scores.)

Oklahoma ranked in the top quintile of the 50 states plus DC and Puerto Rico for two variables related to business formation and early-stage development. These included:

- Average annual amount of initial public offering funds per $1,000 of gross state product, 1997-99 (rank: 7)
- Number of business incubators per 10,000 business establishments, 1998 (rank: 6)

For the following six variables, Oklahoma ranked in the fifth or bottom quintile.

- Expenditures for university-performed R&D per $1,000 of GSP, 1997 (rank: 41)
- Federal obligations for R&D per $1,000 of GSP, 1997 (rank: 42)
- Average number of Small Business Technology Transfer Program awards per 10,000 business establishments, 1996-98 (rank: 44)
- Net formation of technology intensive establishments per 10,000 business establishments, 1996 (rank: 41)
- Average annual earnings per job, 1997 (rank: 43)
- Per capita personal income, 1998 (rank: 45)

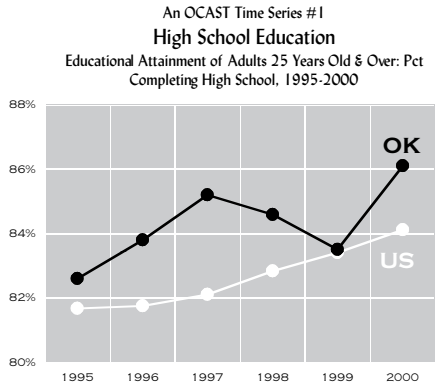
OCAST Analysis

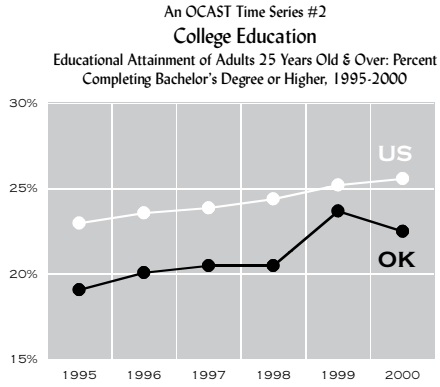
At the request of the Oklahoma Center for the Advancement of Science and Technology (OCAST), the University of Oklahoma's Center for Economic and Management Research developed time series for most of the 1997 variables in the Office of Technology Policy study. The analysis was funded by the Noble Foundation (Ardmore) and the Presbyterian Health Foundation (Oklahoma City).

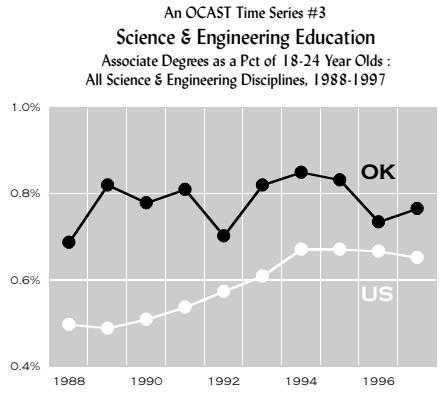
Data were usually collected back to 1990 and forward to 1999 or 2000 for Oklahoma and the United States. This permitted an examination of comparative trends with emphasis on identifying whether Oklahoma has been gaining or losing relative to national norms.

Some of the variables had to be modified slightly to fit available data.

Here are selected observations for the five headings into which the Office of Technology Policy variables were placed. Financial information was adjusted to eliminate the effects of inflation.







FUNDING INFLOWS:

- Total R&D expenditures per capita:

Oklahoma began the decade at 64.4 percent of the national norm and was positioned in 1999 at 70.8 percent.

- Federal academic R&D expenditures per capita:

This variable grew more rapidly for Oklahoma than for the nation during 1990-99. Even with this catching up, the Oklahoma value was 45 percent of the national average in 1999.

- State and local government R&D expenditures per capita:

Nationwide, this variable remained relatively constant during the decade of the 1990s. Oklahoma was far behind the nation in 1990, but well ahead in 1999 - indicating expanded technology development commitment by the state.

HUMAN RESOURCES:

- Percent of adults 25 and over completing high school:

In 1990, three out of four adults were high school graduates both in Oklahoma and nationally. By the end of the decade, the national average high school graduate share was 84.1 percent, while Oklahoma's share was two percentage points higher.

- Percent of adults 25 and over with bachelor's degree or higher:

In 2000, about one-quarter (25.6 percent) of U.S. adults had a bachelor's degree or higher. This represented a gain of 5.3 percentage points during the 1990s. The share of Oklahoma's adult population with bachelor's degrees or above rose from 17.8 percent in 1990 to 22.5 percent in 2000 - a gain of 4.7 percentage points.

- Associate degrees as a percent of 18-24 year-old population:

With its extensive system of two-year colleges, Oklahoma reported a share well above the national ratio throughout the decade, with both shares growing modestly.

- Graduate student enrollment in science and engineering as a percent of 18-24 year-old population:

Nationwide, there was a slight increase in this share during 1990-99, while Oklahoma's share declined slightly - ending the decade at 1.3 percent compared to the national share of 1.9 percent.

CAPITAL INVESTMENT & BUSINESS ASSISTANCE:

- Small Business Investment Company funds disbursed per 1,000 population:

In the SBIC program, the federal Small Business Administration invests funds in small start-up businesses to fill the gap between needs and available venture capital. Both nationally and for Oklahoma, this variable grew substantially during the '90s, with Oklahoma close to zero as late as 1993. Except for 1995 and 1996, this program was used less intensively in Oklahoma than in the nation as a whole.

- Initial public offering (IPO) funds per 1,000 employment:

There was an upward trend in this highly erratic variable during 1994-2000 both for Oklahoma and the nation, with Oklahoma matching the national performance in 1999 and 2000.

TECHNOLOGY INTENSITY OF BUSINESS BASE:

- Percent of private employment in high technology industries:

In both Oklahoma and the nation, this variable stood at nearly 10 percent at the beginning of the decade. Nationwide, there was a very slight decline during the decade, while in Oklahoma the share dropped about 2 percentage points. (In order to obtain recent data, it was necessary to use the U.S. Department of Labor's nonfarm payroll series which is only roughly comparable to the County Business Patterns data mentioned previously.)

- Payroll in high technology industries:

At the national level there was significant growth in this inflation adjusted variable - especially between 1994 and 1999. Oklahoma payroll in this sector was virtually unchanged during the decade.

OUTCOME MEASURES

- Patents per 10,000 business establishments:

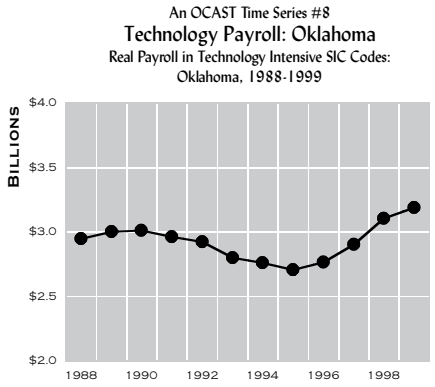
This measure of invention intensity was virtually identical for Oklahoma and the nation in 1990. Between 1990 and 1998, the national trend for this variable was upward by 52.2 percent, while the Oklahoma trend was downward 24.6 percent. In 1998, the figure for Oklahoma was 64 while the national figure was 131.

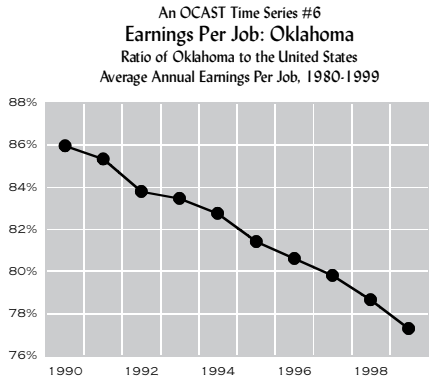
- Ratio of OK to U.S. avg annual earnings per job:

The trend for this variable (1990-99) was steadily downward - dropping from 86 to 77 percent and indicating a failure of Oklahoma earnings to rise as rapidly as the national average.

- Labor force participation rate:

This is a measure of the share of the population 16 and over that is economically active, i.e. is either at work or looking for work. During





the halcyon days of the energy boom (1981-86) the Oklahoma participation rate matched or was above the nationwide average. With the collapse of the boom, Oklahoma's rate dropped below the U.S. and in 2000 stood at 63 percent compared to the nation's 66 percent.

- Ratio of Oklahoma to U.S. PCPI:

During the first four years of the period 1990-2000, Oklahoma's variable hovered around 83 percent. From 1993 through 2000, the variable declined from 83.3 percent to 79.2 percent-a drop of 4.1 percentage points.

Arguably, the most important of the trend variables is immediately above, i.e. ratio of Oklahoma to U.S. per capita personal income. Oklahoma's relative per capita income position slipped 4.1 percentage points during 1993-2000, reflecting the fact that the state's per capita income (not inflation-adjusted) grew 30.0 percent and the U.S. figure grew a more rapid 36.6 percent. At the same time, Oklahoma's nonfarm wage and salary employment grew about 19 percent. This was almost exactly the same rate as the employment expansion nationally.

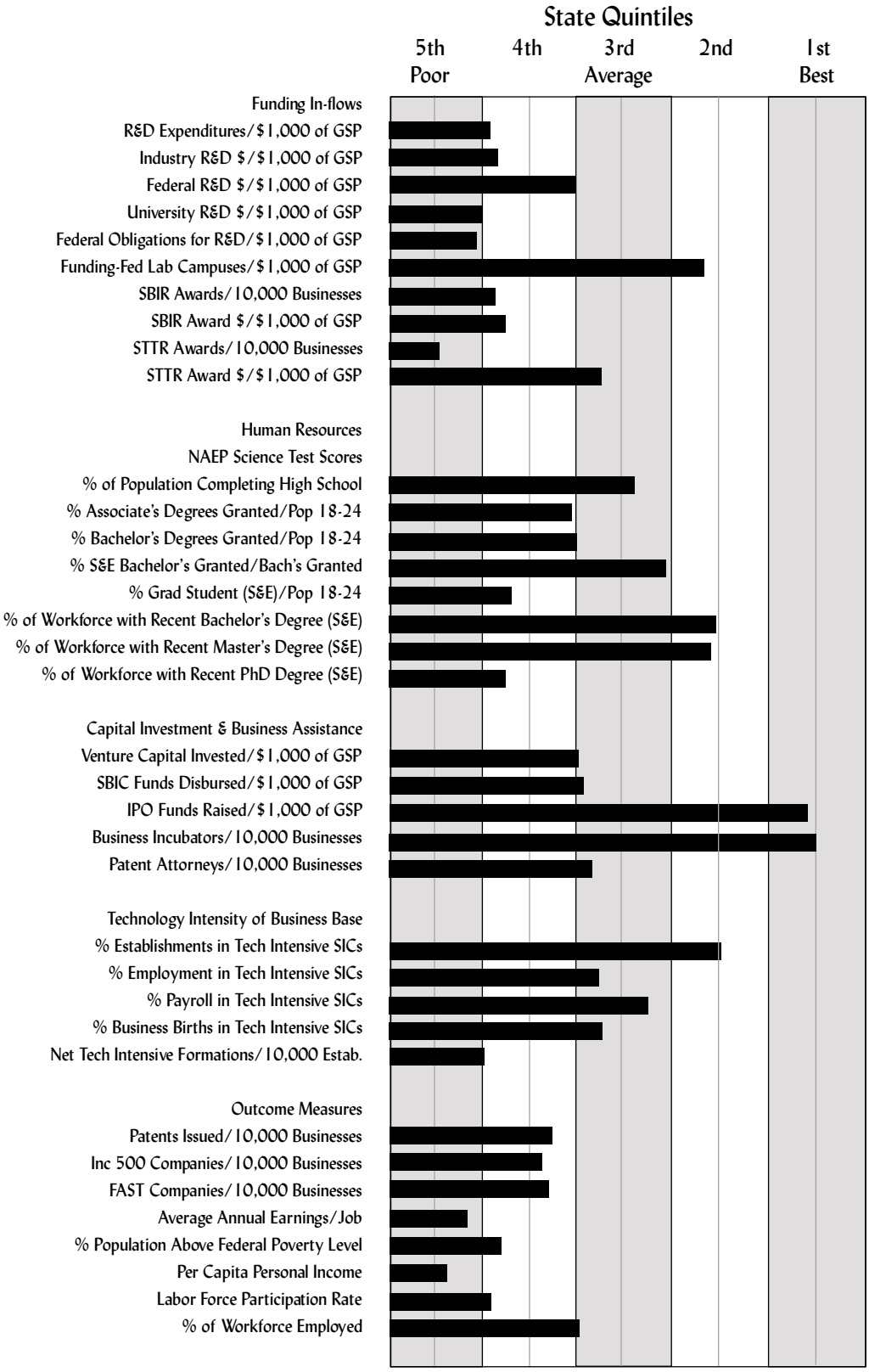
The other trend variables derived from the Office of Technology Assessment study need to be interpreted within the context of these comparative income and employment trends.

Positive Trends:
Oklahoma's most positive trend variables relate to educational achievement, i.e. the higher than average high school attainment, the favorable position with respect to the incidence of people with associate degrees, and the tentative conclusion of catching up to the nation in percent of adults with baccalaureate degrees and above. Also positive is the state's apparent commitment to increased state government spending on R&D. This, no doubt, reflects the commitments from the Oklahoma Center for the Advancement of Science and Technology and the use of state resources for R&D within the state's system of higher education.

Other Trends:
Obviously, the employment expansion in Oklahoma was not generating as great an increase in income as was the case nationally. This is consistent with the observations concerning the unfavorable comparative behavior of the two critical variables, percent of private employment in high-technology industries and payroll in high technology industries. It is also consistent with the state's relatively low R&D expenditures per capita, falling labor force participation rate, failure to keep pace in patents granted and falling relative position with respect to earnings per job.

Figure 2-2

Oklahoma Rankings [9]



Source: Office of Technology Policy, U.S. Department of Commerce, Published in June 2000

Progressive Policy Institute (PPI): Oklahoma ranked 40th among the 50 states ...

	State	Score
1	Massachusetts	82.3
2	California	74.3
3	Colorado	72.3
4	Washington	69.0
5	Connecticut	64.9
6	Utah	64.0
7	New Hampshire	62.5
8	New Jersey	60.9
9	Delaware	59.9
10	Arizona	59.2
11	Maryland	59.2
12	Virginia	58.8
13	Alaska	57.7
14	Minnesota	56.5
15	Oregon	56.1
16	New York	54.5
17	Texas	52.3
18	Vermont	51.9
19	New Mexico	51.4
20	Florida	50.8
21	Nevada	49.0
22	Illinois	48.4
	U.S. Average	48.1
23	Idaho	47.9
24	Pennsylvania	46.7
25	Georgia	46.6
26	Hawaii	46.1
27	Kansas	45.8
28	Maine	45.6
29	Rhode Island	45.3
30	North Carolina	45.2
31	Tennessee	45.1
32	Wisconsin	44.9
33	Ohio	44.8
34	Michigan	44.6
35	Missouri	44.2
36	Nebraska	41.8
37	Indiana	41.0
38	South Carolina	39.7
39	Kentucky	39.4
40	**Oklahoma**	**38.6**
41	Wyoming	34.5
42	Iowa	33.5
43	South Dakota	32.3
44	Alabama	32.3
45	North Dakota	29.0
46	Montana	29.0
47	Louisiana	28.2
48	West Virginia	26.8
49	Arkansas	26.2
50	Mississippi	22.6

Progressive Policy Institute (PPI)

The PPI is a spinoff organization of the Democratic Leadership Council. It has published *The State New Economy Index* [10] (See Figure 2-3). The purpose of this 1999 study is to identify key differences in the structural foundations of state economies as they relate to the degree of adaptation to the New Economy.

State scores and rankings were reported for 17 variables related to the New Economy classified under five main categories: knowledge jobs, globalization, economic dynamism and competition, the transformation to a digital economy and technological innovation capacity.

Overall state rankings were developed on the basis of a system of weighting the values for the 17 variables. Oklahoma ranked 40th among the 50 states, while Massachusetts and California were at the top of the distribution, and Arkansas and Mississippi were at the bottom. Oklahoma ranked particularly high (3rd nationally) with respect to the value of initial public stock offerings as a share of gross state product in 1997.

For nine of the 17 variables, Oklahoma's rank was within the fourth quintile of the states. The two worst rankings for the state were the percentage of a state's workforce employed by foreign companies (43rd) and an index measuring the intensity of the use of technology in the classroom (50th).

In April 2001, the Progressive Policy Institute released another study using essentially the same methodology applicable to the nation's largest 50 Metropolitan Statistical Areas (MSAs). [11] Oklahoma City was included in the analysis, but Tulsa did not make the cut. Oklahoma City's overall rank as a New Economy MSA placed it 39th from the top.

MSAs in neighboring states with higher rankings included:

Austin	2
Denver	7
Dallas	12
Kansas City	24
St. Louis	27

Only San Antonio (49th) among the MSAs in surrounding states was ranked below Oklahoma City. The city exhibited favorable performance with respect to the incidence of managerial-professional-technical jobs, work force education, and the frequency of initial public offerings (IPOs). Particularly low was the city's comparative involvement in manufacturing exports.

Cyberstates
During the period 1994-2000, Oklahoma experienced a comparatively low rate of high-tech employment expansion. Its growth of 20 percent placed it 38th among the states and DC - below the expansion rates experienced in neighboring Kansas (76%), Colorado (72%), Texas (52%), New Mexico (43%), and Arkansas (21%).

Total High-Tech Employment
Oklahoma s annual Cyberstates rankings among the 50 states and DC:

1994 - 28
1995 - 28
1996 - 28
1997 - 29
1998 - 29
1999 - 32
2000 - 33

Cyberstates

Cyberstates: A State-by-State overview of the High-Technology Industry [12] is a rating system prepared by the American Electronics Association (AEA) in association with the Nasdaq Stock Market (See Figure 2-3). The AEA is a trade association of electronics and information technology companies. Critical to the study is the specification of 45 4-digit SIC industry codes applicable only to the electronics and information technology sector. These are referred to as "high-tech.,,

The report combines the 45 industries into nine manufacturing categories, one communications services category and three categories of "software and computer-related services.,, In terms of 1999 employment, Oklahoma ranked 37th among the 50 states and the District of Columbia in high-tech manufacturing, 23rd in communications services and 33rd in software and computer-related services. In that year, Oklahoma ranked 29th in total nonfarm wage and salary employment. The state's high-tech sector employment rank was more favorable than its overall employment rank in five of the manufacturing categories: photonics (18), electromedical (24), computers and office equipment (26), consumer electronics (26) and defense electronics (26).

Thirty-six percent of the state's total high-tech manufacturing employment (7,680) was in the six SIC industries included in the computers and office equipment manufacturing category. High-tech employment levels in the largest states were vastly greater than in Oklahoma. For example, the top ten states in high-tech manufacturing employment averaged 127,171 employees, or 16 times Oklahoma's level. With 26,851 jobs in high-tech services, the state was still well behind the average for the top ten states (184,420).

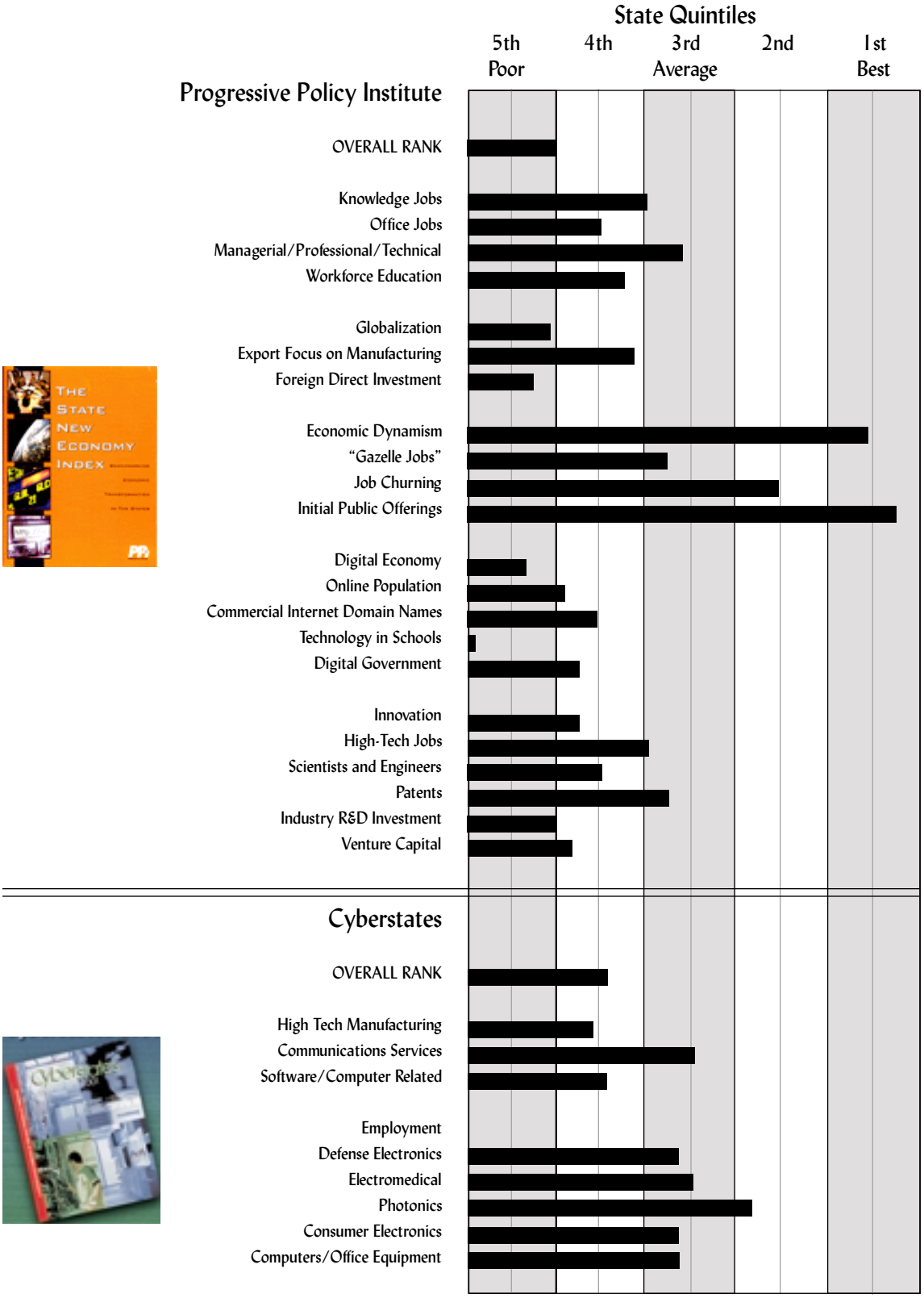
During the period 1994-2000, Oklahoma experienced a comparatively low rate of high-tech employment expansion. Its growth of 20 percent placed it 38th among the states and DC. It was also below the expansion rates experienced in neighboring Kansas (76%), Colorado (72%), Texas (52%), New Mexico (43%) and Arkansas (21%). During 1994-2000, Oklahoma slipped in its relative position as a place of total high-tech employment.

The AEA report also ranked states using other variables indicative of high-tech intensity. Oklahoma's high-tech workers were among the lowest-paid high-tech workers, with annual average 1999 wages of $41,873 placing the state's rank at 42nd. This low ranking was due to Oklahoma's relatively low overall wage level, but was also related to a lower-than-average differential between the high-tech wage level and overall wages. At $154 per capita in 1998, Oklahoma's R&D expenditure level placed it 45th among the states and DC. Ignoring DC because of its concentration of federal outlays, the average R&D per capita for the top ten states was $1,740.

Figure 2-3

Oklahoma Rankings

10, 12



Digital States
Oklahoma s overall rating as a digital state was relatively low (44th) in the 1999-2000 study ... only for taxation/ revenue did the state appear as a leader.

Taxation/Revenue
The ability of taxpayers to obtain information, submit returns and correspond with revenue authorities online, and the ability of states to use digital technologies to store and retrieve taxpayer information.

Electronic Commerce
The availability of regulations, forms and online assistance, and the ability to submit required paperwork using the Internet.

Law Enforcement and the Courts
The utilization of digital technologies by the judicial system, including online access to court opinions, the use of digital communications by police agencies and the availability of digital signature capability for contracts and filings.

Social Services
The availability of online information regarding program eligibility and application procedures and the application of digital technologies such as electronic benefit transfer (EBT) systems and smart cards for benefits delivery.

Education
The utilization of digital technologies for educational purposes, including providing students and teachers with computers and access to the Internet and administrative functions like admissions, financial aid and course registration.

Digital Democracy
The application of digital technologies to permit Internet access to laws, government officials and other sources of information on the functions of various branches of government.

Management/Administration
The adoption of new information technologies with applicability across programs and agencies, and investment in long-term information technology infrastructure.

2000 Digital State Survey [13]

The purpose of this study is to measure the extent to which information technology is being used by state governments to achieve efficiency and to provide better services to the public. This was prepared by The Center for Digital Government, along with the Progress & Freedom Foundation and Government Technology magazine (See Figures 2-4 & 2-5).

The study is limited to government and does not apply to private sector characteristics. In this ongoing rating system, states are surveyed in eight major areas of government function. The Oklahoma rankings are listed below:

• Taxation/Revenue	2nd
• Electronic Commerce	28th
• Law Enforcement/Courts	38th
• Social Services	42nd
• Higher Education	42nd
• Digital Democracy	44th
• K-12 Education	46th
• Management/Administration	48th
Overall	**44th**

Dimensions of information technology that are used to evaluate a state's performance include such features as ease with which citizens can use the internet to obtain information about state policies, regulations, laws, and statistics. It is important for a high rated state to provide downloadable forms and to provide the ability to file reports and requests for permits and licenses via the internet. Communication with personnel via the internet should be feasible. Also important is the degree to which agencies communicate easily with each other via information technology systems.

Oklahoma's overall rating as a digital state was relatively low (44th) in the 1999-2000 study. The state ranked within the fifth quintile or on the 4th-5th quintiles border in seven of the eight categories. Only for taxation/revenue did the state appear as a leader. For that category, Oklahoma achieved a ranking of 2 along with Alaska, New Jersey, Pennsylvania, Washington and Wisconsin. The state's ranking of 46 for the use of information technology in K-12 education placed it ahead of only Alabama, with no rating at all for Rhode Island.

Editor s Comment:
One parameter of this assessment is management and administration . The operation of Oklahoma s OneNet has achieved significant attention as a national model for a state public digital network. This seems to be the exact criteria for management and administration . Nevertheless, Oklahoma is ranked only 48th. It leads one to speculate about the underlying methodology and mesurement tools.

Figure 2-4

2000 Digital State Survey[13]

Final Rankings

Rank	State	Points
1	Washington	93.0
2	Kansas	89.0
3	Alaska	84.1
4	Illinois	81.5
5	Utah	80.1
44	Oklahoma	47.1
46	Vermont	42.3
47	North Dakota	41.1
48	New Mexico	40.4
49	Alabama	35.3
50	Rhode Island	30.9

Higher Education

Rank	State	Points
1	Kansas	100.0
1	South Dakota	100.0
3	Arizona	93.3
3	Montana	93.3
3	Utah	93.3
42	Oklahoma	40.0
46	New Hampshire	26.7
47	Minnesota	13.3
48	New Mexico	6.7
48	Vermont	6.7
n/a	Rhode Island	n/a

K-12 Education

Rank	State	Points
1	South Dakota	100.0
2	Illinois	94.4
2	Tennessee	94.4
2	Washington	94.4
5	Arizona	88.9
46	Minnesota	38.9
46	Montana	38.9
46	Oklahoma	38.9
49	Alabama	27.8
n/a	Rhode Island	n/a

Digital Democracy

Rank	State	Points
1	Arizona	100.0
1	Washington	100.0
3	Idaho	90.5
3	Kansas	90.5
3	Minnesota	90.5
44	Oklahoma	42.9
44	Vermont	42.9
47	Delaware	38.1
48	Montana	33.3
48	New Mexico	33.3
50	Hawaii	23.8

Taxation/Revenue

Rank	State	Points
1	Kansas	100.0
2	Alaska	94.4
2	New Jersey	94.4
2	Oklahoma	94.4
2	Pennsylvania	94.4
44	Kentucky	44.4
47	Hawaii	33.3
48	Arizona	27.8
48	Tennessee	27.8
48	Wyoming	27.8

Management/Admin

Rank	State	Points
1	Washington	100.0
2	Illinois	97.0
3	Michigan	93.9
4	Alaska	90.9
4	Arizona	90.9
46	North Dakota	45.5
46	Wyoming	45.5
48	Oklahoma	42.4
49	Connecticut	39.4
50	Alabama	33.3

Law Enforcement

Rank	State	Points
1	Georgia	95.2
2	Pennsylvania	90.5
2	Utah	90.5
4	Maryland	85.7
4	New Jersey	85.7
38	Oklahoma	38.1
44	Mississippi	33.3
47	North Dakota	28.6
47	California	28.6
47	South Dakota	28.6
50	Rhode Island	14.3

Social Services

Rank	State	Points
1	Washington	100.0
2	Kansas	88.9
3	Utah	74.1
4	New Jersey	70.4
5	Alaska	66.7
42	Oklahoma	25.9
42	Rhode Island	25.9
48	Alabama	22.2
48	New York	22.2
50	Indiana	14.8

Electronic Commerce

Rank	State	Points
1	Georgia	90.9
2	Alaska	87.9
3	Kansas	81.8
3	Kentucky	81.8
3	Washington	81.8
28	Oklahoma	54.6
46	California	27.3
46	Rhode Island	27.3
48	Vermont	24.2
49	Hawaii	21.2
50	Alabama	15.2

Source: The Center for Digital Government , 2000 Digital State Survey, Sacramento CA, 2000.

Milken Institute Rankings

	State	Score
1	Massachusetts	92.3
2	California	85.5
3	Connecticut	83.7
4	Colorado	82.7
5	Washington	79.0
6	Maryland	78.2
7	New Jersey	74.7
8	New York	74.5
9	New Hampshire	71.2
10	New Mexico	70.5
11	Delaware	69.8
12	Utah	68.8
13	Virginia	68.0
14	Oregon	67.0
15	Vermont	64.3
16	Texas	63.3
17	Rhode Island	62.0
18	Arizona	60.8
19	Georgia	59.8
20	Minnesota	59.3
21	Illinois	58.5
22	Pennsylvania	57.2
23	Michigan	55.3
24	North Carolina	53.8
25	Florida	52.3
26	Ohio	48.0
27	Idaho	47.3
28	Missouri	47.0
29	Kansas	42.5
30	Wisconsin	42.5
31	Hawaii	42.0
32	Tennessee	41.5
33	Alaska	40.3
34	Alabama	40.2
35	Maine	37.8
36	Montana	37.0
37	Nevada	34.8
38	Indiana	34.0
39	South Carolina	32.3
40	**Oklahoma**	**31.2**
41	North Dakota	30.2
42	Nebraska	30.2
43	Iowa	29.2
44	Wyoming	27.7
45	Louisiana	27.5
46	Kentucky	24.8
47	Mississippi	23.5
48	South Dakota	19.5
49	West Virginia	16.3
50	Arkansas	10.0

The Milken Institute

The Milken Institute has published "America's High-Tech Economy,, [14] (See Figure 2-5). It reflects a substantial, theory-based research effort whose main purpose is determining the extent to which individual high-tech industries contribute differential rates of economic growth of metropolitan areas (MSAs). Also of interest is the contribution of high-tech industries to overall national economic growth and whether high-tech specialization involves increased economic instability.

The 1999 Milken report takes the position that technological innovation is responsible for a significant share of the recent uptick in productivity growth. Although high-tech information technology, in the aggregate, probably dampens the business cycle because of much more rapid inventory adjustment, the high-tech sectors themselves are quite volatile. Thus, when an MSA concentrates in high-tech, it may face greater cyclical risk.

This study focuses only on 315 MSAs rather than on whole states because the bulk of high-tech related development is in these large urban areas. The report notes that geographic clustering or agglomeration characterizes the growth of high-tech industries. Several features are at work. Larger installations may achieve lower costs through plant-level economies of scale. In addition, similar enterprises locating in the same urban area experience externalities that also reduce unit costs. These externalities result from the existence of a large, specialized labor market; from supplier networks; and from firms acquiring technology information from each other through informal networks. This means the development of technology production centers or "Tech-Poles,,, MSAs that "pull,, high tech activities into their domains. In recent years, high-tech manufacturing has become less spatially concentrated, while high-tech services have become more concentrated.

The Milken Institute uses a process similar to that of the BLS to identify high-tech. Fourteen three-digit SICs are specified as high-tech, ten of which are identical to those determined by the BLS to be "high-technology intensive,, (Table 1). Two more Milkin study industries, medical equipment (SIC 384) and engineering and architectural services (SIC 871) are from the BLS list of "other high-technology industries.,, Industrial chemicals (SIC 281, 286) are included in the BLS list of high-technology intensive SICs, but excluded from the Milken list, while Milken includes, but the BLS excludes, telephone communications services (SIC 481) and motion picture production and allied services (SIC 781).

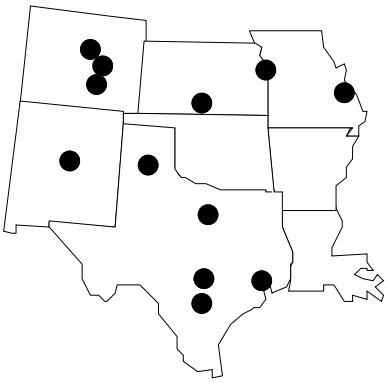
Using econometric techniques, the Milken study concludes that 65 percent of the output differential between MSAs during 1990-98 can

be explained by initial high-tech density and relative growth in the high-tech sector.

The San Jose MSA (Silicon Valley) is the nation's most important Tech-Pole, while Dallas is rated second, Los Angeles third and Boston fourth. There are several more Tech-Poles in states surrounding Oklahoma. These include Albuquerque, Denver, Austin-San Marcos, Houston, Boulder-Longmont, Kansas City, Lubbock, St. Louis, Wichita, Fort Worth-Arlington, Colorado Springs and San Antonio.

Oklahoma MSAs did not rate well in the Milken study. Tulsa and Oklahoma City were ranked 78 and 87, respectively, among the Growth Poles. The other three MSAs were scarcely in the running (Fort Smith, 234; Lawton, 297; Enid, 313).

Milken Institute
No Oklahoma MSA is included in the study s list of the top 50 T ech-Poles . Those in sur rounding states are below:



Also reported were the top ten MSAs in terms of degree of concentration in each of the 14 high-tech SICs. Although MSAs in neighboring states were mentioned a number of times, no Oklahoma MSA was included in this compilation.

It is emphasized that not to be mentioned in the top 10 or the top 50 of the MSAs does not necessarily mean that Oklahoma rates very low; the Milken report simply does not contain enough information to reach a conclusion. In a February 2001 report entitled *Knowledge-Value Cities in the Digital Age*, the Milken Institute includes Tulsa as an "emerging technology city,, with emphasis on the role of The Williams Company in fiber optics.[15]

The 1999 Milken Institute study also examines the cyclical sensitivity of individual high-tech industries - a topic that is of special interest in Oklahoma in 2001. One of the reasons economic development specialists have cited for attracting high-tech activity to a metropolitan area is that these sectors help insulate the local economy from the effects of the national business cycle.

The Milken study's statistical analyses indicate that this assumption is incorrect; these sectors are generally more volatile than the national economy. High-tech manufacturing output is purchased by a wide range of businesses for capital investment purposes and by households for a variety of uses. These purchases are deferrable, and thus are inherently more unstable than many other goods and services.

This instability is affecting Oklahoma's high-tech sectors. With the U.S. economy weakening in the early months of 2001, the large Lucent Technologies plant in Oklahoma City was facing declining demand for its digital switching equipment. The Williams Communications Group in Tulsa was subject to stress resulting from massive excess capacity in the nation's fiber optic cable network and announced in June that as much as 10 percent of its work force might be cut. Moreover, the construction of a Corning, Inc. $400 million fiber optic plant in Oklahoma City was put on hold with uncertainty as to the facility's long-term status.[16]

Figure 2-5

Oklahoma Rankings

13, 14, 8

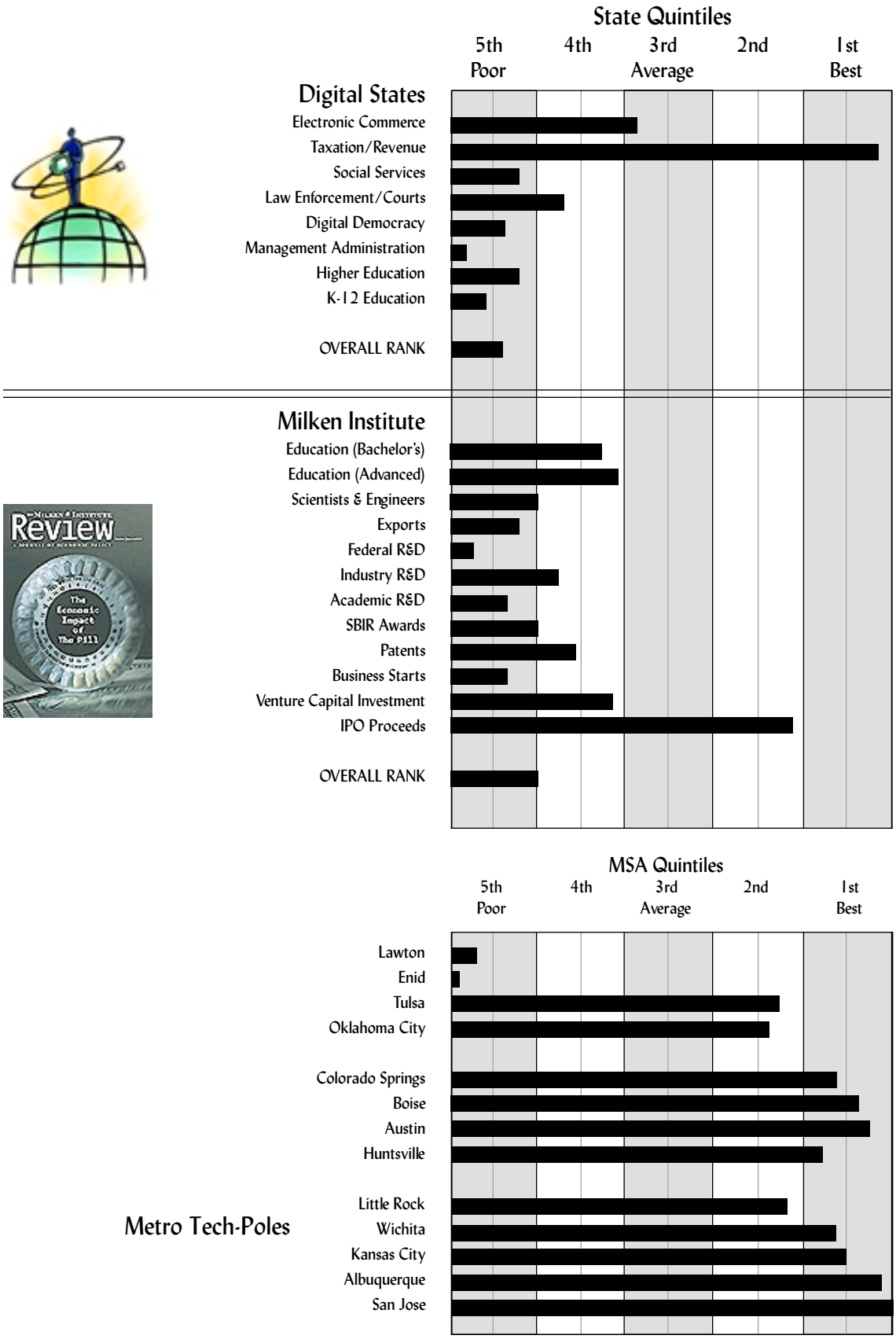


Figure 2-6a

Oklahoma

8,9,12,13,14

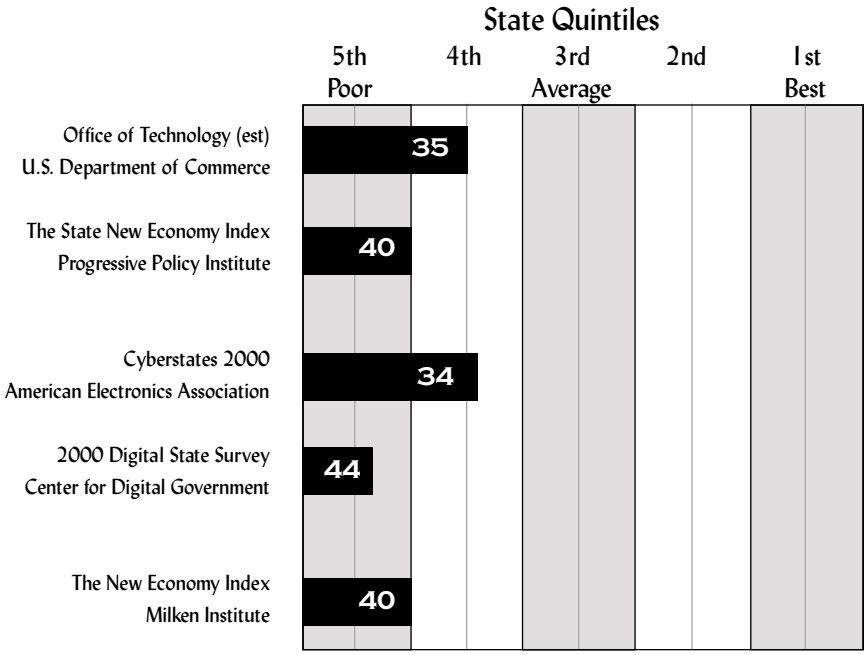
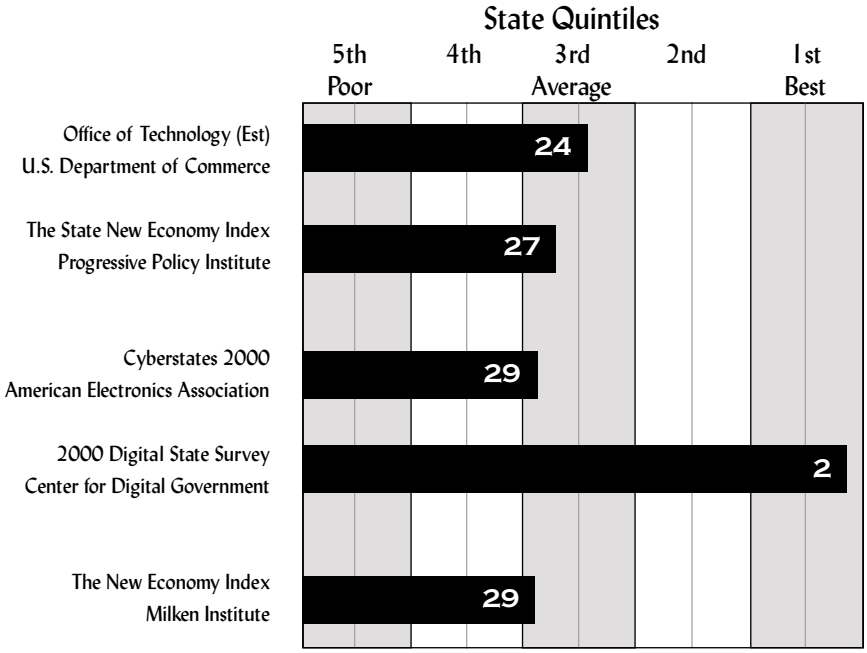


Figure 2-6b

Kansas

8,9,12,13,14



University of Minnesota
Humphrey Institute of Public Affairs

The Humphrey Institute of Public Affairs

(This analysis was released in August 2001. Dr. Warner received this research report several days before our printing deadline. As it is the most recent national analysis available, he insured its inclusion here).

This study produced by the University of Minnesota's Humphrey Institute of Public Affairs focuses on a set of the nation's thirty metropolitan areas that experienced the largest absolute growth in nonfarm employment during 1991-99. Oklahoma's two large metropolitan areas are not big enough to be included in the analysis. Nevertheless, the Humphrey Institute study contains important insights about advanced technologies and the competitive position of metropolitan areas.

The thirty metropolitan areas are ranked in terms of the absolute number of jobs in "high-tech,, industries using an approach similar to that of the Bureau of Labor Statistics described above. It also analyzes the same MSAs with respect to employment in information technology or "I-tech,, industries. Although there is a good deal of overlap, I-tech is not simply a subset of high-tech. For example, included in I-tech are industries providing financial and insurance services because of the intensity with which they hire workers classified in I-tech occupations.

Oklahoma s two large metropolitan areas are not big enough to be included in the analysis. Nevertheless, the Humphrey Institute study contains important insights about advanced technologies and the competitive position of metropolitan areas.

Chicago and Washington, DC, top the list of MSAs in number of high-tech jobs. San Jose (Silicon Valley) and Boston (Route 128) are ranked third and fourth, while New York and Philadelphia are fifth and sixth. Thus three of the top six metropolitan areas are usually thought of as centering on old industrial (Old Economy) cities. In a review of the Humphrey Institute study, Business Week used the headline "Rust Belts? Try Tech Belts,, (Aug. 13, 2001, p. 55).

The growth in MSA employment was not closely related to the number of high-tech jobs during the 1990s. In fact, several of the areas with relatively low concentrations of high-tech employment (e.g. Atlanta, Phoenix) had substantial employment expansion. This led the to the conclusion that "low wage, non high-tech manufacturing jobs and low-tech service jobs may be driving aggregate job gains in many sunbelt cities, while some of the more northerly metros are successfully remaking themselves as high-tech economies.,, Given the poor performance of Oklahoma's per capita personal income during the 1990s, there is reason to suspect that this observation about low wage, low-tech development also applies to the Sooner State.

The Humphrey Institute notes several issues in high-tech development that need further research. Their research does not indicate the degree to which certain groups benefit disproportionately from high-tech development. Who benefits the most-white collar versus blue collar, non-hispanic whites versus minorities, men versus women? How does high-tech development affect the central city/suburban patterns of jobs and residential settlement within a metropolitan area? These distributional issues, often referred to as the emerging "digital divide,,, are just as relevant in Oklahoma as elsewhere.

The Southern Growth Policies Board

The Southern Growth Policies Board has produced a study titled "Invented Here,, [18] (see Figure 2-7). Unlike the preceding five studies on the New Economy, this report has a distinctly regional focus. It is also more closely involved in a strategic planning process. The Southern Growth Policies Board (SGPB) 2001 report on the future of the South was released in June 2001 and deals with the creation of a knowledge-based economic development strategic plan for thirteen southern states and Puerto Rico. Oklahoma state government has been a member of the SGPB from its inception in the early 1970s. The report was developed by a committee of representatives from each of the states.

Southern Growth Policy Board
In fact, life quality appears to be the bottom line in the SGPB s planning process as illustrated by the following: It is an exemplary quality of life that is desired, not money itself, not possessions, but a quality of life.

Throughout 88-pages, there is no specific use of the term "New Economy,,. Nevertheless, the philosophy clearly reflects a paradigm shift in economic development. For example, the SGPB refers to "the next economy,, in contrast to the traditional southern strategies of seeking to attract branch plants. This "next economy,, is also the "knowledge economy,, with innovation driven by technology.

Invented Here: Transforming the Southern Economy sets forth a vision for the area's development:

> *All citizens of the South will experience an exemplary quality of life made possible by a dynamic, diversified, growing, sustainable and competitive Southern economy.*

The achievement of three goals is embodied in this vision for the South. The three goals and their subsidiary objectives are listed in Table 2-2.

Goal One involves education and the development of cultural values committed to education. Goal Two encourages innovation and entrepreneurship to generate business and economic development. Goal Three emphasizes the importance of quality of life.

Southern Growth Policy Board
It is anticipated that each state will develop its own set of ten-year targets for each of the SGPB s benchmarks. The SGPB will then publish an annual report reviewing the region s progress with respect to the benchmarks.

The process by which the vision/goals are achieved is fleshed out with additional detailed objectives, together with specific quantitative measures or "benchmarks,, that can be used to judge the degree to which individual objectives are achieved at any point in time and the degree to which an area is doing better (worse) over time.

Goal 1 has six objectives and 33 benchmarks;
Goal 2 has four objectives and 23 benchmarks; and
Goal 3 has three objectives and 18 benchmarks.

Benchmark data are reported for the latest available single year for each of the SGPB states and for the United States. Many of the benchmarks are similar to, and in some cases identical with, variables used in the five other studies reviewed above. There is good data coverage for the benchmarks for Goals One and Two, while much of the data for the benchmarks of Goal Three remains to be developed through opinion surveys.

Oklahoma Futures

See Figure 2-8 for a summary of the Five Year Strategic Economic Development Plan for Oklahoma. This Plan was crafted by the Oklahoma Futures, an advisory committee to the Oklahoma Department of Commerce.

From an Oklahoma perspective, it is surprising that none of the benchmarks involve measurement of relative wage rates or relative per capita personal income. These are economic development issues of constant concern in the Sooner state. Instead, benchmarks emphasize education, employment, and quality of life achievement for all racial/ethnic groups in the South. In fact, life quality appears to be the "bottom line,, in the SGPB's planning process—as illustrated by the following: "It is an exemplary quality of life that is desired, not money itself, not possessions, but a quality of life.,, Moreover, since quality of life is subjective, emphasis is placed on benchmarks derived from survey results of attitudes and opinions. Oklahomans would apparently argue that quality of life is directly related to income.

With a small amount of data manipulation, it is possible to compare the SGPB's Oklahoma benchmarks with national benchmarks. Since the data are standardized for population scale, each Oklahoma benchmark can be calculated as a percent of the corresponding national benchmark. Comparable data are available for Goal One (education) for 25 benchmarks; Oklahoma surpasses the nation for 15 of those variables. There are 22 comparable benchmarks applicable to Goal Two (business and economic development), with Oklahoma ahead of the nation in only two instances. There is not enough data reported for Goal Three to make meaningful comparisons.

Thus, the SGPB report contains both good news and bad news for Oklahoma's position as a New Economy state. The state appears to be relatively well-positioned with respect to a significant number of benchmarks relating to educational performance and attainment. On the other hand, Oklahoma's high-tech and R&D activity is sub-par.

CONCLUDING ASSESSMENT

Now that we have reviewed seven different evaluations, let's take another look at the New Economy ... or our "innovative world,,.

State Ranking Mega Summary

CyberStates	*34th*
Office of Technology (est)	*35th*
Progressive Policy Institute	*40th*
Milken Institute	*40th*
Digital States 2000	*44th*

The interstate and inter-metropolitan ratings reviewed above have been undertaken because of the need to better understand geographic differences in participation in the paradigm shift known as the New Economy. At the outset, it was noted that there are skeptics who are not convinced that there has been a sea change in the structure of the U.S. economy. And there is nothing new about emphasis on high-technology industry and economic development. [19] Yet Oklahoma would be making a serious mistake to proceed as though the national economic growth patterns of the '70s and '80s will be replicated in the 21st Century.

Examination of the ranking studies indicates several dimensions in which Oklahoma appeared to be left behind during the 1990s. A boom and bust pattern driven by the "heritage industries,,, oil and agriculture has meant very uneven patterns of economic development over time. Perhaps this instability has slowed the state down over the long haul. High-technology economic development offers the promise of a more stable growth path based on intellectual capital rather than natural resources. It is a path including many components; high-tech development building on human capital can lead to a highly diversified economy.

Figure 2-7

Southern Growth Policies Board

Goals and Objectives for a Strategic Plan for the South

Goal 1:
Create a culture of learning throughout the South, in which the acquisition, creation and application of knowledge is viewed as central to our health, happiness and prosperity.

- Make P-12 education efficient and effective in educating our children.
- Make post-secondary education effective in continually raising the level of educational achievement in the South.
- Elevate the value placed on education and significantly increase the percentage of Southerners actively engaged in the process of lifelong learning.
- Overcome the skill shortages in the following fields: science, engineering, information technology (IT) and math.
- Educate those left behind in the knowledge economy, targeting minorities, immigrants and their children.
- Ensure basic competency in the tools of the information age.

Goal 2
Encourage and support innovation and entrepreneurship.

- Infuse an entrepreneurial culture throughout the South.
- Increase significantly public and private R&D in the South.
- Ensure access to capital and technical and management assistance at all stages of business development, paying particular attention to underserved groups.
- Take advantage of the growing commercial and intellectual potential in the global economy.

Goal 3:
Create and sustain a quality of life that is attractive to globally competitive businesses and employees.

- Use Wise Growth principles to ensure that a high quality of life accompanies economic progress in the South.
- Build on the potential strengths inherent in our cultural diversity by overcoming our historic racial and cultural divisions.
- Increase the South's levels of civic engagement.

Figure 2-8

Oklahoma 5-Year Strategic Development Plan

Prepared and adopted by Oklahoma Futures, 2001

Capital Formation

1. Create a court devoted solely to commercial law with an effective business litigation system to resolve complicated commercial disputes competently and efficiently.

2. Encourage state pension funds to invest a small percent (5% or less) of their assets in such alternatives as private equity and venture capital funds.

3. Adopt a new, simplified, comprehensive state tax code that meets Oklahoma's revenue needs, is grounded on fairness, and gives Oklahoma a competitive advantage in economic development.

4. Clarify the appropriate use and constitutionality of tax increment financing.

Rural Initiatives

5. Provide adequate state funding and support for the health care system in rural Oklahoma.

6. Provide adequate and diverse funding sources for economic development in rural communities.

7. Provide rural Oklahoma with state-of-the-art telecommunications infrastructure and better identification and mapping of existing rural telecommunications assets.

8. Support the continuation and development of the agriculture industry in rural Oklahoma by encouraging more profitable alternative crops and providing tax incentives for value-added manufacturing.

Technology Development

9. Prepare a technology-capable workforce in Oklahoma by providing incentives to keep our best talent in the state and allowing business to participate in developing institutions and curriculums that respond rapidly to the changing needs of technology-intensive companies.

10. Create a unified Oklahoma effort to develop and nurture technology including all organizations with this focus; this effort should provide models for success in the new economy and measure Oklahoma's progress with an "innovation index."

11. Invest in and expand Oklahoma's existing technology clusters to create "centers of excellence" – first class research programs and incentives for technology businesses to invest in research and development.

12. Identify and strengthen sources of public and private capital for investment in new technology initiatives and businesses in Oklahoma.

13. Support the success and expansion of an Oklahoma-headquartered airline that would fly direct from Tulsa and Oklahoma City to major U.S. coastal cities.

Workforce Development

14. Establish a statewide business and education partnership to provide input and recommendations to policy-making bodies. The partnership should have the support of all three state education agencies and include the Governor and the Legislature. It should have some legislated authority, include existing businesses and future growth industries as members, and be permanent rather than ad-hoc.

15. Accomplish a systemic change in Oklahoma's educational philosophy that views business as education's customer and the skilled student as its product.

16. Make Oklahoma competitive in retaining, attracting and expanding an excellent, well-trained faculty for common education.

OKLAHOMA DEPARTMENT OF COMMERCE

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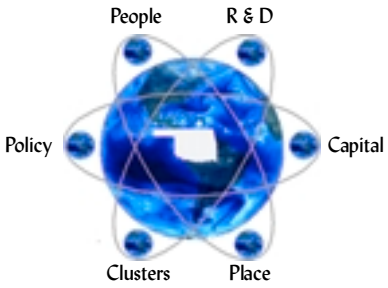
Section 3

Case Studies: Two Industry Sectors and Opportunity in Oklahoma

Kent Olson, PhD and Tabitha Doescher, PhD



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Section 3

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Preface

This section provides two case studies of industry sectors that may offer opportunity in Oklahoma. They are information technology and biotechnology [think stem cells among other things]. We could have used others.

Conventional wisdom says New Economy means high-tech ... and that means computers. In reality, there are dozens of high-tech industry subsectors [see Table 2-1].

For the purposes of this paper, we have selected two important opportunities to explore in depth. They are information technology and biotechnology.

The information technology analysis presents work performed for Oklahoma 21st Century [research affiliate of the Oklahoma State Chamber of Commerce] earlier this year. Town Hall participants may choose to explore other areas such as telecommunications, agriculture or the arts ... or another industry sector.

This section requires extensive statistical analysis. All 23 tables have been included at the Appendix section.

INTRODUCTION

State economic growth is concentrated in metropolitan areas. In fact, 86 percent of the increase in state personal income from 1990 to 1998 occurred in metropolitan areas.[1] The high-tech (HT) sector is responsible for a large part of that growth. According to a recent study by the Milken Institute, changes in the HT sector explain 65 percent of the differences that occurred in Gross State Product (GSP) originating in metropolitan areas from 1990 to 1998. [2] Milken researchers also found that an increase of 1 percent in HT output increased non-HT output by 2 percent. [3] Thus, growth in the HT sector has a strong induced-growth effect on other sectors of the economy.

In this section, we analyze the prospects for developing and applying "information technology,, and "biotechnology,, as growth generators for the Oklahoma economy.

INFORMATION TECHNOLOGY (IT)

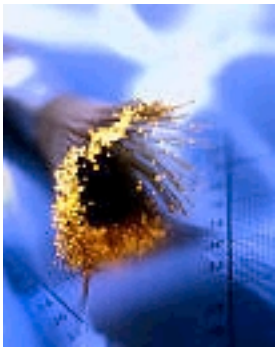
The IT Sector

The IT sector consists of business firms in IT industries. The U.S. Department of Commerce has identified two types of IT industries: those that produce IT goods and services and those that use large amounts of IT in producing other types of goods and services. The IT producing sector contains industries that produce computer hardware and software, communications equipment and services and instruments. The IT using sector consists of the top 15 industries in terms of two measures: IT capital stock as a share of total equipment (net of depreciation), or IT capital investment per employee. Table 3-1 lists both types by SIC Code.

Investment in IT as a share of total capital stock and investment per employee are not fool-proof indictors of the influence of IT on an industry. For example, a recent article in the Atlantic Monthly [4] indicates that the use of IT has greatly enhanced the ability of the Petroleum and Natural Gas industry (SIC Code 13) to find and extract additional oil and gas. This industry does not show up on the list of IT using industries, however, because investment in IT, per se, is still small relative to the investment required in drilling and other equipment.

IT and Economic Growth

There is a growing body of evidence that the IT sector has experienced faster productivity growth than the rest of the economy. According to a recent review of existing studies [5], the IT Sector accounted for 46-74 percent of the acceleration in productivity that occurred in the U.S. economy from 1995 to 1999. The industry data reported in Table 3-2 indicate clearly that IT-producing industries and IT-using goods industries have grown faster than the rest of economy.



The reason that IT has contributed so much to productivity is that IT investments, per se, have been unusually productive. In fact, market conditions dictate that business investment in computer hardware and software must earn very high rates of return. Oliner and Sichel estimate that they must produce gross rates of return of about 68 percent a year to cover estimated real depreciation rates, capital losses and net returns of 30 percent, 34 percent and 4 percent, respectively. [6]

According to Table 3-2, IT-using service industries have grown more slowly than the rest of the economy. This has happened in spite of a large investment in IT by firms in this sector. The apparent failure of IT-using service industries to grow in spite of large outlays for IT has been labeled the "productivity paradox,,.

Economists believe that this paradox largely reflects difficulty in measuring output in many service industries. [7] Given this difficulty, Employment Security Administration economists compared the growth in output per worker of IT-using services industries with that of the non-IT intensive services industries, except for 10 particularly hard-to-measure services industries [8]. They found that IT-using services industries showed greater productivity growth than non-IT intensive services industries when the hard-to-measure industries were excluded.

Given that economic growth depends heavily on productivity growth, it should come as no surprise that IT growth has been an important source of economic growth. According to federal government economists, growth in the IT sector was responsible for 30% of U.S. economic growth from 1995 to 1999. [9]

The benefits of IT growth have been distributed unevenly across the states, however. Which states have been growing the fastest? Which of these are high-IT growth states? Table 3-3 portrays the total growth (in percent) in payroll per capita achieved from 1993 to 1998 in the 10 fastest-growing states (New Hampshire, Minnesota, Massachusetts, South Dakota, Iowa, Utah, Michigan, Oregon, Arizona, Colorado) and Oklahoma. The fastest-growing states are not necessarily high-IT states, however. A high-IT state is one in which growth in the IT sector accounts for a significant share of growth in payroll per capita. The top 10 states according to this measure (Washington, Virginia, California, Colorado, Idaho, Oregon, Texas, South Dakota, New Jersey, Massachusetts) are identified in Table 3-4.

It is clear from comparing Tables 3-3 and 3-4 that high-growth states are not necessarily high-IT states. Accordingly, Table 3-5 combines the measures of growth in payroll per capita and the share of growth in payroll per capita attributable to IT growth, to produce a list of the top 7 high-growth and high-IT states. The states in Table 3-5 are ranked in terms of combined rank; that is, the sum of the ranks in terms of payroll per capita increase and IT share of increase in payroll per capita. South Dakota has the number one spot because its sum of the two ranks -12- is the lowest. It is followed by Massachusetts, Oregon,

Colorado, New Hampshire, Minnesota, and Texas. The list is truncated at 7 states because there is a significant gap in the combined rank of Texas and the next five states: Georgia, Arizona, Utah, Connecticut, and Washington. Oklahoma fared poorly in terms of both measures; its total rank score of 78 was higher (worse) than 44 other states.

The Six Components of State IT Growth

[Ed. Note: Milken lists six ingredients for growth, below. They are similar to the six key elements in our Section 1 that were absracted from several bodies of work. Different authors wordsmith differently. Do not be distracted with this anomaly].

In the end IT-led growth seems like such an alluring prize that most states are interested in seeking it. In fact, several have launched aggressive efforts to do so, in spite of the fact that there is little hard evidence on what really works. Successful models of IT growth in metropolitan areas suggest, however, a handful of ingredients that are necessary if a state is to be successful in catching the IT growth wave.

According to the Milken Institute [10], IT growth requires:

- development of an IT cluster
- a basic research capability,
- the availability of venture capital
- an educated/skilled workforce
- quality of life, and
- competitive business costs.

IT clusters are more likely to form in areas with a pre-existing concentration of IT firms. IT clusters are also more likely to form in metropolitan areas than in non-metropolitan areas.

Clusters are agglomerations of interrelated industries and supportive public institutions and private associations that foster wealth creation in a region, principally through the export of goods and services outside the region. Industry clusters are geographic concentrations of sometimes-competing, sometimes-cooperating firms, and their related supplier network. Supportive public institutions include research facilities, educational institutions and political leadership at all levels. Private associations include trade associations and other business-oriented groups.

IT clusters are more likely to form in areas with a pre-existing concentration of IT firms. IT clusters are also more likely to form in metropolitan areas than in non-metropolitan areas. The presence of facilities engaged in cutting-edge research is an essential ingredient of sustainable IT-led growth. High-tech regional clusters such as Austin, Texas, and California's Silicon Valley are primary examples of areas energized by the work of top scientists and researchers, and of workforces bolstered by new college graduates.

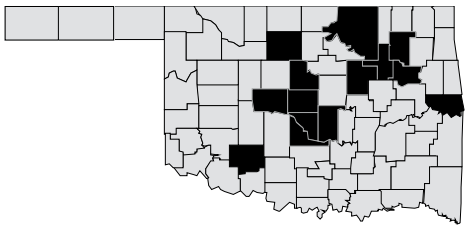
Venture capital is essential in financing the innovation and technology transfer that must occur if the findings of the research laboratories are to be commercialized. Access to a trained/educated workforce is required to fuel the growth of what are essentially knowledge-intensive industries. A good quality of life is essential to recruit and retain this kind of workforce. Low "costs of doing business,, can be a factor in the competition for IT producing firms.

Component 1

IT PRESENCE (CLUSTER)

Table 3-6 contains two measures of the degree of IT presence in the economies of the Top7 states and Oklahoma, drawn from rankings provided by the American Electronics Association (Cyberstates 1999, Washington, DC, 1999) and the Corporation for Enterprise Development (CFED - Development Report Card for the States 2000, Washington, DC, 2000). Each of the Top 7 states ranks highly in terms of share of the workforce engaged in the IT sector. All except South Dakota rank highly in terms of technology companies as a percent of total companies. Oklahoma fares well in terms of technology companies, but not in terms of IT workers. Table 3-7 helps to explain the latter; Oklahoma has a relatively high concentration of workers in only 2 of the 10 IT industries represented. Alternatively, Table 3-7 may indicate that Oklahoma has a comparative advantage in the manufacture of computers and office equipment and/or communications equipment and that its prospects for developing an IT cluster are better in these areas.

Oklahoma s Metropolitan counties



As noted in Section 2, Milken Institute researchers indicates that high-tech growth is primarily a metropolitan phenomenon. [11] Accordingly, they rank 315 of the nation's metropolitan areas in terms of their high-tech growth potential (the reader is reminded that Milken's high-tech sector includes IT-producing and other industries, especially pharmaceuticals). Their "tech pole,, indicator, illustrated in Table 3-8 for selected cities in the Top 7 states and Oklahoma, combines measures of output concentration and recent rates of high-tech growth. Every one of the Top 7 states, except South Dakota, has at least one metropolitan area in the top 15 percent.

Oklahoma has five metropolitan areas: Oklahoma City, Tulsa, Fort Smith AR/OK, Lawton, and Enid. Oklahoma City and Tulsa appear to be the best prospects as locations for high tech growth among the five, according to the Milken measure, ranking 78 and 87, respectively; Fort Smith, Lawton, and Enid were ranked only 234, 297, and 313, respectively.

In fact, Tulsa was featured as a promising technology center in a February 2001 report released by The Milken Institute (Knowledge Value Cities in the Digital Age, Santa Monica, CA, February 13, 2001, pp. 63-67). The authors cited the city's concentration of high-tech workers, its low commercial rental rates, low-priced downtown art deco buildings, and lifestyle amenities that appeal to family-oriented workers.

Tulsa isn't perceived by the Milken authors as an exciting place to live, however, for single "techies,,. They also downgrade the city for its relatively homogeneous population, its "bible-belt,, location and its poor air transportation connections.

Component 2

RESEARCH AND DEVELOPMENT (R&D)

R&D is critical for success in the information technology sector. In 1997, the IT sector accounted for less than 5 percent of the U.S. private workforce, but 41 percent of total industry R&D.[12] Table 3-9 presents state-level measures of money available for research in the Top 7 states and Oklahoma. The column labeled "Total R&D Expenditures Per Capita,, is the average of the three preceding columns. These data do not indicate a strong research presence, except for Massachusetts, Colorado and New Hampshire. The data lump together all types of research support - there are no state-level data that provide a separate accounting of R&D expenditures in the IT sector - but we believe that the rankings for Massachusetts and Colorado reflect a large dose of IT research. We also expect that R&D for IT would weigh more heavily in the other states, with the exception of South Dakota, if IT-specific data were available.

Component 3

VENTURE AND RISK CAPITAL

Risk capital is a vital resource for the development of the IT sector. In fact, the IT sector is the nation's largest user of venture capital, accounting for nearly two-thirds of all venture capital investment in 1999. [27] Table 3-17 shows how the top 7 states and Oklahoma compared to all states in terms of venture capital and SBIC funding in 1998-1999. Venture capital and SBIC funding were relatively more important in all of the top 7 states, with the exception of South Dakota. Venture capital was particularly scarce in Oklahoma.

Component 4

EDUCATIONAL ATTAINMENT

Table 3-10 presents indicators of educational attainment. The measure of high school attainment used here does not seem to be closely related to IT-led growth. College attainment, however, appears to be more closely related to IT-led growth, with the exception of South Dakota. The college-IT connection is especially strong for Massachusetts, Colorado and New Hampshire.

What students learn may be more important than whether they graduate. Student knowledge in science is especially important in an IT environment. According to scores on the National Assessment of Educational Progress exam in Science given in 1996 to high school students, students in Minnesota, Massachusetts, Colorado, Oregon and Texas, ranked 5th, 8th, 12th, 12th and 26th, respectively. The exam was not administered in New Hampshire, Oklahoma and South Dakota.

What students study is also important. The IT sector has a special need for science and engineering students. According to 1996-97 data, only three of the 8 states in Table 3-10 were doing a good job in producing scientists and engineers. South Dakota, Colorado and Massachusetts ranked 3rd, 4th and 13th, respectively, in percentage of bachelors

degrees awarded in science and engineering. Only Massachusetts and Colorado did well in training science and engineering graduate (Masters and PhD) students, ranking 2nd and 5th, respectively, in terms of science and engineering graduate students as a percent of the population aged 18-24.

Oklahoma ranked 39th in the production of science and engineering bachelors degrees and 29th in science and engineering graduate students.

A closer look at the Oklahoma data reveals, in fact, that the number of science and engineering college graduates has not kept pace with the growth of the IT sector. This trend is readily apparent in the numbers presented in Table 3-11. These data suggest, in fact, that Oklahoma may have some difficulty in providing the workers required for a growing IT sector.

IT WORKFORCE [13]

To understand the IT workforce, it is first necessary to understand the business environment faced by IT-producing companies, i.e., computer and data processing companies, IT hardware and software producers, telecommunications companies and so forth. The chief characteristics of this environment are intense competition and rapid technological change. IT products have extremely short life cycles, often on the order of months. Moreover, there is immense pressure to be the first to bring a product to market, in part because early entrants are more likely to capture a large portion of market share and in part because early entrants capture the funds necessary to finance the next generation of products.

In addition, in the area of software development, there are low barriers to entry - a budding entrepreneur needs only a personal computer. As a result, there are a lot of competitors and a lot of different products. Software development is also quite labor-intensive. If a software company wants to accelerate product development, it adds workers.

The proliferation of competing products, the rapid turnover in product lines, the high degree of labor intensity and the intense time pressure in the production of products significantly affect the IT labor force.[14]

First, because of the vast number of products and the high rate of product turnover, companies want workers who are trained in the right skills.

Second, because of the time pressures, companies want to hire workers who already have the right skills and experience - they do not have time to train them. As a result, the IT labor market is not homogenous, but instead consists of numerous niche labor markets, i.e., a wide range of small markets filled with workers possessing specific technical skills, industry knowledge, and experience.

As new technologies come into and spread throughout the marketplace, workers skilled in their usage may come into high demand. Employers may have difficulty finding and recruiting workers with "hot,, technical skills, especially if they are not willing to pay a premium. They may also have problems retaining these workers, especially under conditions of high labor intensity.

IT workers, particularly those in the core IT occupations, receive relatively high wages. However, Oklahoma s IT wages are generally lower than national wages (see Table 3-13).

This kind of business environment has a strong impact on the education and training of IT workers. Because of rapid changes, IT workers must constantly update their skills. They must learn how to use new products on their own or through education and training programs. As a result, IT workers do not tend to follow the traditional path of going to school and then working in a career based primarily on that schooling. Instead, an IT career involves a lot of movement back and forth between the educational system and the work place.

IT workers may also need to adjust often to changes in the level of knowledge and sophistication required to perform particular IT jobs. One aspect of the IT field is that many jobs that once required a high level of education and training are now routine.[15] Continuing education and training provide a way for workers in these types of jobs to adjust.

Finally, the tight labor market, particularly in the niche markets for "hot,, skills, provides numerous opportunities to job hop. Through job-hopping, workers can obtain better jobs (higher pay, better benefits, improved working conditions) and can acquire new skills and additional experience. Enhancing their skills and experience through on-the-job training can help keep these workers in demand.

The development of Oklahoma s IT workforce is heavily dependent on public education. Oklahoma s higher education system and its career and technology (formerly vocational and technical) education system are the state s two publicly-supported pipelines to IT careers.

This dynamic environment affects the institutions that offer IT education and training in two important ways. First, because IT workers need to constantly upgrade their skills, there is a strong demand for IT education and training programs. This demand is enhanced by reluctance on the part of some companies to provide in-house training for existing workers; IT skills are generally transferable between companies, and most companies do not want to train workers for their competitors (however, some companies do view training as a benefit to their workers). Since many IT workers work and attend school (or training programs) concurrently, education and training institutions cannot use only traditional means to meet the need of these students. There is a need for evening and weekend classes and distance learning.

A second way the IT environment affects IT education and training institutions is through its impact on IT faculty. A tight labor market may make it difficult to hire and retain qualified faculty in colleges and universities, in part because faculty salaries tend to be lower than those in industry, and in part because if there are a lot of IT students, the faculty working conditions are not particularly desirable.

Perhaps the most important question about Oklahoma's IT work force is whether there is a mismatch between the supply of and the demand for IT workers. At the national level, the IT labor market is quite tight. Many observers, particularly those representing industry groups, say there is a national shortage of IT workers.[16] Others find no evidence of a true shortage, but do find indications of a tight market, particularly in certain niche labor markets, i.e., those in which the workers are trained in "hot,, technical skills.[17]

Although there is anecdotal evidence of a shortage of IT workers in Oklahoma, an empirical investigation of this issue is not possible: the existing data are insufficient to examine the issue either directly (by assessing supply and demand) or indirectly (by investigating indicators such as occupational wage patterns and occupational vacancy and unemployment rates).18 However, there is some information about Oklahoma's IT work force and Oklahoma's public institution pipelines to IT jobs that may be helpful. DELETE This section examines these data. It should be noted that the work force data are based primarily on the core IT occupations: computer scientists, computer engineers, systems analysts, and computer programmers.

In 1998, there were 18,450 core-occupation IT workers in Oklahoma (Table 3-12). Approximately one-quarter of these workers were computer programmers or programmer aides. Another 19 percent were computer support specialists and 18 percent were systems analysts. The bulk of the remainder were "all other,, computer scientists. Only a small portion worked as database administrators.

The data also show an additional 3,770 workers in non-core computer-related occupations. The majority of these were computer operators (except on peripheral equipment), who generally work on mainframe computers. There were also a small number of data processing equipment repairers, post-secondary computer science teachers and desktop publishing specialists.

IT workers, particularly those in the core IT occupations, receive relatively high wages. However, Oklahoma's IT wages are generally lower than national wages (see Table 3-13). Although there may be cost-of-living differences, or differences in the types of workers in the Oklahoma versus U.S. IT occupational mix, it should be noted that lower wages can make it more difficult to attract and retain good workers.

IT occupations are projected to be among the fastest growing occupations in Oklahoma (1998-2008). [19] For example, four of the top five most rapidly growing occupations in the state are in IT: computer engineers, computer support specialists, systems analysts and desktop publishing specialists. In addition, database administrators and data processing equipment repairers are among the top ten fastest-growing occupations, while computer programmers and post-secondary computer science teachers are among the top 30. Note, however, that the number of annual openings is relatively small (Table 3-12). The

largest number of annual IT openings is 450, for computer support specialists. This stands in sharp contrast to cashiers and retail salespersons, projected to have 2,590 openings and 2,560 openings, respectively.

WORKFORCE DEVELOPMENT

The development of Oklahoma's IT workforce is heavily dependent on public education. Oklahoma's higher education system and its career and technology (formerly vocational and technical) education system are the state's two publicly-supported pipelines to IT careers. In addition to educating and training students for IT jobs, both systems have taken steps to integrate technology into their classrooms and their operations, thereby enhancing the IT literacy of all students. [20]

Oklahoma's colleges and universities provide a broad-based education, offering several IT-related majors (programs). These include, but are not limited to, computer science, engineering with a concentration in computer engineering and business with a concentration in information systems. (Students can also major in an unrelated discipline and take IT classes.) Unfortunately, the only data available are restricted to computer and information sciences.

In 1997-98, nine of Oklahoma's 15 two-year colleges conferred associate degrees in computer and information sciences, while all of the four-year colleges and universities conferred bachelor's degrees in the field. Master's and doctoral degrees were conferred by the comprehensive universities. [21]

As shown in Table 3-14, the state's higher education system conferred 113 associate degrees in computer science, 250 bachelor's degrees, 62 master's degrees and two doctoral degrees in 1998-99. A couple of things are noteworthy in this table. First, the number of degrees in computer science (except doctoral degrees) has risen over the past four years, presumably in response to the tight labor market. The increase has been especially noticeable at the associate level and, to a lesser degree, at the master's level. Taking a longer run view, however, the number of bachelor's degrees conferred in computer science has dropped considerably since the mid-1980s, following a national pattern. This decline has been cited as a possible factor in the tight labor market.

A second item of note is the small number of degrees conferred on doctoral students. These are the people who will be teaching the next generation of IT students (although workers trained in other disciplines can also educate IT students). If the higher education system is not producing enough people qualified to teach IT in the colleges and universities and if the state cannot import them from elsewhere, this will jeopardize the IT work force of the future.

A relatively low proportion of computer science graduates stay in the state, especially at the bachelor's degree level and above. Sixty-two percent of the 1997-98 recipients of bachelor's degrees in computer

science and 53 percent of the recipients of master's degrees were employed in Oklahoma in 1998-99.[22] This is well below the percentages for all recipients, regardless of degree (81 percent for bachelor's and 68 percent for master's). Among those receiving associate degrees, the percentages were much higher; 88 percent of the students receiving an associate degree in arts or sciences and 95 percent of those receiving an associate degree in applied science remained in Oklahoma to work.

Part of the reason for this pattern may be the high proportion of non-resident alien students receiving master's (and doctoral) degrees in computer science; in 1998-99, 79 percent of master's degrees and 50 percent of doctoral degrees went to these students.[23] While there are advantages to educating foreign students who return to their home countries (e.g., it builds up ties which are important in a global economy), if these students do not stay in Oklahoma, they cannot meet the immediate IT needs of the state's businesses.

Oklahoma computer science graduates who stay in the state congregate in a relatively small number of industries. Graduates with associate degrees in applied science tend to work in manufacturing, business services and trade, while those with associate degrees in arts or sciences are found most predominantly in manufacturing and trade. Those with bachelor's degrees are employed in business services and, to a lesser degree, in transportation, communications and public utilities and in trade. Graduates with a master's degree tend to work in business services, manufacturing and mining.

The Careertech system offers several avenues for IT training of both high school students and adults.[24] There are full-time programs ... in business and computer technology, information services, and computer repair and networking.

Salaries of the computer science graduates who stay in Oklahoma generally increase with degree level and generally are higher for more years of experience (Table 3-15). However, doctoral salaries seem low, and the salaries for graduates with bachelor's degrees and with associate degrees in either arts or sciences are inverted. This latter point suggests a tightness, perhaps even a shortage, of graduates with these degrees. It may also indicate that the workers who have been out of school for five years are not updating their skills and do not have sufficient foundation skills to keep advancing in the IT labor market.

IT education in Oklahoma's career and technology system complements that of the higher education system.

The Careertech system offers several avenues for IT training of both high school students and adults.[24] There are full-time programs (for secondary students and adults) in business and computer technology, information services, and computer repair and networking. In addition, there are offerings solely for adults in a wide range of IT subject areas, including computer literacy, database development, digital media, network design and administration, programming and software engineering, technical support, and Web development and administration.

These offerings include open enrollment IT courses offered to the general public at the technology centers and satellite campuses, as well as IT courses offered through Business and Industry Services. Business and Industry training programs include the following: the Training for Industry Programs (TIP), which provide customized training to new and expanding industry at no cost to the company; the Existing Industry Training programs, which provide customized training, at little or no cost, to companies that bring new dollars into the state; and Customized Training, which provides low cost customized training to companies. Although the training that occurs through Business and Industry Services is varied, it frequently includes IT courses.

Much of the career and technology system's current emphasis is on training for IT certifications. All 29 of the state's technology centers offer programs leading to IT certifications. Their offerings differ, but include both vendor-specific and vendor-neutral certifications, e.g., CompTIA's A+, Microsoft Certified Professional and Certified Systems Engineer, Oracle Certified Professional and Certified Novell Administrator.

In FY 1999-2000, there were 5,558 (unduplicated) enrollments in Careertech's three full-time IT programs (Table 3-16). The majority (63 percent) of these enrollments was in the business and computer technology program. Another 26 percent of enrollments were in information services, while the remaining 11 percent were in computer repair. It is especially interesting to note that almost 60 percent of the students in the three full-time programs were adults.

Follow-up data on the full-time IT programs indicate that over 80 percent of the students either continued with their education, or went directly into jobs related to their training. Specifically, 31 percent continued on to higher education, while 51 percent went directly into a training-related job.

Over the same time period (FY 1999-2000), there were 32,619 (unduplicated) enrollments in the Adult and Business and Industry programs (Table 3-16). Sixty-eight percent of these enrollments were Adult (open) enrollments; the remainder were through Business and Industry Services. Unfortunately, at this time, there is no breakdown of the IT program areas being pursued by these enrollees. As a result, it is not possible to tell how many of these enrollees, in particular the adults taking courses through open enrollments, are pursuing either IT certifications or core IT careers. [26]

Component 5

QUALITY OF LIFE

Table 3-18 presents a variety of indicators related to a state's quality of life. Although the indicators encompass many features often purported to be important determinants of business and individual location, it is difficult to discern a pattern between these indicators and IT-led growth. The possible exception might be Colorado, although the most important quality of life factor may be one not in the table; namely, the presence of the Rocky Mountains.

Component 6

TRADITIONAL COST OF DOING BUSINESS

According to the Milken Institute[28], traditional costs of doing business, such as wages, taxes, and electricity, are important determinants of IT development in the early stages of growth for IT manufacturing firms. The data reported in Table 3-19 do not appear to substantiate this claim, with the possible exceptions of South Dakota and Texas. According to these data, alone, Oklahoma should also be enjoying an IT manufacturing boom.

BIOTECHNOLOGY

The Academy Recommended
The Oklahoma Academy recommended major investments in biotech research at the 1998-99 conferences.

What Is Biotechnology?

Biotechnology is not identified by products but by technologies used to make products. Biotechnology is a set of enabling technologies used by a variety of companies in their research, development and manufacturing activities. These technologies have been used primarily by the pharmaceutical industry, but they are being used increasingly by a variety of other industries, such as agriculture, mining, manufacturing and waste treatment.

Biotechnology is a set of techniques that use organisms ... or their cellular, sub-cellular, or molecular components ... to make products or modify plants, animals and micro-organisms to carry desired traits. This includes methods of treating disease based on recent developments in molecular biology and other fields, as well as animal and plant breeding based on centuries-old practices.

Biotechnology enables researchers to isolate, copy and rearrange basic cellular genetic material - DNA - to manipulate the quantity, structure and function of bio-molecules that control cellular processes. Cells and their constituent bio-molecules may be used for a variety of purposes including drug synthesis, food production, and bio-remediation of hazardous waste.

The biotechnology industry serves medical and non-medical markets. The medical market includes human therapeutics and human diagnostics as well as applications in veterinary medicine. Non-medical markets encompass both agriculture and industrial applications.

Over 1,000 U.S. firms now use environmental biotechnology commercially ... the world market is expected to grow dramatically, probably reaching $100 billion in the next few years.

Agricultural applications include making plants and crops pest resistant, improving seed quality, modulating growth and ripening times, enhancing nutrient content of foods and providing simple and inexpensive diagnostics for use in field testing of contaminants and toxic materials. Industrial uses of biotechnology involve many different sectors and include industrial enzymes, waste management, bio-remediation, energy biomass, cosmetic formulations and diagnostics for toxicity determinations. Biotechnology also has promise as a means of sensing toxic compounds and may be a valuable tool in fighting biological terrorism.

The majority of U.S. biotechnology firms are pursuing markets in human health care ...

The majority of U.S. biotechnology firms are pursuing markets in human health care, with a particular emphasis on developing treatments for cancer, acquired immunodeficiency disease (AIDS) and drugs for infectious diseases. Some estimates put the size of this market at nearly $30 billion dollars in 2006. The agricultural market should reach about $2 billion in 2006.

It bears emphasizing, however, that estimates of direct industry output bear little relation to the benefits that biotechnology breakthroughs can provide to society. Cures for diseases can provide benefits in the hundreds of billions of dollars.

The cost of caring for cancer patients, for example, exceeds $100 billion a year. The cost of medical care and lost wages for people with arthritic diseases is estimated at $65 billion; it is almost $40 billion for those with autoimmune rheumatoid diseases. Multiple sclerosis, a neurological autoimmune disease, results in a loss to society of $110 billion (1991 dollars) per 100,000 patients over the course of these patients lives. Medical and social costs of heart disease exceed $110 billion per year.

Biotechnology shows promise in all of these areas. The stake for any state, then, goes far beyond the money and jobs associated with research and development and the manufacturing of biotechnology products.

What is true of biotechnology and disease is also true of biotechnology and agricultural crop and livestock production; that is, biotechnology promises to yield benefits far beyond the research and development and manufacturing of biotechnology products, per se. Biotechnology will enable the world to develop a more abundant, safe food supply while reducing reliance on chemical-based herbicides and pesticides. It will reduce the negative impact of traditional agricultural practices on the environment and conserve soil and other resources.

Over a thousand U.S. firms now use environmental biotechnology commercially, and the world market is expected to grow dramatically, probably reaching $100 billion in the next few years. One of the more promising applications of biotechnology is the use of enzymes and whole-cell bio-catalysts in commercial food preparation and industrial manufacturing.

Another is the development of bio-reagents - biotechnology produced compounds used in chemical reactions to detect, measure, examine or produce other compounds. Biotechnology will also be the source of an increasingly large number of products used to detect chemicals, pathogens and other contaminants in the food supply and the environment. Then there is the emerging new field of bio-informatics - the management and analysis of biotechnology data using advanced computer software and techniques - spurred by projects aimed at mapping the genetic blueprint.

What are the Critical Ingredients for BioTech Growth?

The critical ingredients for biotechnology growth are virtually the same as those required for growth in information technology:

- development of a BT Cluster,
- a basic research capability,
- the availability of venture capital,
- an educated/skilled workforce,
- quality of life, and
- competitive business costs.

The work required to determine the existence and extent of these ingredients in Oklahoma, as was done above for information technology, is yet to be done. There is little reason to expect a different outcome, however, with the exception of the state's basic research capability. We believe that a thorough inventory of research resources available in the universities and private foundations would reveal a good core of research capabilities in medical and agricultural biotechnology. We confirm that to some degree in the analysis that follows.

OKLAHOMA INCENTIVES FOR GROWTH

Oklahoma state government has not yet joined the ranks of the states with an IT or BT strategic plan, but the state has several programs already in place that are related to the determinants of IT and BT growth. The purpose of this section is to review these programs with an eye to determining how much support the state already provides for high-tech growth.

The Academy Recommended
The Oklahoma Academy recommended major investments in University R&D at the 1986, 1990, 1994 and 1998 conferences.

University Research

We noted above the absence of state-level data on total R&D expenditures for IT. There are slightly better state-level data by field of inquiry at doctorate-granting institutions. They are still not detailed enough to determine how much has been spent for IT research. The data reported in Table 3-20 suggest, however, that the money spent on research at Oklahoma State University and the University of Oklahoma has been skewed heavily to support of the life sciences (63 percent). While this may bode well for the development of a biotechnology sector, the small share (perhaps as little as 4 percent) given to IT research does not bode well for the development of the IT sector.

The Academy Recommended
The Oklahoma Academy recommended major investments in University endowed chairs at the 1986 and 1987 conferences.

Endowed Chairs

The State Regents for Higher Education have a program in which state dollars are matched one-for-one with private dollars to fund endowments for academic chairs. Although these positions are not restricted to researchers, much of the money to date has been used to support professors who are heavily involved in research.

Since its inception, the program has produced enough money to endow 160 chairs at an average of nearly $1 million each. In fact, 63 percent of the chairs have an endowment of $1 million or more, as illustrated in Table 3-21. Table 3-22 indicates that the endowed chairs program has also provided considerably more support for building the basic research infrastructure for BT than for IT.

The Academy Recommended
The Oklahoma Academy recommended major increases in OCAST funding at the 1994 conference.

OCAST

The third primary source of state funds for the support of research is the Oklahoma Center for the Advancement of Science and Technology (OCAST). Table 3-23 summarizes OCAST expenditures from 1988-1999. With the exception of basic research in health, OCAST currently focuses on the funding of applied research and technology transfer. It has devoted resources to other basic research through the Centers for Excellence and Eminent Scholars programs. The former program no longer exists, however, and the latter program is now part of the endowed chairs program of the State Regents for Higher Education. Data are not readily available on OCAST support by field of inquiry, but it appears to have provided more support to research related to BT than to IT.

Quality Jobs Program

The Oklahoma Quality Jobs Program (QJP) is another potential source of funding for BT and IT development. The QJP is administered by the Oklahoma Department of Commerce (ODOC). The program provides quarterly cash payments of up to 5 percent of new taxable payroll directly to a qualifying company, for up to 10 years. Through 1999, the program had provided $106 million to 178 firms for the creation of new jobs. [29]

The program is not designed specifically to develop either the BT or the IT sector, but firms in the IT sector are eligible, and the QJP has provided support for IT firms. ODOC estimates that the program will provide support for 66,000 jobs over a three-year period for firms currently enrolled in the program. Approximately 6,900 of these jobs will be in IT producing sectors (Electric Equipment, Communications, and Instruments and Scientific Equipment). Approximately 20,000 of these jobs will be in the Business Services Sector; some of which will be in IT services companies (the America On-Line Customer Services Center is a good example).

Tax Incentives

Oklahoma has a variety of tax incentives for business. Table 3-24 indicates the value of those incentives for which data are provided in the latest available Tax Expenditure Report from the Oklahoma Tax Commission[30]. The Interstate Telecommunications Services Sales Tax Exemption of $11.3 million is clearly a subsidy to the IT sector. The IT sector may have benefited from some of the other exemptions, as well, but this cannot be determined from available data.

The Academy Recommended

The Oklahoma Academy recommended the strengthening of OneNet at the 1998 conference ... and an open letter of support at the 1999 conference.

OneNet

Both the higher education system and the career and technology education system are aware of the education and training needs of working adults and schedule numerous evening and weekend classes. In addition, there is considerable interest in distance education. Of particular note is OneNet, a high-speed telecommunications network administered by the Oklahoma State Regents for Higher Education and operated in cooperation with the Oklahoma Office of State Finance. This system has 42 hubs and electronically links public schools, technology centers, colleges and universities, and state government. It provides a potentially important infrastructure for distance education.

The Academy Recommended

The Oklahoma Academy recommended and strongly supported the passage of both SQ 680 and 681 as a result of the 1998 conference.

State Questions 680 & 681

Two essential pieces of the puzzle were provided when voters approved State Questions 680 and 681. These amendments to the Oklahoma constitution allow the state's colleges and universities to use their assets (such as laboratories) in conjunction with private partners for the purpose of creating new technologies and to take a stake in the commercial benefits ultimately produced by these technologies.

Senate Bill 694

State questions 680 and 681 should spur the development of new technologies. Senate Bill 694 promises to be a powerful complement. SB 694 is a new law that was passed during the 2001 session and signed by the governor. It provides for the creation of the Oklahoma Institute of Technology and the Oklahoma Institute of Technology Trust Fund. The Oklahoma Institute of Technology is intended to:

- attract and retain outstanding faculty and graduate students at Oklahoma colleges and universities through public-private partnerships that will support the creation of endowed chairs, scholarships and research grants in the fields of engineering, information technology and biotechnology

- partner with the public and private universities of Oklahoma to set standards for a world-class curriculum for information technology and biotechnology disciplines

- develop policies and procedures to facilitate joint public-private technology research and development projects using facilities of public higher education institutions

- establish a procedure for certifying courses and programs in information technology and biotechnology disciplines

- coordinate and implement through distance learning strategies the delivery of engineering and technology courses from Oklahoma State University, the University of Oklahoma, and the University of Tulsa, to public colleges and universities and Career Technology Centers in Oklahoma

- develop strategies for providing workforce training in technology

- develop strategies for providing leadership development programs to prepare rural residents for leadership in a technologically advanced economy, and

- develop strategies for upgrading and enhancing rural technology infrastructure, including medical procedures, telemedicine capabilities and emergency response capabilities.

The Oklahoma Institute of Technology Trust Fund will contain money appropriated by the legislature and any money contributed to the fund from other sources. The initial amount of money in the fund is yet to be determined. If adequate money is provided, the Oklahoma Institute of Technology could be instrumental in funding the research that is necessary for Oklahoma to become a more effective competitor in information technology and biotechnology.

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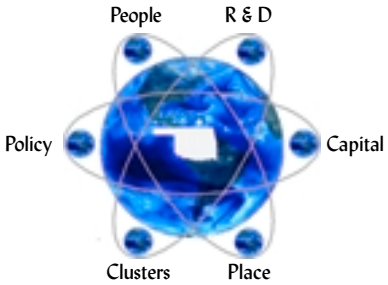
Section 4

Case Studies: Competing in Oklahoma and Elsewhere

Tony Hutchison, Jeannie Bordelon-Parker, and Ryan Kiesel



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Section 4

Case Studies: Competing in Oklahoma and Elsewhere

Tony Hutchison, Jeannie Bordelon-Parker, and Ryan Kiesel

Preface

The previous section provided case studies of two important industry sectors: information technology and biotechnology. There are dozens of other sectors that come under the broad heading of high-tech .

This section is to provide case studies of different organizations cities, states, regions and countries. It is to provide a geographical overview rather than an industrial one.

This section was contributed by the research staff of the Oklahoma State Senate. This section is included to provide a sampler of other places that appear to be successful. They have taken car e to compare ourselves to areas like us in population and makeup. They have included other peer U.S. cities, and an assor ted series of Oklahoma examples ... and the countries of Ireland and Singapore. They have also included some one Oklahoma missed oppor tunity . These examples ar e not to suggest a model, but to inspire discussion and to demonstrate that there are many routes to success.

INTRODUCTION

The following information will offer a comparison of the Oklahoma City MSA and the Tulsa MSA to other U.S. cities that are similar and are considered to have a significant high-tech industrial presence. The "peer cities,, are: Boise, Idaho; Austin, Texas; Huntsville, Alabama; and Colorado Springs, Colorado. These four cities were chosen based not only on their success in attracting this type of industry, but also on like characteristics; they are either similarly-populated or in close geographic proximity to Oklahoma.

In addition to Oklahoma City and Tulsa, some important Oklahoma examples of "successes,, will be offered along with an "opportunity lost,,. This section will also feature profiles of two smaller cities: Morrilton, AR and Ponca City, OK. There are also lessons to be learned internationally. This section will offer three profiles of countries that have similar populations to Oklahoma. They are Ireland (3.6 million) and Singapore (3.4 million).

Oklahoma: Tulsa & Oklahoma City

Oklahoma 2001

The Oklahoma economy has become less dependent on its energy and agricultural sectors and more like the nation in terms of industrial mix. However, the importance and contributions of energy and agriculture continue to contribute significantly to Oklahoma's economy. Oklahoma City and Tulsa each boast many inherent economic advantages, and both have a measure of shortfalls.

Population

Between 1990 and 1999, the population of the Oklahoma City MSA grew by slightly over 9 percent, and the population of the Tulsa MSA grew by nearly 11 percent. While this rate of growth does significantly lag that of the other cities profiled, whose average growth is nearly 30 percent, the state's metropolitan population has kept pace with the 10.1 percent total United States' metropolitan population growth.

Earnings

The Oklahoma City MSA's 1999 Per Capita Personal Income (PCPI) of $24,437, and Tulsa's PCPI of $27,654 were both below the $28,546 average PCPI for the metropolitan portion of the United States. However, one important thing to realize is that the PCPI figure for Tulsa County is, in fact, higher than the national average PCPI figure.

Having a relatively low PCPI level is, to many, a double-edged sword. While having a low income is certainly nothing to brag about, it may cause some potential employers to view this as an opportunity to reduce their payroll costs, thereby reducing their total cost of doing business. Table 4-1 provides a side-by-side illustration of common demographic attributes for each of the profiled cities.

Education

The state's average ACT score of 20.8 is higher than that of Texas and Alabama, and is slightly below that of Idaho and Colorado. The Oklahoma college-going rate of nearly 60 percent also compares favorably to that of the other cities profiled, as well as that of the United States as a whole.

The Oklahoma City MSA is home to fifteen colleges/universities; Tulsa's MSA is in close proximity to fourteen institutions of higher education. There are two in-state comprehensive/research generating universities. They are Oklahoma State University (OSU) in Stillwater, and the University of Oklahoma (OU). OU also has major research presence in Oklahoma City with the Oklahoma Health Science Center; and OSU is establishing a prescence in Tulsa via their College of Osteopathic Medicine and the growing OSU-Tulsa campus.

The latest available data indicate that 22 percent of the state's population (over 25 years of age) has earned a bachelor's degree or higher.

Oklahoma City MSA

MSA Population	1,046,283
Per Capita Personal Income	$24,437
Average Wage per Job	$26,521
Median Family Income	$41,300
1990-99 Growth:	
Population	9.1%
Per Capita Personal Income	40.1%
Average Wage	26.4%
Per Capita Tax Burden	$2,162
Sales Tax Rate	7.88%
Cost of Living Index	94.1
Single-Family Home Cost Index	78
Population w/Bachelor's Degree	22%

The legislature has set-up several grant, savings and scholarship programs to assist Oklahomans with the expenses associated with obtaining a college degree; examples of these programs include the Oklahoma Tuition Aid Grant (OTAG), the Oklahoma Higher Learning Access Program (OHLAP) and the Oklahoma College Savings Plan.

The Oklahoma Department of Career and Technology Education system is nationally recognized for its excellence. It provides training at nine institutions in the Oklahoma City area, and six institutions within the Tulsa area. Their "Training for Industry Program,, has been hailed as a leader among similar programs throughout the nation.

Business Costs

Business costs are instrumental in determining long-term regional economic performance, as they play a central role in the relocation and expansion decisions of firms.

According to Economy.com, in 1999 Oklahoma gained 90,310 jobs due to its advantageous business costs, vis-a-vis the nation as a whole. Given that Oklahoma City and Tulsa exhibit an overall cost of living advantage, and other advantages, compared to the other cities profiled later in this report, one would expect that the state's high-technology presence would be flourishing. However, this isn't the case.

Intangibles: Quality of Life

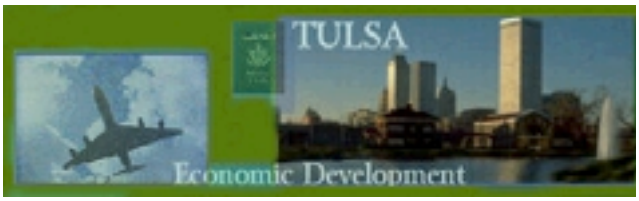
The following section will attempt to shed some light on another vitally important consideration for firms making location decisions among competing cities.

Quality of life is, perhaps, one of the most subjective measures that decision makers evaluate during the site selection process. The state's image is vitally important when it comes to economic development efforts, especially given that potential high-tech firms must contend with a very limited or nonexistent qualified labor pool from which to draw.

These firms must locate within areas that offer the amenities that these professional individuals demand for themselves and their families. These include good schools, pleasing scenery, recreational prospects and cultural entertainment opportunities are some of the amenities that creative knowledge workers insist upon to enhance their quality of life.

Metro Comparisons

How do Oklahoma's cities stack up on these indicators? Of the cities profiled in this report, Tulsa, Boise and Huntsville were each profiled in the Milken Institute's study that was released in February of this year, *Knowledge-Value Cities in the Digital Age*. The section titled, "Prospects for Emerging-Technology Cities,,, featured *Tulsa: Wired in the Heartland.* The study indicated that while the opportunities available in Tulsa include " ... a venerable treasure of classic art deco style, Streamline and Classical style buildings, some with elaborate marble entryways, murals and intricate carvings built in [Tulsa's] days as an oil boomtown in the 1920s and 1930s,, the city lacks some of the personally-important attributes that other cities do not.



While Tulsa does possess an impressive civic infrastructure, thanks to the oil and gas philanthropy in decades past, the Milken study indicates that Tulsa lacks some of the distinctive characteristics that young engineers, scientists and executives expect. "A bible-belt city with a modest nightlife that lacks both a recognized research university and convenient air transportation connections, suggest that Tulsa is unlikely to emerge as a full-fledged information-age capitol.,, However, the presence of the Williams Company, and other Tulsa firms within the telecommunications industry, has led to this industry's concentration to be 30 percent higher in the Tulsa economy than it is for the United States as a whole.

Tulsa MSA

MSA Population	786,117
Per Capita Personal Income	$27,654
Average Wage per Job	$28,768
Median Family Income	$41,400
1990-99 Growth:	
Population	10.9%
Per Capita Personal Income	43.5%
Average Wage	25.7%
Per Capita Tax Burden	$2,162
Sales Tax Rate	8.42%
Cost of Living Index	91.5
Single-Family Home Cost Index	86
Population w/Bachelor's Degree	26%

Another often referred to measure of quality of life is a city's cost of living. The ACCRA organization produces a cost of living index for most major cities throughout the United States. First quarter 2001 data indicate that the cost of living in Oklahoma City, with an index value of 94.1, and Tulsa, with an index value of 91.5, are both well below the U.S., with an index value of 100.

The largest piece of this differential is attributable to the housing market. The average cost for a 2,000 square foot house is a modest $120,000 in Oklahoma City, and $110,000 in Tulsa. The average cost in the other profiled cities ranges from a high of $212,000 in Boise to a low of $130,000 in Huntsville. The affordability of quality housing contributes significantly to quality of life.

Progress in Oklahoma

There are a number of interesting and progressive movements in Oklahoma.

- The Oklahoma Center for the Advancement of Science and Technology (OCAST) committed $8.7 million in 1989 toward the University Health Center's Oklahoma Center for Molecular Medicine; this funding was leveraged in order to

obtain an additional $50 million of private funding in order for this new research facility to attract some of this field's up-and-coming researchers and to purchase state-of-the-art equipment. During the mid-90s, this facility did cease to exist, but many of its top scientists remained and began producing valuable research on their own, thereby creating several biotech start-ups.

- Novazyme Pharmaceuticals, Inc. (Oklahoma City) was started by one of those remaining scientists. This firm is researching and developing drugs aimed at treating genetic disorders. Individually, this firm has attracted $8 million venture capital dollars from New York and Boston, and employs approximately 30 scientists and researchers, and is currently in the process of conducting a major nationwide recruiting effort to employ many more.
- Similar efforts are underway for a telecommunications/networking research center in Tulsa, building on the presence of MCI/WorldCom and Williams, both of which are located within that city.
- The success of the recently implemented Oklahoma City MAPS sales-tax initiative is also receiving positive attention as a strong economic development effort.
- There is an impending vote on a dedicated sales tax to improve the Oklahoma City Public School District. If approved by voters, this revolutionary measure will substantially change the way the city's public education is funded and administered. For the first time, the city and the school district, along with a plethora of other key city leaders, have teamed up to address the school district's crumbling infrastructure and long-abandoned capital needs.

  If supported by voters, this sales tax revenue will provide for much needed, district-wide capital improvements and will go a long way toward the goal of improving quality of life, thereby enhancing the city's economic development efforts, and will also illustrate that the city's leaders are working toward solutions to some of the city's attributes that are considered to be debilitating to its long-term success.

Advantages? Barriers?

Tulsa and Oklahoma City have costs of living at 91% and 94% percent of the national average, respectively. There is also a relatively low cost of doing business, low energy costs, a reasonable tax burden, a highly-subsidized higher education system and a centralized geographical location. One might expect that most firms, even those in high-tech fields, would give the city careful consideration when making location/expansion decisions.

With all of the cost advantages and incentives currently offered, shouldn't the metro area be an easy sell to prospective high-tech firms, whether they are start-ups or existing firms seeking to expand current operations? The answer is, in the eyes of many, far too often ... "no,,.

Despite these lower costs, the Tulsa and Oklahoma City high-technology presence is far lower than any of the other cities profiled in this section. How is this possible? Upon appraisal of the available literature from site selection experts, and reflecting on a few of the recent individual location decisions made, it is clear that the traditional policy incentives make little or no difference to these "new economy,, enterprises.

The lack of having a highly-educated labor pool, including scientists, engineers, and other technology professionals, is another often cited disconcerting factor that hampers the state's ability to attract some types of businesses. Senator Ted Fisher, Chairman of the Senate's Economic Development Subcommittee, suggested the following when asked to respond to this issue:

"We spend so much time on issues that don't make very much difference.We are already a low business cost state. But knowledge and high technology businesses are looking for value ... not just a low cost and well-educated workforce, targeted incentives, like the Quality Jobs Act, research and development support, venture capital dollars, well coordinated business, information technology, and engineering curriculum. We need to build on existing economic clusters, like the growing telecom cluster in Tulsa, if we are going to make a noticeable difference in the not-too-distant-future.,,

Further evidence of this shortcoming comes from a Health Science Center official that has been involved in many economic development projects for the research park, "I have never been asked about some of the traditional business regulatory or tax issues. I have, however, been asked how many PhDs in biological sciences are available within a 500 mile radius of Oklahoma City.,,

Likewise, a state higher education official who has been involved in high-tech recruitment said, "Companies simply ask, 'where are we going to get our workforce?' That is their #1 concern about Oklahoma, nothing else matters as much to them as this.,,

Comparison Tables

Table 4-1 indicates little difference in selected public policy indicators between the cities profiled, except for demographic differences that are considered to be outcomes based on the other categories.

In all but one of these areas -- education -- Oklahoma City and Tulsa are either quite similar or may, in fact, possess an advantage over the other cities in the group.

The difference appears to be primarily attributable to our lower percentage of college graduates in the population, a key indicator of high-tech growth in nearly every study of development of this type. This appears to be consistent with anecdotal evidence that was collected during the course of these case studies.

Table 4-1 provides city-to-city and state-to-state economic comparisons of the Austin, Boise, Huntsville, Colorado Springs and Oklahoma metro areas. What immediately jumps out from this data is how competitive Oklahoma City and Tulsa are on most indicators of cost. Equally apparent is that these competitive factors don't translate into population growth, income levels or wage growth for the Oklahoma cities. Why is this the case?

Economy.com, a well recognized provider of economic data and analysis produces a Cost of Doing Business Index each year. Oklahoma almost always fares well on the measure (5th lowest cost state in 2000) but underachieve in terms of growth. Chief Economist, Mark Zandi has calculated that about 1/3 of state economic growth is related to low traditional business costs - factors such as labor costs, cost of living and tax burden. This is where Oklahoma cities fare well, but as the table below indicates, not significantly better than other cities in the comparison. While explaining 1/3 of growth through cost factors is important it also means that 2/3 of growth is explained by other factors such as the productivity of the work-force (education levels, entrepreneurship, innovation etc.), public and private investment in physical transportation and telecommunications infrastructure and intangibles such as quality of life.

Repeatedly interviews with experts and anecdotal evidence suggest that Oklahoma's workforce is low cost and hardworking but does not possess the knowledge characteristics that are needed to add value and improve productivity. Industries that rely primarily on low labor costs rather than high value added are attracted to the state. Oklahoma wages remain low thus lowering our labor costs and in turn lowering prices in the housing market - the most significant part of the cost of living market basket of goods. This to some degree explains why Oklahoma has a very low unemployment rate but continues to have low wages.

Education scores on a statewide basis are very competitive and even superior in some cases to the other states in the comparison but we have no highly educated and technologically proficient concentrations of population such as Huntsville, Austin, or Colorado Springs. Oklahoma needs to develop its urban areas as "knowledge job,, magnets along the lines of the other cities in the study.

One way of creating these magnets may be to consciously link higher education institutions with military bases in our cities (especially Tinker AFB and Fort Sill in Lawton) and to existing technology related hubs such as the telecom and aerospace industries in Tulsa. This will require assistance from Oklahoma's Congressional delegation as well as state and local officials. For example, Tinker AFB could continue to evolve its mission to include more Research and Development functions in addition to maintenance and logistics.

Cameron University in Lawton in conjunction with Fort Sill has already been studying the Huntsville model and attempting to create similar synergies. An "artillery fire,, simulation center has begun to spin off related private sector enterprises.

Table 4-1

MSA Comparison Table

Prepared by Oklahoma State Senate Staff

	Tulsa	Oklahoma City	Huntsville	Colorado Spgs	Austin	Boise
Population	786,117	1,046,283	343,418	499,994	1,146,050	407,844
Per Capita Personal Inc.	$27,654	$24,437	$25,993	$27,255	$31,794	$27,408
Average Wage Per Job	$28,768	$26,521	$33,401	$30,448	$38,262	$29,341
Median Family Income	$41,400	$41,300	$52,100	$45,800	$50,800	$48,000
1990-99 Growth:						
Population	10.9%	9.1%	17.2%	25.9%	35.4%	37.9%
Per Capita Personal Income	43.5%	40.1%	33.1%	53.1%	68.2%	52.0%
Average Wage Per Job	25.7%	26.4%	30.8%	45.4%	76.2%	46.5%
Per Capita Tax Burden						
State/Local taxes	$2,162	$2,162	$1,855	$2,648	$2,289	$2,293
Cost of Living Index	91.5	94.1	96.5	97.3	105.7	99.9
Single-Family Home Index	86	78	111	116	103	96
Sales Tax	8.42%	7.88%	8.0%	6.0%	8.25%	5.0%
Highest Tax Rate:						
Personal	6.65%	6.65%	5.00%	Flat 4.63%	0.00%	8.20%
Corporate	6.00%	6.00%	Flat 5.80%	Flat 4.63%	* 0.00%	Flat 8.00%
Pop w/Bachelor's Deg.	26%	22%	33%	28%	34%	28%

State Data Comparison Table

	Oklahoma	Alabama	Colorado	Texas	Idaho
Public Education Score (of 4.0)	2.40 (B)	1.25 (c-)	1.60 (C)	1.55 (C)	1.40 (C-)
Average ACT Score	20.80	20.20	21.50	20.30	21.40

- 1999 Population data: U.S. Census Bureau
- 1999 PCPI data and Average Wage per Job: Bureau of Economic Analysis
- Median 2000 Family Income data: www.fdic.gov/news/financial/1998/fil9844c.html (Census data not available beyond 1990 - HUD uses census data to obtain 1998 estimates.
- Tax Burden data: National Conference of State Legislatures
- Personal/Corporate tax data obtained by surveying each of the states. *Texas does not have a "Corporate Income Tax", but it does have a "Corporate Franchise Tax" which is virtually the same thing. This tax is computed at the rate of .25% of net taxable capital, plus 4.5% of net taxable earned surplus.
- Sales Tax Rates: Obtained by calling each of the profiled city's chamber of commerce
- 2000 Cost of Living Data: ACCRA (formerly American Chamber of Commerce Researchers Association)
- Housing Cost data: http://list.realestate.yahoo.com/re/neighborhood/serch.html
- Bachelor's Degree 1999 Data: http://verticals.yahoo.com/cities
- State ACT Score Data: www.act.org
- State Public Education Score: Education Week. Values calculated by assigning a numerical value to the letter grades earned in each of the following four categories: Standards & Accountability, Improving Teacher Quality, School Climate, Resource Adequacy, and Resource Equity. Idaho was not scored in the "School Climate" category. Therefore; their score was calculated using the average of the remaining values. Based upon a 4.0 scale.

It should also be noted that while Oklahoma's overall tax burden measures are very competitive with the other cities in the comparison that tax incidence, or on who the taxes are levied, are increasingly being studied as an indicator of high tech job growth. Some believe that Oklahoma's relatively high marginal tax rate on individual income may be a hindrance to risk takers in the venture capital and technology fields.

Simply put, the rewards to an innovator may be higher in a city like Austin, rather than Oklahoma City, despite almost identical overall tax burdens. Many new technology and knowledge service firms have little physical capital and would gain minor benefit from Oklahoma's low property taxes. They may benefit more from the avoidance of state income and capital gains taxes in Texas.

Colorado Springs has the typical assortment of economic incentives in place, such as research and development tax credits, enterprise zone tax credits and foreign trade zone benefits. The state and local tax burden is at about the national average; ranking 21st per capita. Union membership in the private sector is 7 percent.

Given those less-than-unique characteristics, why is Colorado Springs booming? Aside from its geographic location and its inherent beauty, only two unique policy variables exist:

1. Significant federal installations
2. A highly educated technical workforce

Colorado Springs has implemented an economic development strategy designed to foster technology clusters that are aligned with its workforce. Employing a technique designed to capitalize on the federal military's enormous installation investments in the area, and the vicinity's highly educated and technical workforce generated to staff these installations, the region has been able to entice investment from such large firms as Gateway 2000, Hewlett-Packard, Lockheed-Martin, Federal Express, Oracle, the U.S. Space Foundation, Compaq Computer and MCI/WorldCom. The magnitude of this effort can be observed with the more than 12,000 workers that are employed by software companies.

Forbes magazine has called Colorado Springs one of the 25 "Cities of the Future,,; Entrepreneur has labeled it "one of the top 30 cities for small business.,, Electronic Business Today has termed it "one of the top 20 cities in which to locate a high-tech manufacturing plant.,,

Colorado Springs has a workforce that is well educated. Approximately 28 percent of the Colorado Springs workforce holds a college degree, while that same statistic for Oklahoma City's population is only 22 percent.

Fifty-three (53%) percent of the entire college-educated workforce has at least a master's degree.

Colorado Springs scores highly in the Expansion Management Education Quotient ranking. This ranking combines student standardized test scores with teacher salary, per pupil spending data, teacher-student ratios, the community's average educational level, and income data. The city's overall score of 119 places it ahead of San Jose (Silicon Valley -- 116) and equivalent to the score obtained by Austin, Texas.

Colorado Springs MSA

MSA Population	499,994
Per Capita Personal Income	$27,255
Average Wage per Job	$30,448
Median Family Income	$45,800
1990-99 Growth:	
Population	25.9%
Per Capita Personal Income	53.1%
Average Wage per Job	45.4%
Per Capita Tax Burden	$2,648
Sales Tax Rate	6.0%
Cost of Living Index	97.3
Single-family Home Cost Index	116
Population w/Bachelor's Degree	28%

More than 400 outplacements from military installations within the Colorado Springs MSA reenter the workforce in the private sector each month. Peterson Air Force Base alone (a NORAD facility) sends 84 technically trained personnel into the private sector monthly; of these, 62 percent have a master's degree.

Another side benefit of the military's extensive presence in Colorado Springs is the city's highly sophisticated telecommunications network. The region boasts a broad fiber optics infrastructure and transmission mechanism that serves all of the area's major industrial, commercial and residential areas.

Despite Colorado Springs' growth in the technology sector, and the private sector in general, the city's economy is still largely based on federal military spending.

According to data released by the Colorado Springs Economic Development Corporation, the economic impact of military installations is more than $2 billion annually to the local economy.

More than 43 percent of the local economic output is related to military spending. Nearly 56 percent of the area's total employment is directly attributable to the military's presence (January 2001 Economic Development Corporation Study conducted by David Bamberger and Associates).

Austin, Texas

High-Tech in the Southwest

In the 1950s, the city's first high-tech firm (Tracor) was formed by a UT physics professor who believed that the area's high quality of life and access to university resources was an ideal combination for technology firms. During the 1960s, Austin's efforts to attract technology firms began to pay off and a new era of private sector growth began to emerge. Other firms began to capitalize on the positive aspects Tracor had identified. IBM, Motorola, and Texas Instruments followed suit by capitalizing on Austin's well-educated workforce, cost of living and quality of life.

Much of this progress was made possible by state government's commitment and support to the electrical engineering and computer science departments at UT. The more than $23 million in financial support assisted these programs in becoming what they were then, and what they are today. Austin also invested more than $30 million in an effort to lure the Microelectronics and Computer Technology Corporation (MCC) consortium to the area, again using UT land and resources as bait. They managed to beat-out their competitors from San Diego, Atlanta and the North Carolina Research Triangle.

The traditional components of Austin's economic climate made the area a lucrative option for the technology firms looking for relatively low-cost land, a highly skilled workforce that is attainable at a competitive wage and a desirable quality of life. Today, the technology development cluster in Austin revolves around three primary industries: (1) Semiconductors and electronics (2) Computers and peripherals and (3) Software.

Austin has no sales tax on unprepared food items (groceries), and the state of Texas does not impose a personal income tax. However, their per capita state and local tax burden of $2,289 is the third highest among the cities included in this report, Colorado ($2,648) and Idaho ($2,293) being the two that impose a higher per capita state and local tax burden. The lowest per capita state and local tax burden among the cities contained in this report was Alabama at $1,855.

The Austin MSA is home to seven universities and/or colleges. The average ACT score for the state of Texas (20.3) is below the national average of 21.0, and below the Oklahoma average of 20.8. Austin, however, is not typical of Texas as a whole, having higher scores and a higher density of technology graduates.

Austin MSA

MSA Population	1,146,050
Per Capita Personal Income	$31,794
Average Wage per Job	$38,262
Median Family Income	$50,800
1990-99 Growth:	
Population	35.4%
Per Capita Personal Income	68.2%
Average Wage per Job	76.2%
Per Capita Tax Burden	$2,289
Sales Tax Rate	8.25%
Cost of Living Index	105.7
Single-family Home Cost Index	103
Population w/Bachelor's Degree	34%

ACCRA (formerly American Chamber of Commerce Researchers Association) indicates that Austin's overall cost of living of 105.7 is 5.7 percent higher than the national average. Further, the city's cost of living was the highest among the cities studied in this report. The average cost for all housing within the Austin MSA is $133,430; the average price for a 2,000 square foot home is reported to be $210,000.

The computer hardware industry is the anchor of Austin's high-tech economy. Dell Computer Corporation is a prime example. Dell is the second-largest personal computer manufacturer in the nation and the city's only Fortune 500 company.

Companies within this cluster are of high value to the areas in which they choose to locate by offering, by their offering a wide range of products and covering various market niches. Some of Austin's high-tech fortune is attributable to good public policy decisions. As Michael Dell was a resident before founding the company, good outcomes are sometimes simply fortuitous.

In addition to the large companies that manufacture computers, the computer peripheral industry is supplied and supported by local companies, which specialize in instrumentation manufacturing, tool and die machinery, telecommunications equipment, as well as plastics fabrication.

Boise, Idaho

A Silicon Valley Satellite

The success in Boise, Idaho cannot be attributed to a single factor. An array of empirical and anecdotal benefits explains the recent surge in the high-tech industry. Looking at the per capita personal income, median household income and public policy initiatives aimed at technology growth independently, nothing appears unique to Boise. But combined with a young workforce, below average cost of living, high quality of life and regional proximity to major high-tech cities, Boise has become a relocation and entrepreneurial haven.

Boise, unlike Huntsville and Colorado Springs, is not as reliant on federal government programs, and its diversity among the private sector leads the local economy. High-tech industry in Boise grew tremendously in the last 20 years. According to the Milken Institute, the "contribution of the high-tech sector to the local economy jumped from 12 to 43 percent, and high-tech jobs increased from 1,900 in 1987 to 3,500 in 1998.,,

Boise MSA

MSA Population	407844
Per Capita Personal Income	$27408
Average Wage per Job	$29341
Median Family Income	$48,000
1990-99 Growth:	
Population	37.9%
Per Capita Personal Income	52.0%
Average Wage per Job	46.5%
Per Capita Tax Burden	$2,293
Sales Tax Rate	5.0%
Cost of Living Index	99.9
Single-family Home Cost Index	96
Population w/Bachelor's Degree	28%

The Milken Institute also reported that Boise ranked fourth in the nation in high-tech job growth between 1990 and 1996. Other evidence of the technological boom includes the increased employment in electronic components from 3,900 in 1990 to 10,200 in 1999, and electronic components employment is nine times more concentrated in Boise than in the U.S. as a whole. Boise continued its rise to high-tech prominence by achieving a rank of third among all metros in the country for growth in high-tech output from 1990-1998.

While Huntsville and Colorado Springs rely on the federal government to produce and/or attract a highly skilled workforce, Boise benefits from a demand for high-tech products and its proximity to technology giants like San Jose, Portland and Seattle.

While not high-tech, the largely agricultural and agricultural value added companies such as, Albertson's Inc., J.R. Simplot Co. and the Boise Cascade Corporation, demand high-tech products, services and a workforce educated in technology.

A corporate leadership concentration contributes to the city's nationwide ranking of sixth in corporate headquarters per capita. Boise, serving as a regional corporate leader, medical center, retail center and political center, creates a significant level of demand for technologically advanced goods and services.

The fact that the cost of doing business is below national average has undoubtedly helped them entice major technology firms, such as Hewlett-Packard, to locate within this city.

As the high-tech industry grew in Boise, so did native entrepreneurial spirit. Local up-starts include the now successful Micron Technologies. The CEO of Micron Technologies, Joseph Daltoso, sees great benefits associated with being a high-tech firm outside of Silicon Valley, "When you are out here, away from the major technology hubs, you don't have negativity constantly wearing on you. You're not under the constant din of 'that's not the prevailing thought today' or 'that's not the prevailing way to do business.',,

Gary Mahn, Director of the Idaho Department of Commerce, says that "the major factor behind our growth is the quality of talent we've been able to attract and retain.,, Not only is Boise attractive to talent outside of its MSA and across state lines but cooperation with the higher education community is steadily contributing to the highly skilled workforce that high-tech firms require throughout the state.

Boise is evolving from an industrial mix that was once dominated by agriculture into a center of high-tech entrepreneurship. This evolution offers hope to similar cities across the country seeking to cultivate their own high-tech industries.

Huntsville, Alabama

A Foundation Custom-Built by NASA

Huntsville, Alabama's economic development plan is typical of other emerging high-tech cities. A survey of the city's public policy indicators and incentives does not indicate anything extraordinary that would establish Huntsville as a leader in technological development.

The per capita state and local tax burden is below the national average, and the lowest of the cities profiled here. Huntsville ranks below the national cost of living average, but higher than Oklahoma. Given Huntsville's less than unique attributes, the explanation for its success in technology development rests with their very highly educated workforce.

The EDGE (Excellence in Marketing, Development of Workforce, Growth in local Enterprise, Enhancement of Image) Plan, implemented by the Huntsville/Madison County Chamber of Commerce, seeks to provide quality and competitive growth all while investing in the quality of life.

The EDGE plan has successfully worked to complement Huntsville's existing workforce and the equal division between manufacturing and service industries. The commitment of EDGE has attracted leading technology companies such as United Technologies, SCI Systems, ADTRAN, Lockheed Martin, SDI, IBM and Alabama Super Computers. This, however, would not be possible without the existing presence of a highly educated and qualified workforce already established in Huntsville.

Federal investment in the NASA Marshall Space Flights Center is the reason that one out of twelve residents in the Huntsville area is a PhD, scientist, engineer or technologist, and Huntsville is home to more than 1,000 PhDs not affiliated with the area's colleges and universities.

In addition, Huntsville is home to eight universities and colleges. The Chamber of Commerce of Huntsville/Madison County heads up the Alliance for Technology Transfer. This committee focuses on technology transfer and commercialization issues.

Newsweek magazine recently profiled Huntsville as one of their ten "high-tech havens,, and Expansion Management Magazine listed Huntsville among the "Top 25 High-Tech Cities.,,

This survey, weighing factors such as high-tech job growth, high-tech job creation, annual average wages and high-tech jobs vs. other private sector jobs, ranked Huntsville third behind high-tech superpowers San Jose, California and Hartford, Connecticut. Expansion Management also included Huntsville among "America's 50 Hottest Cities,, for business relocation and expansion with a ranking of 19. Huntsville's quality workforce played an essential role in this national recognition.

Huntsville MSA

MSA Population	343,418
Per Capita Personal Income	$25,993
Average Wage per Job	$33,401
Median Family Income	$50,800
1990-99 Growth:	
Population	17.2%
Per Capita Personal Income	33.1%
Average Wage per Job	30.8%
Per Capita Tax Burden	$1,855
Sales Tax Rate	8.0%
Cost of Living Index	96.5
Single-family Home Cost Index	111
Population w/Bachelor's Degree	33%

The Huntsville Times hired a nationally known planning consultant to evaluate Huntsville's high-tech growth and its effects on the quality of life. Quality of life is one of the factors attracting high-tech business to Huntsville, but a long-term plan to deal with the consequences of development is lacking. The planning consultant noted that Huntsville/Madison County "flunks the forward thinking test,, and the "long-range planning is just not there.,,

Huntsville owes much of its success to the federal government's investments in technology development. City officials say that up to 85 percent of Huntsville's high-tech companies trace their origins to the Army or to NASA. Furthermore, venture capital investment has increased from $2 million in 1999 to $66 million in 2000. Job growth, also reflecting dramatic leaps in development, experienced a 100 percent increase from 1995 to 1999.

The increase in industrial diversification in the private sector, and the federal government's continuation in the development of a highly skilled workforce, promises a healthy future for this city.

A Smaller Community

Morrilton, Arkansas (pop 6,500)

How a small town is TRANSFORMING ITSELF from within

Lost Opportunity

In the space of a dozen or so days in early 1999, little Morrilton, AR. lost almost one-third of its jobs when two plants closed. It's a story that has played out in town after town across the South. But the people of Morrilton pulled together, took classes, started small businesses and attracted new employers to the town. And they're not resting on their turn-around laurels. The community is taking steps to make sure it's never again left wondering what happened when the local economy takes an unexpected turn.

New Opportunity

At the same time, about 20 miles down Interstate 40, one of the 100 best companies to work for in America was hiring. But most of the jobs Acxiom had available at its Conway, AR. facility couldn't be filled by Morrilton's displaced workers. The reason wasn't a lack of will or enthusiasm - Morrilton's workers have a work ethic any company would want. But some of them had never even turned on a computer, and a lot of Acxiom's best-paying jobs were for engineers, software designers and programmers. Morrilton suddenly symbolized a dilemma facing many Southern towns in a changing economy: How can a community reconcile the mismatched skills of its workforce with the needs of high-tech, information-driven businesses? Morrrilton is a success story.

When Brad Lacy came to Morrilton as a staff member with the Arkansas Department of Economic Development, he was surprised to see what was happening. "The impulse that communities have when they lose employers is to say 'Okay state of Arkansas, we need a grant, and you need to bring us a company today.' And I understand why communities think that way,,, Lacy says, "But Morrilton said, 'Okay, what do we need to do now?',, "First of all, we wanted to get our people jobs. Second, we went out recruiting. We made a pledge on the front end that we weren't going to be gloom and doom.,, Nelson says. "Was everyone sad? You bet. Was everyone willing to go out and find a job? You bet.,,

W e re seeing the problem (in the South) that really has existed for a while. It really started some time ago. We just didn t realize it for what it was, Ahlen says. Before, you left school and got a job, you went to college and got a job. That s no longer the case. Jobs don t last for a lifetime. They require a constant upgrade of skills. Education provides today multiple entry and exit points instead of a linear exit point into the working world.

Education

A community that takes responsibility for educating its workforce has an advantage when prospective employers comes knocking, says Dr. John Ahlen, president of the Arkansas Science and Technology Authority. It's a lesson that has been taught over and over as the U.S. economy changes, in such places as the Rust Belt and now in the South.

"They understood that new skills were needed which were unrelated to the garment or automotive parts industry,,, Crook says. "Most jobs today, including many associated with agriculture and manufacturing, require computer information skills. Employers tell us that they want employees who can follow verbal and written instructions, have a solid command of mathematics, have computer skills, and above all, they must be reliable, dependable and work well with others.,,

Gordon says. "I think every community needs to realize the local economy is changing. We've moved from an agrarian economy to a manufacturing economy, and now we're moving to an information economy.,,

Morrilton's mayor says leadership is important, but the individuals who live and work in an area must be willing to put forth an effort and make discerning choices about how they want their community to develop."Where do we want to be in 2020?,, McKuin says. "We know with the changing economy and what's happening in the social area as well, we have to be an attractive community.,,

"The solution lies somewhere in our approach to education, continuing education and lifelong education and our workforce,,, Ahlen says. "It's got to do, I think, with a diversity of a community's employment portfolio.,,

Abstracted from Southern Gr owth magazine, V1, N2, summer 2001, fr om an article written by Andy Owens, Mor rilton s NEW Economy , pp 14-19.

Ponca City, Oklahoma (pop 26,000)

Editor s Comment

The Research Committee is offering this example of how non-metropolitan Oklahoma communities may creatively become mor e competitive in an innovative world. Most Oklahoma small communities offer some unique combination of people, place and infrastructure. Not every community can pursue carbon fiber technology. But every community can act collaboratively and energetically to maximize opportunity for their citizens.

The Challenge

In 1993, Ponca City was emotionally and economically drained after Conoco/ Dupont "downsized,, nearly 3000 professional, scientific and clerical jobs. For a small community the drop from 5,000 employees to 2,000 was devastating.

An economic development sales tax was passed which provided incentives to attract a meat processing plant and computer call center. This brought back 1000 jobs, but the pay, benefits and quality were noticeably lower. Soon community leaders realized that there was a large gap to fill if they would be able to create a bold new future for this northern Oklahoma community.

In October, 1998 Conoco spun off from Dupont once again becoming a "stand alone,, company. New management was much more receptive to company/ community partnerships and offered to help diversify the economy. The springboard for the revitalization effort was the vacant office and lab space no longer utilized by the company. Jointly Conoco and the community, began a program to market these facilities to acceptable companies at affordable rates.

The Conoco office space (8 stories with 150,000 square feet) was ideally suited for distance education. The first tenant was the University Learning Center, a unique project for local students designed by the Oklahoma State Regents for Higher Education to deliver degreed programs from a dozen different state colleges and universities through interactive television instruction.

To expand on the distance education possibilities, two private companies were recruited and looked at the facility. The office space was affordable and very attractive; however, the lack of high-speed Internet bandwidth created an insurmountable barrier to quality distance learning experiences. Private carriers considered Ponca City too remote and therefore cost inefficient for fiber optics. Their fiber investment was directed at the major metro areas first with smaller communities finishing last. Ponca City was "behind the wave,,, and therefore out of the picture for knowledge-based growth.

Private carriers considered Ponca City too remote and therefore cost inefficient for fiber optics. Their fiber investment was directed at the major metro areas first with smaller communities finishing last. Ponca City was behind the wave, and therefore out of the picture for knowledge-based growth.

In response, Ponca City developed a plan based upon blending business, government and education partnerships aimed at short-circuiting historical approaches to problem solving and making the city a global competitor. Two initiatives emerged.

Telecommunications

First, Mayor Tom Leonard formed a coalition to design/build Ponca City's own connection to the global Internet. The group consisted of community leaders in economic development, business and education as well as representatives from the Chamber of Commerce, the OSRHE and OneNet, Oklahoma's statewide education delivery system.

Together, they successfully lobbied the national Congressional delegation for a $4.5 million dollar federal grant earmarked for education and economic development. With support from Congressman Ernest Istook and Senator Don Nickles, a totally new approach to providing competitive resources to rural communities emerged.

Grant funds are earmarked for switches, routers, and fiberoptics that will create and operate a substantial Internet telecommunications hub in Ponca City.

When completed, it will provide high speed, high capacity, redundant access to the World Wide Web for education, business, government, and military users.

Carbon Fibers & Nanotechnology

The second initiative began when the economic development team succeeded in winning a competition with five other states for Conoco's revolutionary carbon fiber project. At first, Conoco was reluctant to select Ponca City because it viewed the community as complacent and reticent in its approach to economic growth, education and community development.

That skepticism was overcome with initiatives that delivered a competitive incentive support package, measurable cost efficiencies in city government, improved K-12 education and enhanced quality of life.

The community value of the facility far exceeds Conoco's $140 million dollar investment and the potential for 400 new jobs averaging nearly $50,000 per year. For the first time this new technology allows carbon fibers to be manufactured at an affordable price and high volume.

It will soon be available for enhanced efficiency of batteries, concrete and asphalt reinforcement, composite materials and a broad array of other applications which were previously cost constrained. Japanese automakers are extremely interested in its potential for car bodies that are stronger, more resilient and easily repairable. It is the high-tech composite material of the future.

The apparent success of the project has led community leaders and Conoco to consider establishing a new partnership for the creation of a Carbon Science Research Center in Ponca City. It would capitalize on emerging new markets launched by carbon fiber advances and the possible extension of research into nanotechnology.

Carbon fiber is a large size rudimentary nanotube ... the smallest nanotubes will allow only one atom at a time can pass through its center. Their use in computer chips could lead to extreme miniaturization of computers or to giving researchers the ability to pipette a single DNA molecule from a cell thereby changing its genetic coding.

Carbon fiber is a large size rudimentary nanotube, a cylindrical carbon molecule whose atoms linked in a geodetic pattern. The smallest nanotubes will allow only one atom at a time can pass through its center. Their use in computer chips could lead to extreme miniaturization of computers (e.g. the Dick Tracy wrist watch); or to giving researchers the ability to pipette a single DNA molecule from a cell thereby changing its genetic coding.

We Can Create Our Own Future

Mayor Tom Leonard emphasizes, "our vision for Ponca City now includes a wired, globally connected community at the central point of what may become the 'Carbon Prairie' which in 10 years will take the technology of the 'Silicon Valley' to a higher level as we move into the 21st Century. If we will think on a larger scale, small communities can compete on the global stage.,,

Contributed by:
Tom Leonard, Mayor of Ponca City and Jan Jarrett, executive director of Ponca City Chamber of Commerce.

EKIPS Technologies, Inc.
Norman (www.ekipstech.com)

EKIPS Technologies, Inc., a Norman-based laser company, is developing a rapid and accurate testing method using semiconductor lasers applied in the form of a Breathalyzer test.

University of Oklahoma Professor Patrick McCann is founder of EKIPS and has produced a mid-infrared Laser Spectrometer Breath Analyzer that can measure the ratio of molecules present in a breath sample. How does it work?

Dr. McCann's method uses a mid-infrared laser fired through a breath sample. The tunable system measures the intensity of the transmitted laser light and notes the light absorption ability, which determines what molecules are present. Such molecules could include exhaled styrene, an indicator of the presence of lung cancer; or the isotope ratio of carbon dioxide, which can determine the presence of ulcers or liver problems.

Hyalose LLC
Oklahoma City(www.hyalose.com)

If there is a true "elixir,, of life and if Ponce de Leon discovered the fountain of youth, both would probably be in the form of Hyaluronic acid, a biological polymer found in many human tissues. What does it do? Nothing short of keeping skin and eyeballs supple and elastic, lubricating joints and fostering the healing of human tissue.

Hyalose LLC, a start-up company based on the research of Oklahoma University Health Sciences Center professors Paul DeAngelis and Paul Weigel, was formed to produce synthetic hyaluronic acid polymers that can be used in a range of medical applications. Such applications include ophthalmology, arthritis treatment, wound healing, scar reduction, dermatology, cosmetics and drug delivery systems.

Emergent Technologies, a Texas-based group of investors originally from Oklahoma, is the primary financial base for Hyalose LLC and their objective is to keep this Oklahoma-based company in Oklahoma. Emergent expects Hyalose LLC to be publicly traded within two years, following the path of their highly successful sister company, Pure Protein, which had a net value of $50 million in late 2000.

NanoSource Technologies, Inc.
Oklahoma City (www.nanosourcetech.com)

NanoSource Technologies, Inc. of Oklahoma City has achieved a major milestone through proof of concept and first articles available for commercial evaluation.

The company has staked out a niche market, worth an estimated $900 million annually, developing nanopowders, or ultra-small particles for applications ranging from photo catalysis to broad-spectrum ultraviolet filters, such as sunscreens in cosmetic products and protective coatings.

NanoSource Technologies uses a proprietary process to turn titanium dioxide into an ultra fine powder, which is perfect for the sun care products segment of the personal care production industry.

Novazyme Pharmaceuticals, Inc.
Oklahoma City (www.novazyme.com)

Some diseases are so rare and afflict so few people, the medical community has designated them as "orphan,, diseases. The reason: Such a relatively small portion of society would benefit most research efforts bypass these diseases, leaving the victims with few places to look for relief.

One such is Pompe's Disease. Pompe's Disease is a fatal neuromuscular disease for which there is currently no approved therapy. There are fewer than 10,000 Pompe patients in the developed world.

Novazyme Pharmaceuticals, Inc., and its chief scientific officer, Dr. William Canfield, has chosen to focus on orphan diseases, especially those that are based on lysosomal storage disorders. Novazyme is a pharmaceutical company developing biotherapies for the treatment of lysosomal storage disorders. These biotherapies are based on Novazyme's proprietary technologies for the targeted delivery of the missing enzymes critical for the treatment of these diseases. Dr. Canfield developed the technologies in his laboratories at the University of Oklahoma Health Sciences Center.

Investors are convinced that Novazyme will be successful. So much so they have invested $8 million in the company's future. Soon after their successful private equity placement, Novazyme announced the company received notification from the Office of Orphan Products Development at the Food and Drug Administration (FDA) that its proprietary enzyme replacement therapy for the treatment of Pompe's Disease.

ProhibiTx
Oklahoma City (www.omrf.ouhsc.edu)

Diagnosis is the first step in finding a treatment for any of the thousands of diseases that affect our lives. Effective treatment can be even more elusive. But an Oklahoma City company with its roots deep in the Oklahoma Medical Research Foundation, is working on both - at the same time.

ProhibiTx, led by its senior research scientist Dr. Eldon Jupe, is a spinout company from OMRF. The company has attracted investment capital from the Oklahoma Life Sciences Fund and has benefited from preliminary market analysis provided by the Tech Center. The company name is from the gene Prohibitin, a gene discovered to be closely tied to the development of breast cancer, and a marker that health professionals can use to determine a woman's likelihood to develop the disease.

Prohibitin is the basis for the new company's breast cancer diagnostic kit designed to evaluate a woman's susceptibility. Prohibitin is also a tumor suppressor gene, which can exist in either of two forms classified as "C,, and "T.,, The diagnostic under development at ProhibiTx is based on the premise that women who carry the "T,, form are at an increased risk for breast cancer.

Shared Replicators, Inc.
Tulsa (www.sharedreplicators.com)

Shared Replicators, Inc. of Tulsa is a prime example of a company taking a relatively new technology and converting it into a commercial product. Or, in Shared Replicator's case, several products. The company uses solid imaging technology to take an engineer's drawing of a product, component or part and translate it into a digital code for prototype and tooling.

Using this technology cuts up to six weeks from the prototype process, using rapid prototyping, said Ron Jones, the company's president.

Once the prototype digital file has been created, it is saved as part of a CAD/CAM - Computer Assisted Design and Computer Assisted Manufacturing program. This will make it easier to not only prototype the part, but also to manufacture it. Shared Replicators, Inc. is the parent company that also operates a large research facility on the Oklahoma State University campus in Stillwater. Some of the research the company is involved with is so intricate, OSU has been retained as a sub-contractor.

TPM2, Inc.
Bartlesville

TPM2 Inc. of Bartlesville produces advanced thermoplastic composite materials for industrial use. Materials produced by the company are high-strength, low-weight, non-corrosive, thermally stable, re-formable and, perhaps most importantly, environmentally green. That is, they are friendly to the environment because they can be reused and recycled material can be used in their manufacture.

The company uses a pultrusion system with a constant cross section consolidation die for long runs of product to produce materials with desired characteristics for industry use. According to TPM2 president John D. Martens, the company's market strategy is to lead, develop and dominate the pultruded thermoplastic advanced composite market.

VoiceLogger.com
Enid (www.voicelogger.com)

If you have ever wished you could track down important telephone conversations in a fast, convenient way; needed to verify data called into your office. VoiceLogger's DigiVoice recording system is your solution.

DigiVoice is a state-of-the-art voice logger that records up to 128 talk paths per cabinet. Offering complete network capability and redundant disk operation, DigiVoice stores telephone and radio conversations to a PC hard drive for easy retrieval and archiving. It provides everything needed to record, store and manage conversations with ease. Valuable data can be retrieved at the host unit or other networked PC's while the system is recording and monitoring.

The Women s Care Network
Oklahoma City (www.twcn.com)

The Women's Care Network, is an e-care solution for women's health concerns through all stages of life. The company has become of the latest inductees into the Oklahoma Technology Commercialization Center's Million Dollar Hall of Fame after successful fund placements. The Women's Care Network is a comprehensive e-health solution company that focuses on a woman's "lifelong health journey.,, The company is building a business model, doing women's marketing research and developing infomediary applications for computer software which will help women stay abreast of the latest news and developments concerning their healthcare.

OneNet is Oklahoma's telecommunications and information network for education and government. It is a Division of the Oklahoma State Regents for Higher Education and operated in cooperation with the Oklahoma Office of State Finance. This comprehensive network is unlike any other in the country - utilizing fiber optics and wireless technologies to transmit video, voice and data throughout Oklahoma, the nation and the world. OneNet is not a state-owned utility, but rather a state led partnership among telecommunications companies, equipment manufacturers and service providers.

OneNet's was formed in 1992. It was at this time that voters in Oklahoma approved a statewide capital bond issue that provided $14 million for the implementation of a statewide telecommunications network. In late 1995, the State Regents approved the OneNet business and implementation plan in 1996.

Upon its implementation, OneNet focused on establishing the necessary hub sites throughout Oklahoma to provide the infrastructure necessary to support the high-speed telecommunications network. In addition, it moved aggressively to establish an equitable rate structure and enroll customers.

OneNet's state-of-the-art technology and dedicated staff currently provide high-speed communications to a variety of Oklahoma entities such as: public and vocational-technical schools; colleges and universities; public libraries; local, tribal, state and federal governments; court systems; rural health care delivery systems; and programs engaged in research. As of December, 2000, over 1,600 organizations are customers served through OneNet. With a few exceptions, state policy precludes private business membership at this time.

This electronic linkage is made possible through a partnership between the State of Oklahoma and private telecommunications companies - enabling OneNet to negotiate reduced rates and utilize established, private communications networks. The result of this partnership is millions of dollars in savings to Oklahoma taxpayers, as well as the rapid development of a telecommunications infrastructure that is one of the most comprehensive in the nation.

Internet 2

OneNet has recently connected the statewide education network to the next-generation Internet – Internet2. This linkage will provide Oklahoma's educational system access to the world's largest and fastest research network for research & distance learning activities.

Internet2 is a consortium being led by over 180 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet. The primary goals of Internet2 are to:

- create a leading edge network capability for the national research community;
- enable revolutionary Internet applications;
- and ensure the rapid transfer of new network services and applications to the broader Internet community.

Oklahoma has had ties with Internet2 since its inception. However, direct access to the advanced network has been, up to this point, limited to the three higher education research institutions: the University of Oklahoma, Oklahoma State University and the University of Tulsa. These institutions are considered primary Internet2 connectors, and sponsorship from one of them is required for access to the advanced network.

A very unique sponsorship arrangement was achieved earlier this year when the Western Heights public school district in Oklahoma City became the first public school in the nation to secure a connection to Internet2. Under sponsorship of OU, the purpose of the advanced network connectivity was to establish high-quality distance learning communications between the school district and academic resources throughout the country.

"Knowledge is wealth, and the Internet2 connection will provide us an extraordinary tool to become more competitive as a state . Hans Brisch, Chancellor , Oklahoma State regents for Higher Education

Oklahoma's VISION

Virtual Internet School in Oklahoma Network (VISION)

The Oklahoma State Regents for Higher Education and OneNet are partners in the development of the Virtual Internet School in Oklahoma Network (VISION). Other partners providing significant support include Microsoft, Dell and Intel. They are doing so in recognition of Oklahoma's unique network that provides a sound test bed for advanced networking.

The VISION project, established by law, is an ambitious project that will profoundly impact the way the business of education is structured in the State of Oklahoma and nationally.

In its simplest form, VISION has the potential to remove the geographic and technological barriers that currently exist in our educational system, resulting in increased access to essential information that was once unattainable. The outcome of the VISION project will be the development of an Internet-based education portal -- designed to manage the delivery and performance of educational content and restructure the education management process within the State of Oklahoma.

The enabling legislation that created VISION defined that a pilot program be developed. The purpose of the pilot program is to provide verifiable information on the advantages of web-based instructional programs. Specifically, it will concentrate on the development of web-based instructional programs in mathematics for all grades - beginning with the third grade. The pilot will also enable development and testing of procedures and standards so that implementation of a virtual, statewide Internet school network can be achieved seamlessly.

" It is an honor to be aligned with prominent tech industry leaders [Microsoft, Dell, Intel, SAS] and to play a role in the enhancing of Oklahoma's educational technologies," said Bill Shafer, Executive Director of OneNet.

The schools selected for the initial pilot are: Claremore, Lawton, Stilwell, Durant, Muskogee, Tulsa, Frontier, Oklahoma City and Western Heights.

To assist in the design, development and implementation of the VISION project, Oklahoma sought assistance from technology corporations. To date, Dell, Intel, Microsoft and SAP have committed millions of dollars in support of the initiative.

VISION will improve:

- ***How we teach***
- ***What we teach***
- ***Teacher/student assessment***
- ***Enhance accountability***
- ***Socio-economic "Quality of Life"***
- ***Quality of knowledge***

Public-private partnerships have been the cornerstone to OneNet's success and have afforded Oklahoma the ability to move rapidly in the integration of state-of-the-art technologies and advanced applications. Similarly, this partnership between the State of Oklahoma, Dell, Intel, Microsoft and SAP demonstrates not only a continued commitment to a common goal, but engenders the same spirit of innovation that made OneNet what it is today.

As a national leader in distance learning and telecommunications, OneNet recognizes the importance of new technologies and the multifaceted impact a project such as VISION can have on Oklahoma's educational and economic progress. Moreover, OneNet is a partner in this historic endeavor and will contribute in the development and deployment of this twenty-first century system.

Source:: http://www.onenet.net/onenetnews/category2/sub3 vision_project.htm

Oklahoma Research

Agriculture & Technology

Oklahoma State University

The Oklahoma Food and Agricultural Products Research and Technology Center houses nearly 20 faculty and staff members with expertise in a variety of technical areas, including: Agricultural Economics, Business and Marketing, Cereal Science, Food and Process Engineering, Horticultural Food Science, Meat Science, Food Microbiology, Oils and Oilseeds, Quality Control and Assurance and Sensory Analysis.

The center's technical faculty and staff, with experience in both university and industry settings, can assist companies with projects from meeting new USDA regulations for food safety, to process optimization, and helping you redefine a new product or improve an existing one.

Besides acting as a rapid-response team to the needs of industry, the center is the site of numerous long-term research programs. Each of the center's technical faculty and staff serves on both extension and research appointments. This allows faculty to assist with the needs of the value-added food and agricultural products industry while looking forward to the future of the industry they serve.

The Food and Agriculture Products Research Center houses specialists in several disciplines connected with food and agricultural products processing. Here, we detail some of these specific areas of interest and expertise.

Center faculty and staff also work closely with other members of the Oklahoma State University 'Value Added Faculty' team from across the campus and the state, as well as the Oklahoma Departments of Agriculture and Commerce and other state agencies to provide individuals with technical support and reliable information.

Oklahoma Research

Energy & Technology

University of Oklahoma

The University of Oklahoma Sarkeys Energy Center is the most comprehensive center of knowledge in the petroleum industry.

The Center includes six interdisciplinary institutes and a special institute which focuses on the Western Hemisphere. All the institutes involve faculty from the colleges of Geosciences, Arts and Sciences, Law, Business and Engineering. Focusing on the energy-related strengths of the university, the institutes develop technology and programs that advance the energy industry in the state and throughout the world and provide significant, "real world" research and education opportunities for students.

The center is a four-square-block, seven-acre, 340,000 square-foot teaching and energy research complex located on the northeast corner of the Norman campus of the University of Oklahoma. There are more than 200 teaching and research laboratories, over 30 classrooms, and faculty and administrative offices.

The center is also home to the Lawrence S. Youngblood Energy Library, which houses the combined geology and geophysics collections of the Oklahoma Geological Survey and the University of Oklahoma that began in the late 1890s, and today contains more than 90,000 catalogued volumes and more than 200,000 map sheets.

The center makes possible an interdisciplinary approach to research as well as critical interaction and collaboration with industry and governmental agencies. The facility provides researchers with highly sophisticated equipment in state-of-the-art laboratories, enabling them to effectively seek solutions not only to today's problems, but to identify and begin addressing the problems of tomorrow as well.

A Missed Opportunity in Oklahoma

Oklahoma Telemedicine Network

Any futurist, technology strategist or policy analyst worth their salt will readily concede that medicine can be ... and will be ...practiced much differently in the future due to the application of advanced communication technology. That said, "telemedicine,, seems to be a wonderful idea ... at sometime in the future.

It is written that "telemedicine,, will be the "seventh revolution in medicine. [1] The first six are: anesthesia, scientific disease model and public health, radiology and diagnostic imaging, educational reform, antibiotics and prevention, and genetics and pharmaceuticals.

So where has Oklahoma been?

In truth, Oklahoma has been a national leader in telemedicine efforts during the 1990's. The Oklahoma Telemedicine Network (1994-97) was the most ambitious state effort in the nation. In 1996, an Oklahoma hospital was judged to have the "best telemedicine program in the nation,,. The 1997 Oklahoma Telemedicine Act removed private insurance reimbursement barriers, and was the second state in the nation to do so. However, public barriers (Medicare/Medicaid) remained. Unfortunately, lots of effort bore little fruit. Consider this brief timeline.

1992
The Governor's Conference on Rural Health called for consideration of "telemedicine,, in Oklahoma.

The Oklahoma Academy convened a Governor's Conference on Telecommunications. Telemedicine was a featured demonstration application, and national experts spoke of its utility.

1993
In 1993, the Telecom Conference Task Force called for favorable tariffs for "quality of life,, applications such as education and health care. Those tariffs were allowed by the Oklahoma Corporation Commission and were a foundation for an affordable OneNet.

1994
In 1994, the Oklahoma launched a $4.3 million Oklahoma Telemedicine Network consisting of 45 hospitals in smaller communities. It was one of the most ambitious public telemedicine projects to-date.

All funds were provided by federal Community Development Block Grant funds. No monies were invested by participating hospitals; and no state appropriated funds were committed. The OTN pre-dated Oklahoma's OneNet. This forced the OTN to try to build the infrastructure necessary to transmit data. At that time ... such an effort was expensive and difficult. The expense significantly eroded the $4 million.

1997
The federal grant funds expired and the OTN was disbanded. All teleradiology equipment remained in possession of participating hospitals.

Hospitals were provided OneNet membership with a state subsidy. Most accepted. Upon expiration of the subsidy, most hospitals were invited to use their own funds to sustain their connectiuons. Most declined.

1998-2000
A few OTN hospitals individually reconditioned their teleradiology equipment, sought and received urban radiology support, and are meeting selected hospital needs.

"Success has many fathers ... but failure is an orphan,, There are a host of real, imagined or assumed reasons why the OTN did not flourish. In reality, the OTN may simply have been the case of a great idea; less than great execution; pre-dating affordable technology; and being too far ahead of its time. It is also a lesson that even "free,, money (federal grants) cannot defy the laws of the marketplace. The Oklahoma Telemedicine Network was a missed opportunity for Oklahoma.

[1] *Telemedicine and the Reinvention of Healthcare, Jeffrey Bauer, PhD, McGraw-Hill, 1999*

Michael Lapolla, Senior Consultant, Telemedicine Center
Oklahoma State University Center for Health Sciences

Ireland: The Celtic Tiger

The population of Ireland is only slightly larger than Oklahoma

One of Europe's economic success stories is the Republic of Ireland, a small and seemingly remote country on the far western edge of Europe, facing the Atlantic Ocean.

History has not been kind to it. For centuries, it was a place of civil conflict between the largely Celtic indigenous population and the ruling British. It suffered poverty and continuous emigration. But from being an economic backwater only two decades ago, Ireland has emerged as one of the world's strongest-growing developed economies - a "Celtic Tiger,,, as it is called. How did it achieve this, and what lessons does it offer the post-communist states now seeking similar transformation?

The single-minded policy of the Irish Republic has been to attract investment by offering itself to multinational companies as a base for service, distribution or manufacturing. This achieved only limited success until the 1970s, because the country has a market of only 3.5 million people, and transport costs are high. But then came membership in the European Union, and perspectives changed.

Irish success story began with education
April 23, 2001 ¥ Houston Chronicle

W e ve positioned ourselves to capture the second industrial revolution, said Ireland s President Mary McAleese at the Baker Institute here last week. ... She earlier told the Chronicle s Editorial Board that one of the big things we [Ireland] got right was when industry took notice of its role in helping to promote the country s college sector.

Suddenly, Ireland looked attractive to companies, particularly from the U.S., as a stepping stone into the huge EU market. Added to this was an incentives package including low taxes on company profits and capital grants.

Major EU grants over the years have given the country a modern infrastructure. Today, Ireland attracts close to $11 billion annually in direct investment, and — in a remarkable turnaround — has become a country of immigration, as Irish-based companies seek to recruit extra Irish staff from the U.S., Europe and even New Zealand.

The major sectors of growth are manufacturing of computer equipment, particularly software, the manufacture of pharmaceuticals, the marketing of financial services and general service sector activities like international telephone marketing.

Fergal Shortall, research specialist with the Economic and Social Research Institute in Dublin, says Ireland offers three lessons on how to prosper in modern conditions. He lists these as emphasis on social partnership between government and governed, workforce flexibility and education.

The government's intention is to pass on gains in economic wealth to the people not just through wage increases, but through tax relief. It is continuing to reduce individual tax burdens as a means of increasing spending power.

As to labor-market flexibility, this relates to the willingness and ability of the work force to take on new jobs and skills as technology and market requirements change. To try to minimize dislocation and cushion the impact on individuals, the government offers job re-training schemes, generous unemployment benefits and free medical care for those whose incomes drop below a certain level.

On education, Shortall notes that emphasis on schooling means that up to half those entering the work force are university graduates. They have a good employability profile and are able to contribute a high return to the economy. The result of all this is a modest prosperity in which joblessness, always one of the scars on Ireland's social fabric, is dropping. Unemployment stood at 15 percent in 1993, but is now below 10 percent - which is beneath the EU average - and it is still dropping.

A Peer Country

Singapore: The Asian Tiger

The population of Singapore is only slightly larger than Oklahoma

Singapore is a city-state with a population of 3.5 million. Singapore faced daunting economic challenges when it gained independence in 1965. They included:

- A small country with no natural resources;
- High unemployment rate (10%);
- Little domestic entrepreneurial capital or technological know-how to start new businesses;
- A small manufacturing base;
- Economy heavily dependent upon the British Military.

The Government boldly adopted economic policies to encourage open trade and investment. These policies have allowed this small country to attract huge inflows of Foreign Direct Investment (FDI), which in turn have fueled economic growth, prosperity and stability.

Singapore's economic transformation occurred in several stages. Between 1965-1980, the government liberalized trade and investment laws to attract foreign direct investment (FDI). It invested heavily in infrastructure and established new companies where the private sector lacked capital or expertise. It also put in place governmental organizations that would promote trade, develop modern infrastructure and regulate industrial relations.

In 1980, the Government recognized that the world economy was changing and that it had to adopt new policies to successfully compete, including: a renewed emphasis on education and training, policies which encouraged automation and computerization, investment in research and development (R&D) and the creation of new service industries.

By 1990, Singapore had reached the ranks of a Newly Industrialized Economy (NIE) and a new strategic plan was implemented to transform Singapore into a developed country. Key elements of the 1990 plan included:

- Enhancing human resources,
- Promoting national teamwork,
- Creating a climate that would encourage innovation,
- Developing manufacturing and service clusters and
- Promoting Singapore as a center of global trade.

By the mid-1990's, Singapore had become an Asian Tiger and one of the greatest economic success stories in all of Asia.

Singapore has been actively cultivating intellectual capital and advanced infrastructure to build strong industries with competitive levels of innovation and technology. To facilitate the new knowledge-based economy, the Government is making further improvements in infrastructure.

- Terminal 3 at Singapore's Changi Airport will be completed in the year 2004, which will increase the capacity of the airport to 60 million passengers a year.

- Singapore will be the 1st country in the world to be connected by a single broadband network. Singapore ONE's collaboration with US-based @Home Network will expand its services beyond the domestic market.

- Singapore ranked 2nd behind the U.S. as the world's most competitive economy in the World Economic Forum's Global Competitiveness Report 1998. Attributes of openness, efficient government, strong finance and advanced infrastructure and technology, were vital in obtaining that rating.

- The National Science and Technology Plan 2000 aims to spend more than S$4 billion over five years to strengthen indigenous technological capabilities to support private R&D work.

- The Singapore government is spending S$2 billion on Information Technology for education. By the year 2002, there will be a ratio of one computer for every two students in Singapore.

Statistics Source: Singapore Ministry Funded by the United States Agency for International Development

AMIR Program Office: 66 Abdul Hameed Badees Street,
P.O. Box 940503, Shmeisani, Amman 11194 Jordan
Main Tel: 962-6-566-1831 or 962-6-566-1832
Fax: 962-2-560-3599
EMail : info@amir-jordan.org

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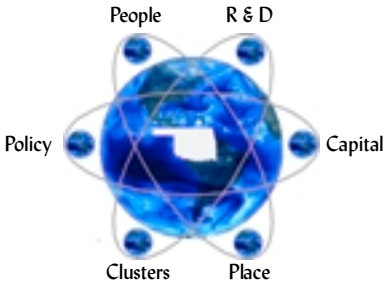
Section 5

Preparing to Compete in an Innovative World

Alexander Holmes, PhD



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Section 5

Preparing to Compete in an Innovative World

Alexander Holmes, PhD

Preface

The Research Committee tasked Dr. Holmes to bat cleanup ... that is offer his concluding perspective after the first four sections were presented. We asked that he write an informed op-ed style narrative that draws upon the previous sections ... and upon his extensive experience in the public policy arena in Oklahoma. We asked him to focus upon the fundamental and essential requirements for Oklahoma s successful adaption to an increasingly innovative world. His informed opinions follow. It happens that our Research Committee agrees with them.

Now What?

There are any number of ways to slice the economic landscape, just as there are any number of ways to slice a government budget.

The usual and most relevant way of analyzing a government budget, in terms of oversight and accountability, is agency by agency. There is a presumption that functions of government are organized on an agency basis. Clearly, however, when considering broad targets of government services multiple agencies are involved.

If one is examining the government's role in education, perhaps as many as ten agencies are directly responsible. If one wished to know the government's commitment to children, then the number increases to perhaps 30 agencies. In the area of promoting economic development, ten to twenty agencies can easily be identified as having some programs with this specific mission.

The economy can be similarly segmented into various sub-sets of activity. Perhaps the broadest cut is simply dividing economic activity into the two categories of private sector and public sector. Within the private sector, (leaving aside for the moment the issue of where exactly the non-profit sector lies) the usual divisions are along industry lines; manufacturing, mining, real estate, et cetera.

This taxonomy has been historically used by economists to measure the general condition of an economy, and by those wishing to identify areas of potential future expansion. Those concerned with this activity include investment advisors seeking the most promising stock picks, venture capitalists deciding where they might receive the greatest return, and those in government hoping to forecast trends that can be used in determining policies to the advantage of their state's or nation's economic development.

A New Economy?

Some use the term New Economy as if it were a separate industrial sector. It is not. This analysis acknowledges that new technologies are being embedded in an existing economy. We are swimming in the same lake.

In fact, there is no such thing as the "new economy,, today, any more than there was a "new economy,, in 1900 when electricity was being widely adopted in manufacturing, or in the 1940's and 50's, when motor carriers were providing an alternative form of surface transportation. Indeed, any number of examples of major shifts in economic activity flowing from technological change can be identified, starting perhaps with the wheel and fire to domesticated animals, water power, steam power, and the use of fossil fuels in internal combustion engines.

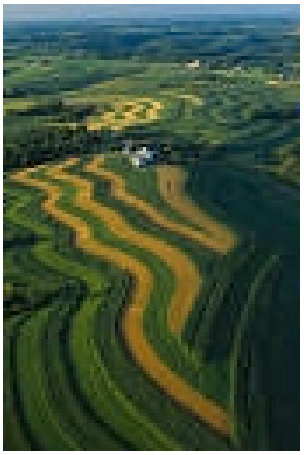
What seems common to each of these "new,, economies is the shift from one source of power to another, each providing a substitute for the primary source of power: human muscle. In essence, the human brain devised ways to relieve the human long muscles.

In each of the instances, the innovation found its way into <u>all</u> sectors of the economy. Certainly, some were more effected than others: water power provided no relief to the farmer at his plow, although now less time and expense were required to bring the crop to market. How quickly the transformation took place and the impediments to adoption are of some interest.

Innovation, Adaption and Culture

All innovations challenge the cultural status quo.

Contour plowing is tilling along the lines of the hills and valleys of a field to reduce erosion and retain rain for the crops. It was acknowledged to be an improvement over straight line plowing from at least the time of Benjamin Franklin. It took more than a century,



and significant expenditure by federal and state agricultural extension agents, to fully overcome the cultural stigma associated with this technique: only lazy farmers plowed along the lines of a hill; the mark of a good farmer was perfectly straight and parallel furrows!

Some cultures, for whatever reasons, are more fluid, more adaptable, less entrenched in past practices. Some cultures embrace the future and the potential of innovation while others, even in the face of incontrovertible evidence of the economic benefits, reject change. The historical record tells us that those who have most quickly adopted the "new economies,, of the past have been those who have gained the most economically. And just like compound interest, future gains are more easily added to a large base than to a small base. Taken over a long period, say a century, those who have come late are behind by a significant distance and must work harder just to stay even.

Culture and Change
All innovations challenge the cultural status quo ... Some cultures embrace the future and the potential of innovation while others ... even in the face of incontrovertible evidence of the economic benefits ... reject change.

Also common to these "new [innovative] economies,, is the required increase in the need for the human brain to adopt and adapt. The "shade tree,, mechanic is a thing of the past, and not the very distant past. Through history, those segments of the economy that have been the last to adopt innovation are the last bastions of the poorly educated. They are those who have failed to exercise their brain muscle to substitute for their long muscles. These sectors lag the rest of the economy and retard the general growth. Those who find themselves toiling in these economic backwaters are increasingly marginalized. This is as true for whole counties, and states as it is for individuals.

Often, it is simply the frailty of the human condition that finally completes the transition as those in these marginalized sectors die out. This has occurred countless times through history with an associated social cost in each instance. Before government intervention in the form of various transfer programs, this process proceeded relatively quickly, if a bit less humanely.

Motivation
Public policy that subsidizes those who refuse to make the changes demanded by changing economic conditions draws resources from high growth potential pursuits and directs them to low growth pursuits.

Cultures that regard change as either frightening or "bad,, or both, in a democratic society, have the ability to further retard the transition. Public policy that subsidizes those who refuse to make the changes demanded by changing economic conditions draws resources from high growth potential pursuits and directs them to low growth pursuits. Mandating agricultural education in colleges and universities, as done in Oklahoma in the 1930's through the efforts of Governor "Alfalfa,, Bill Murray, is an example of such a policy.

This is not to say that all innovation is without its costs. Pollution, loss of open space and privacy are frequently brought complaints against various changes brought on by the previous "new economies,,. Each year, some 42,000 people die in the United States in automobile accidents, a type of death not even possible just 100 years ago. Modern technology increases dramatically the level of damage to people relative to older technologies, although the probability of damage is significantly reduced. Many tens of thousands of people suffered various ill health effects from lighting with oil and kerosene, but few died. Today there is no general ill health effects from the electric light,

but those few damaged are either killed or much more severely effected than those relatively modest health problems in days gone by. New technologies seem to reduce the probability of damage to an individual, but increase the extent of that damage when it occurs.

But it does not seem to be the cost-benefit calculation of damages that underlies the intransigence of one culture as compared to another when it comes to adapting to changing economic circumstances. At core, some cultures embrace the opportunity for change, others are suspicious and threatened.

Dominant Culture
When the dominant culture is suspicious that they will be losers in the new economy they may be able to r etard its adoption through public policy ...

When the dominant culture is suspicious that they will be losers in the New Economy they may be able to retard its adoption through public policy. This may be as subtle as the outright prohibition against teaching writing to children in various Pacific Island cultures in the early 1900's, to more overt practices as the restrictive banking laws reducing competition in Oklahoma throughout much of her history. There is essentially no difference in the desires of the two policies, both are born of a culture that is not only unprepared for change, but reacts to counter the perceived ill effects on those capable of forming public policy. The long-lasting damage of such policies is not considered relevant; these policies are those of a present oriented culture, and to some degree, a selfish culture.

Preparation and Change
Participation in the New Economy ... requires preparation. As the new technologies emerge ... they require even more preparation and change than that which went before.

Participation in the New Economy, whether it be that of information technology, biotechnology or the new horseless carriage, requires preparation. As the new technologies emerge they are by their very nature more complex than that which preceded them. Consequently, they require even more preparation and change than that which went before. In order to provide this preparation something must be given up today for the benefit received tomorrow. Unfortunately, most of us will not be here tomorrow, thus we are asked to sacrifice for a future in which we will participate only temporarily. A present oriented culture will not make such sacrifices, and thus will leave as it legacy a generation ill prepared and unable to reap any of the fruits of the innovations.

Oklahoma s Assets and Liabilities in an Innovative Economy
If there is no real New Economy, then the analysis of this report is to be viewed as a discussion of the current New Economy ... or what we call an "innovative world,,. It follows others and will be followed again by something even newer. But historically, everything that follows builds on that which came before. What is new now will remain in place, and all the requirements to succeed in this environment will likewise remain in place and be increased as the future unfolds.

As a rationale for slicing economic activity according to how a state fares in a New Economy, one need go no further than to compare the growth rates of states with significant concentrations of New Economy jobs with those states with a small proportion of jobs so defined. States' growth rates are dramatically improved if they have high concentrations of such jobs. It follows that, at least for the short-

term, and perhaps longer, public policy that provides a foundation for expansion of these jobs can only be beneficial to the state's overall growth potential.

It is not as if Oklahoma has done nothing that might be effective in exploiting the potential of New Economy jobs, although the record of success is slim. In some cases, more promise is offered than delivered. Changes in the state's constitution to allow contracting by the comprehensive universities with the private sector with the possibility of royalties and high tech jobs for Oklahomans has borne no fruit since its inception in 1998. It seems the only employment gain has been for lawyers squabbling over various rights of ownership.

The Oklahoma Center for Science and Technology (OCAST) was created as a new state agency in 1987. Today its mission is to support basic and applied research, to facilitate technology transfer, to stimulate seed capital investment in firms commercializing new technologies, and to encourage manufacturing modernization. With expenditures of about $15 million in the 2001 fiscal year, the agency has played an especially important role in expanding the research infrastructure of Oklahoma higher education. More detail on OCAST is found in the Appendix section (see The Oklahoma Model and Partial Oklahoma Time Series charts).

Tax incentives are in place for everything from venture capital to low-interest loans. It is extremely difficult to evaluate the actual economic impact of economic development incentives. The critical problem in evaluating these programs centers on issues of whether or not the project would have taken place anyhow-even without the benefits of the state/local economic development program. Moreover, many of the economic development programs are competitive reactions in Oklahoma to initiatives implemented in other states. It is often the case that no careful analyses of these programs have been conducted and only impressionistic conclusions can be reached. More effort needs to be devoted to evaluation of the often expensive economic development initiatives in terms of how well they meet their stated goals.

Competitive?
This report ... relying heavily on various measures of the magnitude of the New Economy in Oklahoma as compared to other states ... sadly concludes that Oklahoma is lagging significantly. Oklahoma s place in this current New Economy is tenuous.

This report ... relying heavily on various measures of the magnitude of the "new [innovative] economy,, in Oklahoma as compared to other states ... sadly concludes that Oklahoma is lagging significantly. Oklahoma's place in this current New Economy is tenuous. As the report clearly shows, various ranking systems place Oklahoma, as a state, below most other states. Other ranking systems, however, show what is already well known using other more traditional economic measures: rural Oklahoma is not and has not participated fully in several of the past "new economies,,. The current New Economy is perhaps more urban than economic changes in the past and Oklahoma's two urban centers are much more well prepared to participate. But the new technology-based economy is urban by its very nature, in Oklahoma and elsewhere. Urban location seems critical to success.

Both Tulsa and Oklahoma City would seem to be potential growth poles for New Economy development. The location of extensive private and public sector research activities in these two cities would seem to be the justification for such a claim. These are clearly assets as one evaluates Oklahoma's New Economy potential. It also poses a public policy problem in the context of Oklahoma's culture. If history is any guide, concentrating state resources in targeted geographic areas runs contrary to the political will of the legislature. Such programs as state subsidized research professorial chairs at the comprehensive research universities had to be accompanied by expenditures at non-research colleges, and funding of the Oklahoma School for Science and Mathematics had to carry the weight of funding "lecture,, programs at regional schools. The culture seems to require a spreading of resources even when no, or only trivial gains, are possible. These policies come from some notion of fairness rather than from an efficient use of scarce funds. This mind set must be counted as a liability simply because subsidies to less productive use of funds reduces the overall effectiveness of the limited resources of the state.

Education: A Fundamental Need
No amount of state public policy can substitute for the value of offering high skilled, productive workers to the private sector ... the new economy requires even higher quality and extensive education than that which have proceeded it.

This current New Economy, as with those past, places a greater reliance on mental preparation. If the internal combustion engine augmented human and animal muscle, this new economy augments mental ability. The preparation needed for participation in this new economy is obvious: education. Participation can occur at the margins, such as the manufacture of computer hardware. Here, relatively low levels of skill are required but are, of course, accompanied by low wages and little in the way of possible advancement.

Oklahoma often touts her low cost of labor as an economic development advantage. When the jobs offered are low skilled, it is no wonder that the cost of labor is low. Wages reflect the value of the labor to the enterprise. A true economic advantage is one where the wages are low relative to the skill offered. Saying that Oklahoma's cost of labor is low is often simply nothing more than saying that Oklahoma's labor pool offers below average skills, hardly a powerful draw for industries that require high skills to compete in the world market.

More devastating is the future of an economy that lags behind in the skills needed by the growth centers of the New Economy. As with all past new economies, workers with low skills and little way to augment them become increasingly isolated from the growth trends of the world economy. The relative position of workers in such situations falls ever increasingly behind those who have more to offer the marketplace.

No amount of state public policy can substitute for the value of offering high skilled, productive workers to the private sector. Low taxes may induce modest increases in jobs offered relative to high taxes, but what is offered in terms of the quality of the jobs will always be matched to the skills possessed by the indigenous workforce. No state can buy quality jobs with low taxes, low interest rates, subsidized land and capitol, relief from regulation, or any other form of cost abatement policy. All quality jobs flow to those with quality skills. Who, after all, would pay for medical care rendered by someone with no training or experience simply because they offered to do the work at ten cents on the dollar.

There is a car often parked in the Dale Hall lot at the University of Oklahoma with the bumper sticker, "If you think education is expensive, try ignorance,,.

The New Economy requires even higher quality and extensive education than that which have preceded it. What was good enough for the current generation will not be good enough for the next.

The New Economy raises the stakes considerably. Ignorance in the form of poor education for the current generation dooms them to a marginalized economic future.

If there is a single lesson to be drawn from this analysis of the impact of the New Economy on Oklahoma, it must be that now more than ever before the future belongs to those with solid education and training. Here seems to lie the only truly productive public policy for a long-term solution to secure a place in the New Economy for Oklahoma s next generation.

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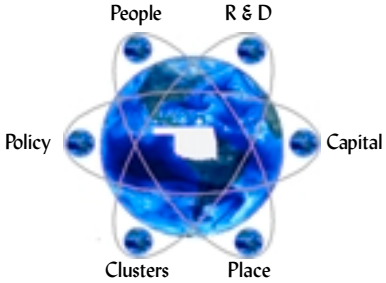
End Notes



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21. Oklahoma State Regents for Higher Education, Degrees Conferred in Oklahoma Higher Education 1998-99, Vol. 1, Sect. I (October 2000), Tables 6-8 (http://www.okhighered.org/degrees-conferred(.

22. All data on employment outcomes (employment, industry, and salaries) of Oklahoma graduates is from Oklahoma State Regents for Higher Education, Annual Employment Outcomes Report (June 2000) (http://www.okhighered.org/reports/employrpt-6-2000.pdf(. Because of insufficient data, employment patterns for recipients of computer science certificates and doctoral degrees are not reported.

23. Calculations based on Oklahoma State Regents for Higher Education, Degrees Conferred in Oklahoma Higher Education, Vol. 1, Sect. III (October 2000), Table 32.

24. The following individuals at the Oklahoma Department of Career and Technology Education helped explain the training opportunities available through the career and technology education system and also provided invaluable information about IT in general: Laurence Beliel, Gerald (Mac) Brown, Sheryl Hale, Robert Hamilton, Kelly Johnson and Larry Keen.

25. Oklahoma Department of Career and Technology Education, unpublished data.

26. The career and technology schools offer training toward certification. They do not do the certifying. Therefore, there are no data on the number of people receiving IT certifications through the career and technology education system.

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Tony Hutchison, Jeannie Bordelon-Parker, & Ryan Kiesel

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- 1999 Population data: U.S. Census Bureau
- 1999 PCPI data and Average Wage per Job: Bureau of Economic Analysis
- Median 2000 Family Income data: www.fdic.gov/news/financial/1998/fil9844c.html (Census data not available beyond 1990 - HUD uses census data to obtain 1998 estimates.
- Tax Burden data: National Conference of State Legislatures
- Personal/Corporate tax data obtained by surveying each of the states. *Texas does not have a "Corporate Income Tax", but it does have a "Corporate Franchise Tax" which is virtually the same thing. This tax is computed at the rate of .25% of net taxable capital, plus 4.5% of net taxable earned surplus.
- Sales Tax Rates: Obtained by calling each of the profiled city's chamber of commerce
- 2000 Cost of Living Data: ACCRA
- Housing Cost data: http://list.realestate.yahoo.com/re/neighborhood/serch.html
- Bachelor's Degree 1999 Data: http://verticals.yahoo.com/cities
- State ACT Score Data: www.act.org
- State Public Education Score: Education Week. Values calculated by assigning a numerical value to the letter grades earned in each of the following four categories: Standards & Accountability, Improving Teacher Quality, School Climate, Resource Adequacy, and Resource Equity. Idaho was not scored in the "School Climate" category. Therefore; their score was calculated using the average of the remaining values. Based upon a 4.0 scale.

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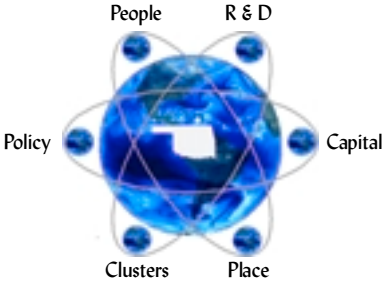
Appendices



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Appendices

Oklahoma State University College of Business Administration

Oklahoma's Economic Outlook

Growth is expected to be sluggish the remainder of the year, rebounding modestly in 2002.

With a smaller employment share in the hi-tech industry, and its greater share of employment in the energy sector, Oklahoma has not been as adversely impacted by the U.S. economic slowdown.

Following its losses in 2001, Oklahoma manufacturing is forecast to level off in 2002. Construction growth will cool off somewhat in 2002, while employment in the energy sector will stabilize after its recent rebound. Service sector employment growth will pick up as consumer spending accelerates.

Personal income is forecast to grow 3.9 percent in 2001, and 3.8 percent in 2002. This maintains the ratio of Oklahoma's per capita income to that of the nation at approximately 80 percent. With the slowing growth of employment, the unemployment rate will creep up slightly above 3 percent. Real GDP likewise will slow to growth of 1.3 percent in 2001 and 1.9 percent in 2002.

Oklahoma City Metro area: Personal income is forecast to grow 4.4 percent in 2001 and 4.6 percent in 2002, maintaining a ratio of per capita income relative to the nation of 84 percent. Growth of approximately 1.4 percent is forecast for total non-farm employment in 2001, followed by 1.8 percent in 2002.

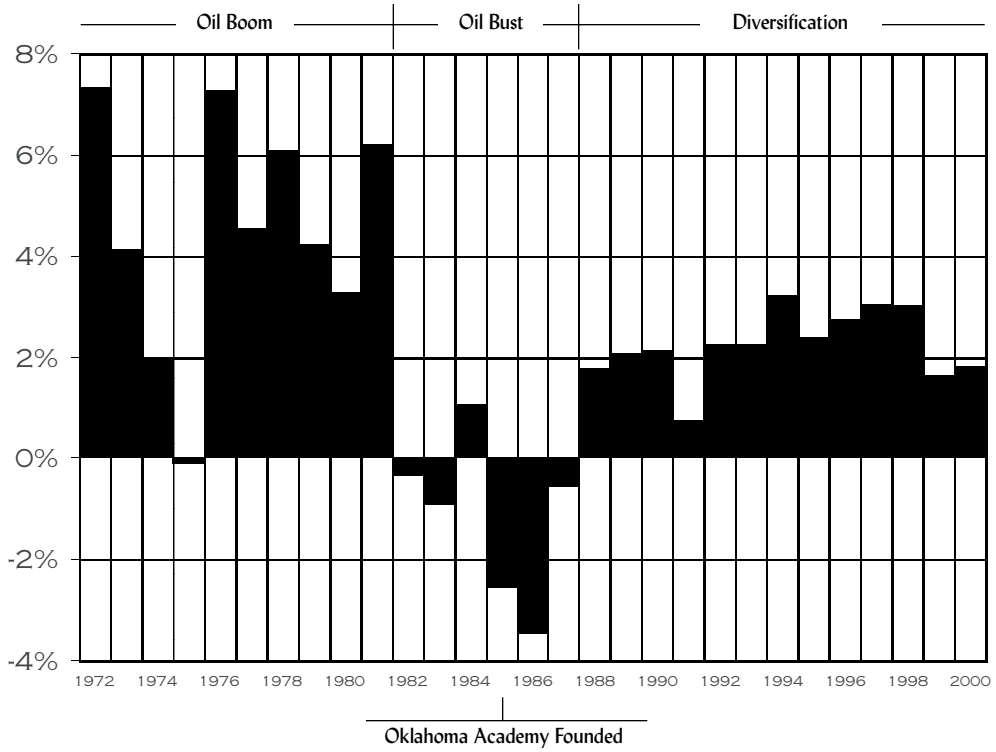
Tulsa Metro area: Personal income growth of 4.7 and 5.1 percent is expected for 2001 and 2002, respectively. This maintains Tulsa's ratio of per capita income to that of the nation at approximately 93 percent.

Source: Oklahoma State University College of Business Administration, July 2001. http://economy.okstate.edu/outlook/2001/julyupdate.asp

Michael F. Price College of Business, The University of Oklahoma

Oklahoma's Historical Economic Performance

Year to Year Percentage Change of Oklahoma's Annualized General Business Index



Source: Center for Economic Management and Research, Michael F. Price College of Business, The University of Oklahoma (http://origins.ou.edu)

The Oklahoma Model

by H. Randall Goldsmith, Ph.D. Executive Director, Oklahoma Technology and Commercialization Center

Faxes and phone calls poured into my office this week from friends in New York, Florida, Texas and California congratulating me on Oklahoma's recognition in the Wall Street Journal. The article opened with ...

"Hungry for high-tech venture-capital money, states far from technology hotbeds are offering institutional investors an incentive they may find hard to resist: guaranteed returns.,,

It went on to note that Arkansas recently adopted a plan to raise $80 million using tax credits as guarantees, with at least three other states - North Carolina, Idaho and Arizona - filing similar legislation.

However, the faxes and phone calls were generated by a part of the article that stated, "The plans are modeled after a program established in Oklahoma back in 1993, which has helped that state steadily boost its technology presence.,,

The article went on to describe how Oklahoma uses tax credits to stimulate private sector investment through the Oklahoma Capital Investment Board which has realized a 28 percent return over the years.

The main point of the story was to demonstrate how states are trying to level the playing field with resource and capital-rich states like California, Texas, Massachusetts and New York. While I wish them well, a quick legislative fix might not be the total solution. If states want to look at Oklahoma as a model, there is much more to know and understand.

What many don't know - even in Oklahoma - is Oklahoma's progress is based upon an evolution of well thought-out programs supported by Oklahoma legislation. Oklahoma legislators in 1987 passed several bills that are now resulting in dramatic economic impacts and gaining national recognition.

One bill created the Oklahoma Center for the Advancement of Science and Technology (OCAST). It authorized five new funding mechanisms: the Centers of Excellence program, the Health Research Program, the Applied Research program, the Small Business Innovation Research Incentive and Matching Funds program and the Oklahoma Seed Capital program.

Today these mature programs are effectively stimulating the conception, development and growth of high-tech, research-based companies.
A second legislative bill created the Oklahoma Capital Investment Board that contributes state backing to venture capital firms, particularly those investing in technology companies starting in Oklahoma.

Oklahoma in 1988 approved an amendment to the State Constitution authorizing OCAST to use public funds to make investments in private enterprise. This decision ultimately led in 1998 to the creation of the OCAST Technology Business Finance Program, which currently is generating $14 of private investment for each $1 of repayable state money. In 1989, the OCAST Board approved a Seed Capital Program but has never pursued legislative appropriations.

The Legislature in 1992 created the Oklahoma Research and Development Incentives Act and the Oklahoma Quality Jobs Program allowing companies to access state sales tax and income tax credits.

In 1994 the Quality Jobs Investment Program legislation provided matching funds to investment groups who raise funds to increase capital in Oklahoma. This legislation along with the Small Business Capital Formation Incentive Act providing tax credits for investment in qualified Oklahoma companies, underlies the dramatic change in Oklahoma's angel investor environment.

For many, 1998 will be remembered as the defining year for Oklahoma's technology future. Governor Frank Keating created a cabinet position for the Secretary of Science and Technology.

The State passed State Questions 680 and 681 unshackling Oklahoma's universities to become important players in technology-based economic development. And OCAST created the Oklahoma Technology Commercialization Center (Tech Center) to assist with the commercialization of new technologies and start-up new technology businesses.

Anyone not actively engaged daily in this environment, and not many are, might perceive all of this legislation and these organizations as disorganized and disjointed. Nothing could be further from the truth.

While none of these decisions were made within the parameters of a grand plan, today they fit together perfectly like a hand in a glove. It is a model of legislation that supports the development of intellectual, financial and human capital as well as a dynamic startup environment for high-tech companies. While some might say this model is a result of luck, I believe that, like the evolution of technology, it is the culmination of sound judgment, common sense and good government.

We are experiencing tremendous achievements at the Tech Center - more than 50 new Oklahoma high-tech companies receiving in excess of $50 million in start-up capital - but none of this success would be possible without this legislation. While we are woefully lacking in resources as a state to address all of our challenges, we can be proud that our evolving infrastructure will help us achieve our goals.

H. Randall Goldsmith, Ph.D. is executive director of the Oklahoma Technology Commercialization Center.

Table 3-1

Information Technolgy Sector of the Economy

IT Producing Industries

SIC	Industry
3571	Electronic Computers
3572	Computer Storage Devices
3575	Computer Terminals
3577	Computer Periphals
3578	Calculating and Accounting Machines
3579	Office Machines
3651	Household Audio and Video Equipment
3652	Phonograph Records, Tapes and Disks
3661	Telephone and Telegraph Apparatus
3671	Electron Tubes
3672	Printed Circuit Boards
3674	Semiconductors and Related Devices
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils, Transformers, and Inductors
3678	Electronic Connectors
3821	Laboratory Apparatus
3822	Environmental Controls
3823	Process Control Instruments
3824	Fluid Meters and Counting Devices
3825	Instruments to Measure Electricity
3826	Laboratory Analytical Instruments
3827	Optical Instruments and Lenses
3829	Other Measuring and Controlling Devices
4812	Radiotelephone Communications
4813	Telephone Communications
4822	Telegraph and Other Message Communication
4832	Radio and TV Broadcasting
4841	Cable and Other Pay Television Services
4899	Other Communications Services
7371	Computer Programming Services
7372	Prepackaged Software
7373	Computer Integrated Systems Design
7374	Computer Processing and Data Preparation
7375	Information Retrieval Services
7376	Computer Facilities Management Services
7377	Computer Rental and Leasing
7378	Computer Maintenance and Repair
7379	Other Computer-Related Services

IT Using Industries

SIC	Industry
28	Chemicals and Allied Products
29	Petroleum and Coal Products
36	Electronic Equipment
46	Pipelines, Except Natural Gas
50	Wholesale Trade- Durables
51	Wholesale Trade- Nondurables
60	Depository Institutions
61	Nondepository Institutions
62	Security and Commodity Brokers
63	Insurance Carriers
64	Insurance Agents and Brokers
65	Real Estate
67	Holding and Investment Offices
73	Business Services
78	Motion Pictures
80	Health Services
81	Legal Services
89	Misc Services, NEC

Source: US Department of Commerce, *The Emerging Digital Economy II*, 1999

Table 3-2

Annual Percent Rate of Growth

in Gross Product Per Worker, US, 1990-1997

Industry Type	AGR
Total Private Non-Farm	1.4
IT-Producing	10.4
Goods	23.9
Services	5.8
IT-Using	-0.1
Goods	2.4
Services	-0.3
Non-IT Intensive	1.1
Goods	1.3
Services	1.3
All Other Sectors	0.5

Source: US Dept of Commerce, *The Emerging Digital Economy II*, 1999

Table 3-3

High Growth States 1993-1998

(Increase in Payroll Per Capita)

State	Percent
New Hampshire	31.7
Minnesota	28.1
Massachusetts	27.6
South Dakota	26.9
Iowa	26.5
Utah	25.8
Michigan	25.8
Oregon	25.6
Arizona	25.5
Colorado	24.7
United States	20.2
Oklahoma	16.6

Source: U.S. Bureau of Labor Statistics

Table 3-4

High IT States 1993-1998

(IT Share of Increase in Payroll Per Capita)

State	Percent
Washington	49.5
Virginia	33.5
California	27.8
Colorado	26.7
Idaho	22.6
Oregon	18.9
Texas	18.2
South Dakota	18.0
New Jersey	14.8
Massachusetts	13.9
United States	10.7
Oklahoma	3.9

Sources: U.S. Bureau of Labor Statistics and
American Electronics Association, *Cyberstates*, Vol 4, 1999

Table 3-5

High Growth & High IT States; Top Seven, 1993-98

PPC/SI - Payroll Per Capita Share of Increase
IT/SI - IT Share of Increase

	Payroll Per Capita		IT Share Increase		
State	PCT	Rank	PCT	Rank	Score
South Dakota	26.9	4	18.0	8	12
Massachusetts	27.6	3	13.9	10	13
Oregon	25.6	8	18.9	6	14
Colorado	24.7	10	26.8	4	14
New Hampshire	31.7	1	13.0	14	15
Minnesota	28.1	2	10.6	16	18
Texas	24.3	12	18.2	7	19
Oklahoma	16.6	41	3.9	37	78

Table 3-6

IT Presence by State

State	1998 *	1997 **
Colorado	1	2
New Hampshire	2	4
Massachusetts	3	1
Minnesota	6	9
Oregon	9	21
Texas	11	12
South Dakota	13	49
Oklahoma	31	17

** IT Workers: Number as Percent of Private Workers Rank in 1998*
*** Tech Companies: Number as Percent of Pvt Businesses Rank in 1997*
Source: *AEA Cyberstates **CFED

Table 3-7

IT Employment Concentration Ratios: 1995

Oklahoma Relative to the National Average

Industry	U.S	OK
Computers & Office Equipment	1.00	1.60
Communications Equipment	1.00	1.82
Electronic Components	1.00	0.48
Search & Navigation Equipment	1.00	0.47
Measuring and Control Devices	1.00	0.55
Medical Instruments and Supplies	1.00	0.47
Telephone Communications	1.00	1.00
Computer and Data Processing Services	1.00	0.52
Engineering and Architectural Services	1.00	0.77
Research and Testing Services	1.00	0.46

Source: Calculated from Bureau of Labor Statistics Data

Table 3-8

Metropolitan Tech Poles: High Growth and High IT States

State	City	Rank*
SD	Sioux Falls	178
MA	Boston	4
CO	Boulder-Longmont	27
	Colorado Springs	42
	Denver	19
OR	Portland-Vancouver	26
NH	Manchester**	36
MN	Minneapolis-St Paul	32
	Rochester	16
TX	Austin-San Marcos	21
	Dallas	2
	Fort Worth-Arlington	41
	Houston	23
	Lubbock	33
	San Antonio	46
OK	Tulsa	78
	Oklahoma City	87

*Milken Institute's "Tech Pole" Index **Standard & Poor's DRI
High Tech Output Rank (Manchester, NH, not ranked by Milken Inst)

Table 3-9

1998 Research Resources: R&D Expenditures Per Capita

Top 7 States and Oklahoma

	*Univ	*Fed	*Ind	**All	SBIR
South Dakota	49	43	49	47	36
Massachusetts	2	4	2	3	1
Colorado	8	9	8	8	3
Oregon	21	31	21	24	13
New Hampshire	19	11	19	16	5
Minnesota	34	25	34	31	18
Texas	30	15	30	25	27
Oklahoma	40	47	40	42	40

Source: *Cyberstates **Milken Institute

Table 3-10

State Ranking of Educational Attainment

Top 7 States and Oklahoma

	High School [1]	Bachelors [2]	Advanced [3]
Massachusetts	26	2	4
Colorado	4	5	8
New Hampshire	24	8	13
Minnesota	7	17	29
Texas	41	19	22
Oregon	11	22	19
South Dakota	20	40	48
Oklahoma	24	32	30

1 - CFED: State rank, percent of heads of household who have attained high school diploma, 1997-99.

2 - Milken Institute: State rank, percent of population over age 25 who have attained a bachelor's degree, 2000.

3 - Milken Institute: State rank, percent of population over age 25 who have attained an advanced degree, 2000.

Table 3 -11

Science and Engineering Graduates

Oklahoma Colleges and Universities, 1988-89 and 1998-99

	1988-89			1988-89		
	S&E	All	Pct	S&E	All	Pct
Associate	632	4,967	12.7%	632	6,830	9.3%
Bachelors	1,834	11,376	16.1%	1,937	12,648	15.3%
Masters	483	3,077	15.8%	464	3,794	12.2%
Doctorate	113	344	32.8%	119	359	33.1%
Total	3,062	19,764	15.5%	3,152	23,631	13.3%

Source: Calculated from OK State Regents for Higher Education data.

Table 3-13

Average Wages in Selected IT Occupations

Oklahoma and the U.S., 1998

	Hourly Wage		Annual Wage	
Occupation	OK	U.S.	OK	U.S.
Core IT occupations				
Computer engineers	$24.31	$28.77	$50,570	$59,850
Systems analysts	24.09	26.02	50,100	54,110
Database admin	19.83	24.28	41,250	50,490
Computer support spec	13.43	19.52	27,920	40,590
Computer prog	23.85	25.67	49,610	53,400
Computer prog aides	11.35	15.35	23,610	31,930
Other computer scientists	20.81	24.18	43,270	50,300
Other computer-related occupations:				
Computer science teachers, postsecondary	na	na	46,230	46,890
Computer operators, exc peripheral equipment	$10.87	$12.92	$22,610	$26,860
Peripheral EDP equipment operators	14.9	11.89	31,000	24,730
Data entry keyers, except composing	8.79	9.64	18,280	20,040
Data processing equipment repairers	13.96	15.15	29,030	31,520

Source: U.S. Department of Labor, Bureau of Labor Statistics, 1998 National Occupational Employment and Wage Estimates (March 17, 2000) (http://stats.bls.gov/oes/national oes_nat.htm); U.S. Department of Labor, Bureau of Labor Statistics, 1998 State Occupational Employment Statistics: Oklahoma (January 7, 2000.(http://stats.bls.gov/oes/state/oes_ok.htm)

Table 3-12

Oklahoma Employment Projections in IT Occupations, 1998-2008

Occupation	Employment [a] 1998	Employment [a] 2008	Change in Employment Number	Change in Employment Percent	Avg Ann Openings [b]
Core IT occupations:					
Computer engineers	970	2,310	1,340	138%	140
System analysts	3,260	6,260	3,000	92%	320
Database administrators	670	1,110	440	66%	60
Computer support specialists	3,490	7,780	4,290	123%	450
Computer programmers	4,120	6,330	2,210	54%	350
Computer programmer aides	520	640	120	23%	30
Other computer scientists	5,420	7,470	2,050	38%	240
Total Core IT	18,450	31,900	13,450	73%	1,590
Other computer-related occupations:					
Computer science teachers, postsecondary	300	440	140	47%	20
Computer operators, except peripheral equipment	2,590	2,140	-450	-17%	NA
Data processing equipment repairers	750	1,230	480	64%	60
Desktop publishing specialists	130	220	90	69%	10
Total	22,220	35,930	13,710	62%	1,680

a In 1998, Oklahoma's total non-agricultural employment was 1,441,200. See Oklahoma Employment Security Commission, *Current Employment Statistics* (July 2000), 7. The occupational employment data presented in this table is from a different data source and may not be strictly comparable.

b Average annual openings may not calculate exactly because of rounding, and they are not reduced by negative growth.

Source: Oklahoma Employment Security Commission, *Trends in the Oklahoma Job Market: 1998-2008 Projections* ·http://www.oesc.state.ok.us.

Table 3-14

Degrees Conferred: Oklahoma's Public Colleges & Universities

Computer Science (CS) and Total, 1984-85 to 1998-99

	Bachelors		Masters		Doctoral	
Year	CS	ALL	CS	ALL	CS	ALL
1984-85	471	11,116	37	3,222	1	368
1985-86	497	11,456	30	3,259	4	379
1986-87	529	11,290	26	3,220	3	310
1987-88	410	10,852	34	3,236	4	323
1988-89	344	11,376	43	3,077	5	344
1989-90	312	11,348	37	3,012	1	375
1990-91	291	11,668	26	2,961	7	352
1991-92	250	12,035	41	3,195	11	360
1992-93	280	12,416	33	3,472	6	381
1993-94	250	12,696	42	3,754	11	359
1994-95	266	12,496	33	3,603	5	347
1995-96	217	12,191	34	3,007	6	333
1996-97	213	12,840	65	3,649	6	399
1997-98	230	12,648	57	3,794	4	359
1998-99	250	13,038	62	3,797	2	363

	Certificates		Associates	
Year	CS	ALL	CS	ALL
1995-96	0	361	49	5,992
1996-97	12	529	68	6,547
1997-98	5	374	81	6,537
1998-99	0	419	113	6,397

Source: Oklahoma State Regents for Higher Education, Degrees Conferred in Oklahoma Higher Education, Vol. 1, Sect. I, Tables 3-5 and Sect. III, Table 12 (October 2000) _http://www.okhighered.org/degrees-conferred_.

Table 3 -15

Salaries by Degree Program

1993-94 and 1997-98 Oklahoma State System Graduates
Oklahoma Employees Only

Degree Programs	Average Annual Salary 1993-94 After 5 Years	Average Annual Salary 1997-98 After 1 Year
Certificates		
Computer Science Grads	na	na
All Graduates	$22,755	$21,412
Associate in Applied Science		
Computer Science Grads	17,714	16,508
All Graduates	26,066	25,569
Associate in Arts & in Science		
Computer Science Grads	18,622	23,158
All Graduates	19,436	14,125
Bachelor's		
Computer Science Grads	32,825	35,382
All Graduates	24,310	21,048
Master's		
Computer Science Grads	72,941	44,277
All Graduates	28,777	28,296
Doctoral		
Computer Science	19,146	na
All Graduates	34,470	36,017

Source: Oklahoma State Regents for Higher Education, Annual Employment Outcomes Report (June 2000 http://www.okhighered.org/reports/employrpt-6-2000.pdf

Table 3 -16

FY 1999-2000 IT Program Enrollments

Oklahoma Career & Technology Education System

Program	Unduplicated Enrollments Secondary	Adult	Total
Full-time:			
Business & computer tech	1,533	1,972	3,505
Information services	613	839	1,452
Computer repair	167	434	601
Total full-time	2,313	3,245	5,558
Adult and Business and Industry:			
Adult	na	22,106	22,106
Business and Industry	na	10,513	10,513
Total full-time	na	32,619	32,619

Source: OK Department of Career and Technology Education, unpublished data

Table 3 - 17

Risk Capital: Top 7 States and Oklahoma

State	VC 1999	SBIC 1998
Massachusetts	2	3
Colorado	3	6
New Hampshire	8	29
Oregon	10	11
Texas	15	12
Minnesota	17	16
South Dakota	44	34
Oklahoma	44	26

Source: CFED. VC: Venture Capital Per Worker. SBIC: SBIC Funding Per Worker

Table 3 -18

Quality of Life Indicators

Top 7 States and Oklahoma

	[a]Home Owner	[b]Rent Cost	[c]Energy Costs	[d]HS Grad Rate	[e]Math Scores
SD	23	30	5	7	44
MA	47	46	10	15	8
CO	33	34	1	21	15
OR	43	39	1	33	20
NH	27	37	10	31	44
MN	4	19	5	11	2
TX	43	20	6	42	5
OK	18	11	6	12	44

	[f]Tourism	[g]Air Qual	[h]Safety	[i]Poverty	[j]Charity	[k]Health
SD	45	20	18	32	33	45
MA	24	32	9	17	33	4
CO	5	9	13	3	14	15
OR	24	19	19	30	14	24
NH	7	24	1	11	48	7
MN	27	1	3	14	14	27
TX	31	34	48	41	25	31
OK	21	11	34	35	3	21

a Percent of units that were owner-occupied rank in 1999 *
b Lowest rent per urban unit rank in 1998 *
c Energy costs lowest dollars per household regional rank (10 regions) in 1998 **
d High school effectiveness, completion rate in 1996-97 *
e Math: Test scores of 4th graders, rank in 1996-98 *
f Tourism: Travel expenditures per capita, rank in 1997 *
g Air Quality: Percent of population with clean air, rank in 1998 *
h Safety: Fewest serious crimes per capita, rank in 1997-98 *
i Poverty: Percent of the population above poverty, rank in 1998. *
j Charitable Giving: Dollars as a % of gross income, rank in 1997 *
k Health Care: Percent of population with ready access *

Sources: *CFED **Energy Information Administration

Table 3-19

Business Cost Indicators

Top 7 States and Oklahoma

	[a]Power *	[b]Wages **	[c]Tax ***	[d]Tax ***	[e]Tax ***
SD	27	2	0.19	0.44	2.86
MA	47	47	0.59	1.76	3.09
CO	13	41	0.20	0.56	2.42
OR	15	29	0.27	0.66	2.54
NH	49	36	0.59	1.46	5.04
MN	31	37	0.50	1.50	2.91
TX	17	10	0.31	0.82	2.74
OK	23	9	0.33	0.90	1.37

a Electricity cost. Cents per Kwh to business, rank in 2000
b Wage Cost: Lowest annual private wage. Rank in 1998
c Corporate license and income taxes as a % of GSP
d Corp. license & income taxes as a % of property income
e Property taxes as a percent of GSP

Sources:
* Energy Information Administration
** Cyberstates
*** Calculated from Bureau of Economic Analysis Data

Table 3-20

R&D Expenditures:

Doctorate Granting Institutions in Oklahoma
by Science and Engineering Field, 1998-99 (Thousands of Current Dollars)

	Engineering	Physical Sciences	Math/Computer Sciences	Life Sciences
OK	$31,793	$19,433	$5,955	$95,291

Source:
National Science Foundation,
Science and Engineering Indicators 2000.

Table 3-21

Distribution of Endowments for Chairs, by Amt Per Chair

Amount per Chair	No. of Chairs
$250,000 to 500,000	41
$520,000 to 700,000	11
$708,000 to 992,000	7
$1,000,000 to 1,500,000	77
$1,800,000 to 2,000,000	18
$2,008,000 to 4,363,000	6

Source:
Calculated from data provided by
Oklahoma State Regents for Higher Education

Table 3-22

Distribution of Endowments by Field (Millions)

Field	Amount
Medicine	$68.5
Engineering	14.1
Life Sciences	7.3
Earth Sciences	4.6
Physical Sciences	3.7
Math & Computer Sc (IT)	3.0
Technology Mgt (IT)	0.5
Information Systems (IT)	0.5
Total IT	4.0

Source: Calculated from data provided by Oklahoma State Regents for Higher Education

Table 3-23
OCAST Funding by Program and Recipient, 1988-1999
(Millions of Current Dollars)

Program	OSU	OUHSC	OU	Industry	OMRF	TU	Total
Health Research	8.27	15.10	4.25	0.09	6.59	0.77	35.07
Applied Research	10.95	0.98	10.04	5.60	1.08	4.41	33.06
OTCC	0.00	0.00	0.00	0.75	0.00	0.00	0.75
OAME	0.00	0.00	0.00	3.47	0.00	0.00	3.47
Technology Finance	0.00	0.00	0.00	1.00	0.00	0.00	1.00
SBRA	0.00	0.00	0.00	2.16	0.00	0.00	2.16
Inventor Assistance	0.00	0.00	0.00	0.15	0.00	0.00	0.15
Centers Of Excellence	10.15	8.74	2.40	0.00	0.00	0.00	21.29
Eminent Scholars	2.09	1.55	1.47	0.00	0.00	0.05	5.16
Total	31.46	26.37	18.16	13.22	7.67	5.23	102.11

OSU: Oklahoma State University
OUHSC: University of Oklahoma Health Sciences Center
OU: University of Oklahoma, Norman
OMRF: Oklahoma Medical Research Foundation
TU: University of Tulsa
OTCC: Oklahoma technology Commercialization Center
OAME: Oklahoma Alliance for Manufacturing Excellence
SBRA: Small Business Research Assistance

Sources: SRI International, Benchmarking OCAST, February, 2000, IV-5. OTCC: Oklahoma Technology Commercialization Center
OAME: Oklahoma Alliance for Manufacturing Excellence. SBRA: Small Business Research Assistance

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Table 3-24
Oklahoma Tax Incentives
(Millions of $ in 1996)

Investment/New Jobs Income Tax Credit	$12.00
Venture Capital Income Tax Credit	.07
Interstate Telecom Services Sales Tax Exemption	11.30
Manufacturing Machinery Sales Tax Exemption	2.70
Manufacturing Facility Ad Valorem Exemption	13.90

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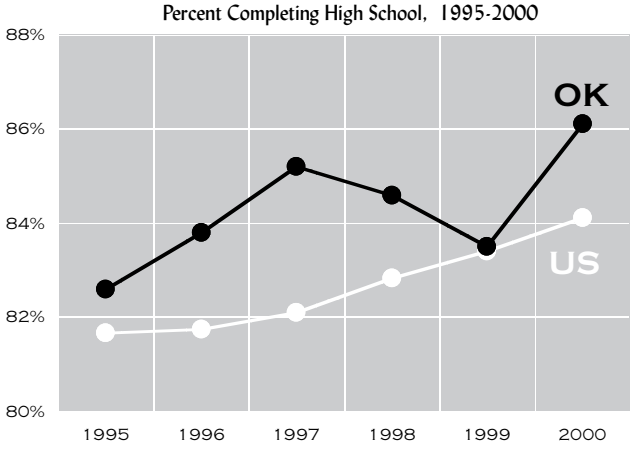
An OCAST Time Series #1

High School Education

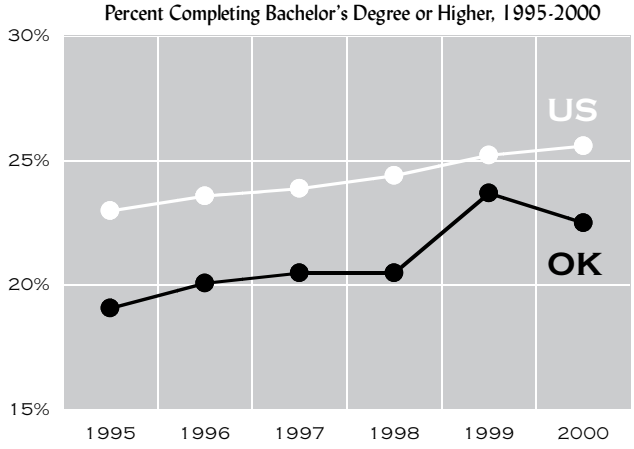
Educational Attainment of Adults 25 Years Old & Over:
Percent Completing High School, 1995-2000



An OCAST Time Series #2

College Education

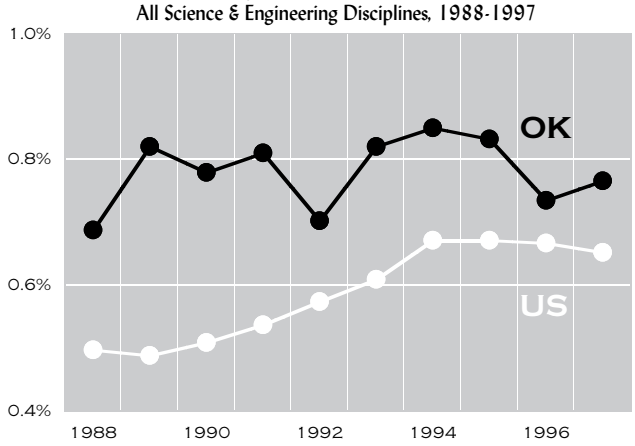
Educational Attainment of Adults 25 Years Old & Over:
Percent Completing Bachelor's Degree or Higher, 1995-2000



An OCAST Time Series #3

Science & Engineering Education

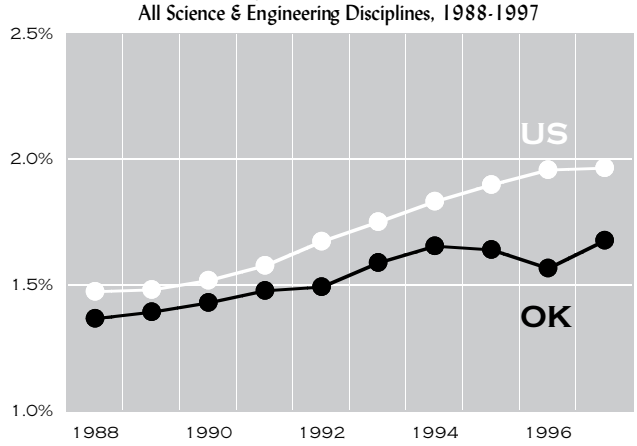
Associate Degrees as a Percent of 18-24 Year Olds :
All Science & Engineering Disciplines, 1988-1997



An OCAST Time Series #4

Science & Engineering Education

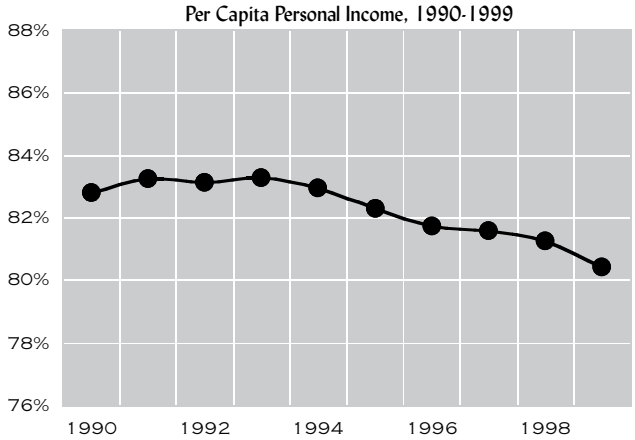
Bachelor's Degrees as a Percent of 18-24 Year Olds:
All Science & Engineering Disciplines, 1988-1997



An OCAST Time Series #5

Per Capita Income

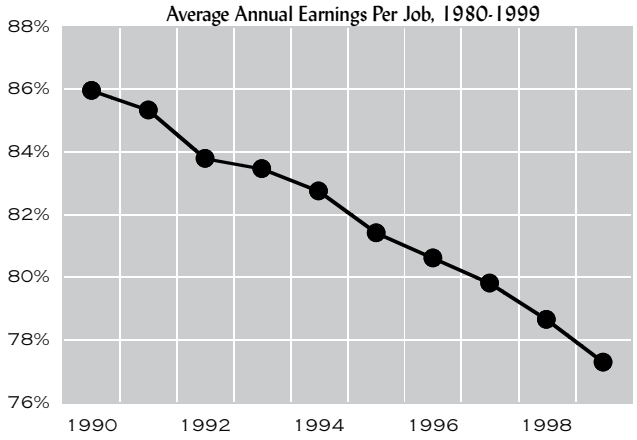
Ratio of Oklahoma to the United States
Per Capita Personal Income, 1990-1999



An OCAST Time Series #6

Earnings per Job

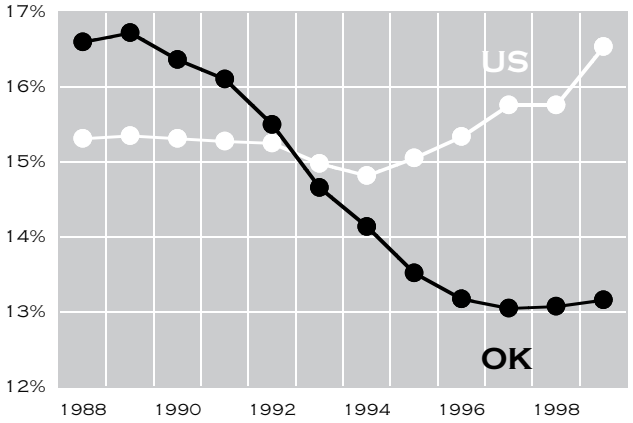
Ratio of Oklahoma to the United States
Average Annual Earnings Per Job, 1980-1999



An OCAST Time Series #7

Technology Payroll

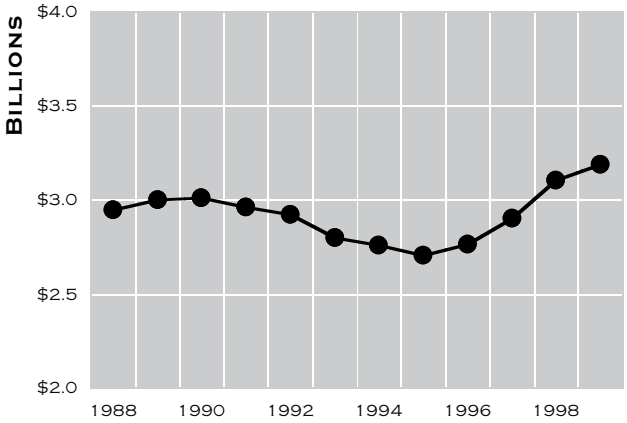
Oklahoma and U.S.
Percent of Payroll in Technology Intensive SIC Codes, 1988-1999



An OCAST Time Series #8

Technology Payroll

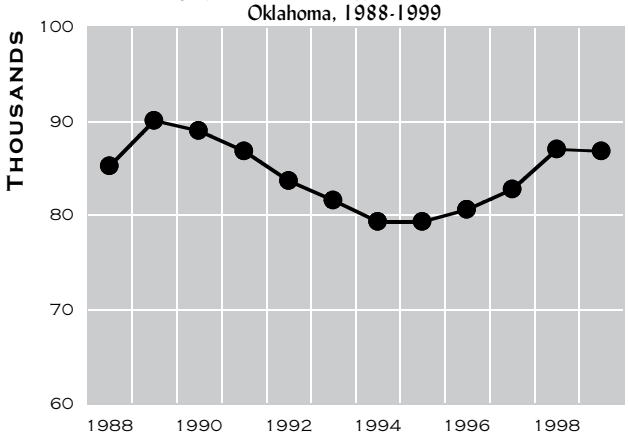
Oklahoma
Real Payroll in Technology Intensive SIC Codes, 1988-1999



An OCAST Time Series #9

Technology Employment

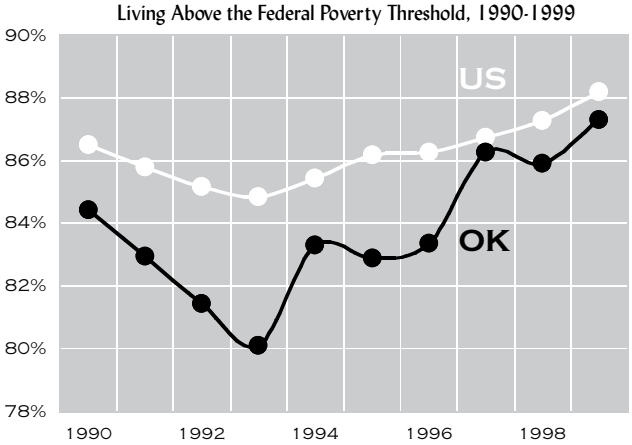
Employment in Technology Intensive SIC Codes
Oklahoma, 1988-1999



An OCAST Time Series #10

Economic Status

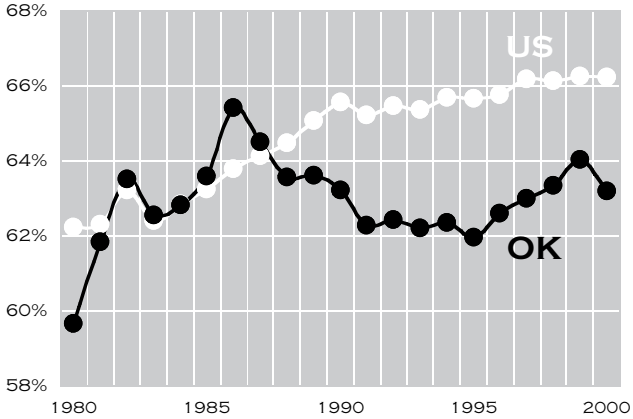
Percent of Population
Living Above the Federal Poverty Threshold, 1990-1999



An OCAST Time Series #11

Labor Force Participation

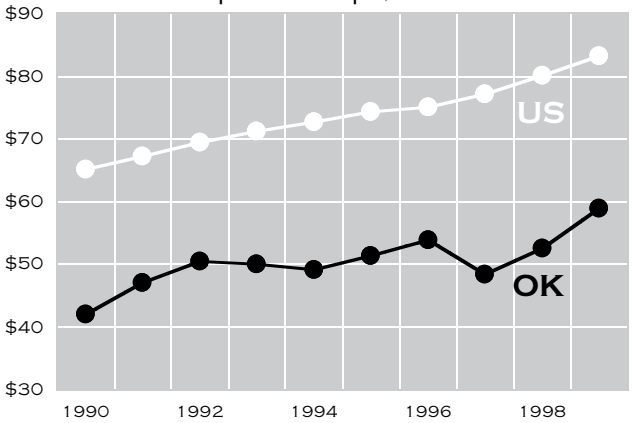
Labor Force Participation Rate (16+ Years),
1980-2000



An OCAST Time Series #12

Research & Development

Total Real Research & Development:
Expenditure Per Capita, 1990-1999



The Academy Research Team

Michael Lapolla
Mike is the Chairman of the Academy Research Committee, and served as the overall editor of this Town Hall research effort. He is the Director of the Center for Health Policy Research at the Oklahoma State University Center for Health Sciences in Tulsa. He is the founding director of the OSU Telemedicine Center and has previously served with the Oklahoma Medical Research Foundation and University of Oklahoma College of Medicine - Tulsa. Mike has been an Academy member since 1988, and an Executive Committee member since 1992. He is a graduate of West Point and holds a Master's in Health Care Administration from Trinity University in San Antonio.

Mike Metzger
Mike is a member of the Academy Research Committee as served an an editor for this research effort. He is a Professor of Economics at the University of Central Oklahoma ...

SECTION 1

Craig Knutson

Steve Smith
Mr. Smith is Professor of Economics at Rose State College. He is also an Adjunct Professor of Economics at the University of Central Oklahoma. Professor Smith's research has focused on regional and urban economic issues. He has published and co-authored numerous articles on economic development issues in Oklahoma, including transportation, state and local finance, education, public safety and energy. Mr. Smith has advised federal, state and local governments, the State Chamber, Oklahoma City and Midwest City Chambers of Commerce on policy issues and served on the Governor's Council of Economic Advisors, Citizens' Task Force on Taxation and is past Chairman of the Midwest City Economic Development Commission. Professor Smith has also published PowerPoint presentations for several introductory and intermediate economics textbooks. He received the Outstanding Teacher Award at Rose State College and the NISOD Excellence Award from the University of Texas at Austin. Mr. Smith's academic preparation was at Oklahoma State University where he received a B.S. and M.S. in economics.

SECTION 2

Larkin Warner, PhD
Larkin Warner is Regents Professor Emeritus, Economics, Oklahoma State University. Throughout his career, Dr. Warner's research and public service have emphasized issues in economic development, public finance, education, and transportation that are important to Oklahoma. From 1988 through 1991 he was a member of the Oklahoma Constitution Revision Study Committee appointed by Governor Henry Bellmon. During the 1996-97 academic year, he served with the Oklahoma State Regents for Higher Education as Staff Director for the Citizens' Commission on the Future of Oklahoma Higher Education. Since May 1999, he has been assisting the KIDS (Keep Improving District Schools) committee of the Oklahoma City Public Schools Foundation.

Robert Dauffenbach, PhD
Robert C. Dauffenbach is Professor and Director, Center for Economic and Management Research, Price College of Business, University of Oklahoma. Dr. Dauffenbach received his Ph.D. in economics from the University of Illinois at Urbana-Champaign in 1973. He joined the faculty at Oklahoma State University in 1977 and served as Director, Office of Business and Economic Research, 1985-1990. He assumed duties as

Director, Center for Economic and Management Research, University of Oklahoma, in the fall of 1990. CEMR publishes the Statistical Abstract of Oklahoma, The Oklahoma Business Bulletin, and operates the ORIGINS economic development web site.

SECTION 3

Tabitha Doescher

Kent Olson, PhD

SECTION 4

Tony Hutchison

Jeannie Bordelon-Parker

Ryan Kiesel

SECTION 5

Alexander Holmes, PhD

ACADEMY STAFF

Julie Knutson
Julie Knutson is the President and CEO of the Oklahoma Academy ...

Rhonda King ...