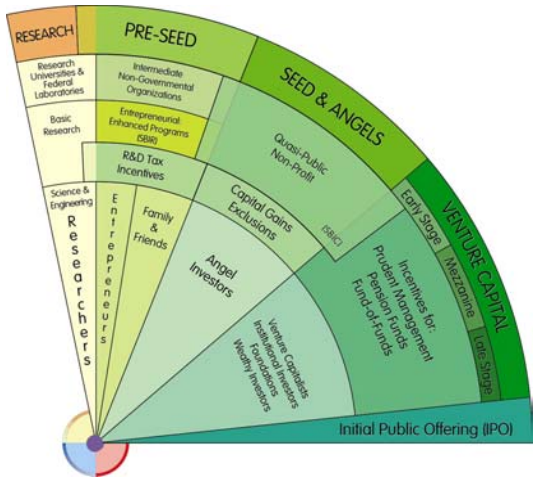
The Keys to Growth in the New Economy

Investing in Discovery, Engineering, and Entrepreneurship

John W. Ahlen
Mark Diggs



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February 18, 2003

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PREFACE

The Keys to Growth in the New Economy: Investing in Discovery, Engineering, and Entrepreneurship is about the increased economic return derived from what we know. John Ahlen and Mark Diggs have described Arkansas' transition from an agricultural-based economy to a more diversified manufacturing economy. They've also pointed out that we're entering a new economic phase.

In this new economy, Arkansans can no longer rely on bountiful natural resources, rich agricultural lands and manufacturing firms seeking a workforce with a good work ethic. We need quality education from better schools, higher-level skills and more college degrees because our workers are worth more when they know more. About half of the variation in per capita income among the states is explained by the number of those with college degrees. That's why we must invest in education, discovery and entrepreneurship.

Arkansas is changing its job creation incentives so they're based on total payroll rather than just the number of jobs created. As part of the Consolidated Incentives Act of 2003, firms that invest in research and development will qualify for income tax

credits for research expenditures in a variety of areas. The act includes firms targeted by the Arkansas Department of Economic Development and firms investing in research and development projects under the Arkansas Science & Technology Authority.

From our preparation for super projects to research and entrepreneurship to better schools, we're putting Arkansas in a position to be more competitive than ever before. The Keys to Growth in the New Economy: Investing in Discovery, Engineering, and Entrepreneurship tells us why this is important.

Gov. Mike Huckabee

ACKNOWLEDGEMENTS

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The members of the Task Force for the Creation of Knowledge-Based Companies added depth to the discussion throughout because of their insights, discussion, and debate.

The staff of the Arkansas Science & Technology Authority made the Arkansas Experiment a reality.

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EXECUTIVE SUMMARY

Contemporary economic development, based on industrial recruiting, has been so successful at expanding the number of jobs that it may have lost sight of the other dimensions of economic growth, the very dimensions that created the recruited jobs in the first place. The purpose of this work is to remind policy makers that the "modern" economic development infrastructure that focuses on knowledge creation is the original foundation of contemporary economic growth.

Knowledge-based economic development works. It has provided the jobs in other locations that have been recruited. The practice of what is today called knowledge-based economic growth is based on a complex system of education, research, entrepreneurship, and capital formation and generates the "increasing returns" of knowledge that drive economic growth. Science, engineering, and technology are fundamentally important to this process because they are the bedrock competencies upon which economic growth is built. Acquiring these competencies should be

elevated to the level where they receive urgently needed policy attention. The time to invest in them is now.

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Investments in research, development, and commercialization produce jobs, wealth, and economic growth. The purpose of this publication is to provide a technology-based economic development handbook for policy makers and community developers who are looking for a new approach to economic growth. This volume provides a road map through some high-tech terrain so communities can chart a course to a new economy that they choose to create based on an understanding of the mechanisms by which new companies, knowledge-based jobs, and wealth are created.

The key resources for creating knowledge-based companies are education, research, entrepreneurship, and risk capital.

The challenge at the state and community level is to comprehend and incorporate knowledge from the complex system of education, research, entrepreneurship, and capital formation into policies, goals, and budgets. Building a successful policy infrastructure to support economic growth will position states and communities to better compete in the new economy.

Technology-based economic development was proposed as a new model for growth in the 1980s. The results are in: technology-based economic development works, compares favorably with mega projects, and complements traditional programs.

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Consider the Arkansas Experiment, the 20-year experience of the Arkansas Science & Technology Authority,

included here as an introductory example of how technology- and knowledge-based economic growth works.

The Arkansas Science & Technology Authority was created by the legislature in 1983 and given the mission of bringing the benefits of science and advanced technology to the people and the state of Arkansas.

One of the authors became its first executive director in February 1984. John Ahlen moved to the Authority from the position of Associate Director for Science and Technology with the Illinois Legislative Council. For the 10 preceding years, he answered legislators' questions about energy, the environment, natural resources, and healthcare in the Council's staff Science Unit. The interesting thing in retrospect is that technology-based economic development wasn't on the public policy radar screen, at least at the state level, until 1982 when the Science Unit received its first question about technology-based economic development. A couple more questions followed in 1983, including one about the then-new Ben Franklin Partnership in Pennsylvania.

The legislation creating the Arkansas Science & Technology Authority was based on the growing state-level interest in replicating the technology-based economies of Boston, Silicon Valley, and the Research Triangle Park. For most of the states, the justification for establishing mechanisms similar to the one in Arkansas was faith that investments in science and technology would lead to high-tech job creation.

It took several years to plan and establish a collection of programs designed to stimulate technology-based economic development. The Authority fully implemented these first programs in 1986. Additional programs to fill gaps were added later.

The results of the Arkansas Experiment are clear.

- Investments in the research infrastructure show that there is a follow-on return as scientists convert small basic research grants into major awards from federal agencies. The return is more than seven dollars for every dollar invested.
- Arkansas scientists are nationally competitive when given the same kind of support that their peers in other states receive.
- Existing companies want new technology transferred into their processes and products and invest company funds in university-based applied research.
- The Authority's Manufacturing Extension Network, affiliated with the National Institute of Standards and Technology's Manufacturing Extension Partnership, transforms Arkansas manufacturers into world-class competitors or helps keep them globally competitive.
- The Authority's technology development and seed capital investment programs help entrepreneurs to develop new products and processes and create new businesses and jobs for knowledge workers who do not have to leave the state to find employment.

The conclusion that can be drawn from the Arkansas Experiment is that technology- and knowledge-based economic development not only works well, but also compares favorably with more traditional approaches. Recent information about a neighboring state's incentives to attract a mega project illustrates the point. The incentives included a $295 million bond issue, with a 20-year maturity to attract 4000 primary jobs. In the Authority's near-20-year history, it has invested over $50 million to create over 1000 primary jobs in small technology-based firms. The comparison is that one-sixth of the 20-year investment in a mega project produced one-quarter of the jobs, and this does not take into account the spin-off job creation that the investments in the research and development infrastructure

continue to produce. In other words, if the scale of the Arkansas investment were equal to the investment in a mega project, then it would not be unrealistic to expect that 5784 new technology-company jobs could have been created, as shown below.

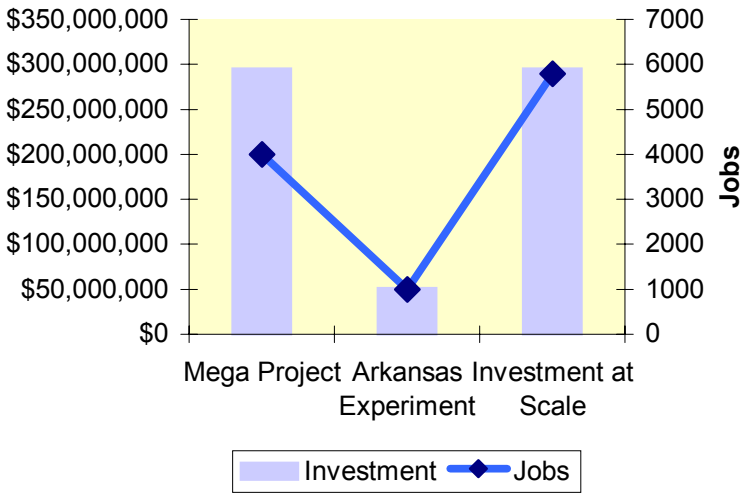

Figure. Comparison of investments (bars) to job creation (line) for a Mega Project, for building knowledge-based companies in the Arkansas Experiment, and projected jobs for the investment in building knowledge-based jobs at the scale of the investment in a mega project.

This comparison is not to suggest that one approach is better than the other. There is no question about the value of a mega project to a state's economy. The point of the comparison is to underscore the complementary job-creation value of systemic investments in education, research, entrepreneurship, and risk capital.

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The practice of knowledge-based economic growth generates the "increasing returns" of knowledge that drive the economy, builds experience and know how, and generates the feedback that can be used to adjust, improve, and fine tune the relevant public policy infrastructure.

Communities and their economies are based on their use of knowledge. There is an economic contest between communities, regions, and countries; those that adopt new developments, apply new know-how, and share information have a competitive advantage over those that don't.

Research influences the whole system of economic growth, but the economic value of research becomes real when private equity capital is invested, creating new companies, creating new knowledge-based jobs, and commercializing new products and services.

The formation of new businesses begins with innovations and capital from entrepreneurs and their friends and families. The financial "virtual valley of death" – that is, the scarcity of next stage financing from "angel" investors – however, is a barrier to entrepreneurial success, economic growth, wealth creation, and knowledge-based jobs. Bridging the virtual valley of death begins with the construction of a "public policy on-ramp" from the laboratory to the bridge that leads to seed capital investments.

Public policy can also create appropriate incentives for private investments in the early-stage research and development activities of young, technology-based enterprises. Incentives are needed for angel investors, as well as efforts to organize, educate, and train them. The establishment of venture capital funds will have an impact on knowledge-based businesses, jobs for knowledge workers, wealth creation, and economic growth by keeping entrepreneurial firms from wandering to other locations in search of risk capital. Quasi-public sources of

financing may offer a one-stop-shop, but the range of financing from such sources may reflect disconnected funding programs rather than an integrated system of finance.

Science, engineering, and technology are important. They seldom rise to the level of crisis or become the subject of urgently needed policy initiatives, but they are of primary importance to economic well being and central to 21st Century economic growth. Policy makers have taken the initial steps of creating the public policy infrastructure and making investments in math and science education, science and engineering degree programs, university research, technology-based economic development, and risk capital formation.

It is time to elevate them to the level of a crisis and for them to become the subject of urgently needed policy attention. Investments in science, engineering, and technology will galvanize economic growth, but investments must be made at scale. **The time to invest at scale is now.**

SETTING THE STAGE

The following chapters provide the starting point for discussions about stimulating economic growth within a complex system involving education, research, and entrepreneurship. The challenge is twofold. First, it is important to recognize that economic growth is the result of a system functioning as a whole. Second, optimizing the system of economic growth requires data about how well the entire system is working.

Silver Bullet Solutions

Economic development at the state level is a matter of public policy. In the new economic environment, economic development is about investments in research and development, involves science and technology, and is increasingly a matter of science and public policy.

The interface between science and policy is important and has been studied intensely since World War II. Brad Byerly, a Congressional staffer speaking to an engineering forum in 1995, provided one of the more imaginative views of the interaction that takes place at the science and public policy interface. The engineers at the forum, representing their respective disciplinary associations, had gathered to review how their profession could help Congress in dealing with public policy issues that involve engineering and science, subjects with which members of Congress usually have little direct experience. The engineers are capable of developing realistic solutions to complex problems and were exploring ways to communicate with Congress about the pressing science policy issues of the day.

The question Byerly asked was, “Does Congress have too little or too much information?” The engineers were thinking that the Congress had too little information, but the answer, Byerly said, depends on whether the information helps Congress to do something, like set priorities. He further stated that Members of Congress view the problems they face as political (not technological) and the solutions they seek are “Silver Bullet Solutions” that have no cost and no side effects. In the end, if one can't find the Silver Bullet Solution, then one changes the problem definition to fit an available solution.

The notion of a Silver Bullet Solution is an easy one to apply to economic development.

Consider *Opportunity Arkansas* as an important but brief example. *Opportunity Arkansas* was an effort to establish a state economic development strategy based on regional plans that were initiated at five concurrent *Opportunity Arkansas* conferences held on July 12, 2001. In the Southeast Arkansas region, Dr. Jan Duggar, dean of business at Arkansas State University, described the U.S., Arkansas, and southeast Arkansas economies. Of special interest and concern is the decline in U.S. manufacturing employment since the mid-1980s and how Arkansas is lagging in time but following that same downward trend. At the end of Duggar's presentation, the very first question was, "That was interesting, but how do we get a shirt plant to locate here?"

Industrial recruiting is the Silver Bullet Solution to economic development policy.

A Great Complexifier

> For every complex problem, there is a solution that is simple, neat, and wrong.
>
> H. L. Mencken

Unlike Silver Bullet Solutions, the component parts of economic growth and development are numerous, have complex interconnections, and take time to show results.

This is apparent from even a superficial review of an entrepreneur's biography. The things that are typically important involve the community that instilled early values, the local and higher educational systems attended, and the person's

work and life experiences. Somehow a niche for a new product or service became apparent, the decision to take the risk of starting a business was made, and the resources to launch a new business were found. The routes that an entrepreneur might take are convoluted, take time to traverse, and involve thousands of steps.

Economic development that relies more on entrepreneurship than recruiting will depend more on a broad and comprehensive public policy infrastructure for science and technology than on Silver Bullet Solutions. As former U.S. Senator Daniel Patrick Moynihan said, "There is no easy answer to this, and what we need is a 'Great Complexifier.'"

Contemporary economic development needs a public policy infrastructure that can deal with the complexity of science and technology, not a Silver Bullet Solution.

Stages of Technology Development

In the 1980s, practitioners defined the process of technology-based economic development as going from basic research, to applied research, to development, to commercialization.

In 1997, Richard W. Marzewski[1] described the process as having five stages: basic research, focused research, demonstration, validation, and commercialization. Each stage has a particular emphasis: building a knowledge base, establishing feasibility, prototyping, designing for production, and responding to the market. According to Marzewski, navigating the five stages can take 13 to 20 years.

[1] R. W. Marzewski, "Bridging the Virtual Valley of Death for Technology R&D" *The Scientist*, January 20, 1997.

It occurred to the authors that each stage is comprised of smaller steps. For example, one taking an idea through the basic research stage probably has, among other things, developed specific research objectives; done a literature review; crafted an implementation plan including experimental design, facilities, equipment, and personnel; prepared a detailed budget for personnel, fringe benefits, equipment, supplies, travel, and indirect costs; drafted a statement addressing institutional capability; and documented the qualifications of personnel, including their academic credentials, recent publications, and grant support. This is all done long before data analysis and report preparation.

Similarly, an entrepreneur who begins with basic research results and sees the commercial potential will not only accumulate an enormous amount of know how, but will also negotiate hundreds of steps while going through the details of focused research, demonstration, validation, and commercialization. The entrepreneurial effort will include a complete business plan covering the marketing plan, management structure and key individuals, an operations plan, financial projections, and the technology involved.

Understanding technology development is like unraveling the DNA for economic growth; there are many details in the delicate structure.

Commercializing research innovations involves hundreds of detailed steps and years to map them out. The public policy infrastructure that supports knowledge-based economic growth must reflect the complex ecology of the marketplace if the policy is to be successful.

Understanding the Complexity of Economic Growth

The Arkansas Department of Economic Development created the Task Force for the Creation of Knowledge-Based Jobs in 2001 with the mission of finding ways to increase the number of knowledge workers in the state.[2] The Task Force's initial approach was to review recruiting incentives with the idea that they could be amended to include knowledge-based companies. After more than a year of discussion and fact finding, the Task Force made this important observation: it is difficult to recruit knowledge-based companies because they are created as part of a long-term process that involves local educational, innovation, and financial resources that anchor them to a particular location.

The Task Force was inclined to think of the resources as a continuum along which strands of education become intertwined with research and risk capital. More specifically, math and science education in middle and high school become woven into science and engineering education in colleges and universities, where education and much (but not all) of the state's research infrastructure is located. Educational know-how, inventions, and intellectual property are generated through this close proximity of education and research. The innovations from university research (and spin-offs from existing knowledge-based companies) provide seed crystals of innovation around which new products and services are developed and around which new companies are established. These entrepreneurial, knowledge-based companies go through several stages of evolution. Their success is marked by

[2] Much of this chapter is based on the *Report of the Task Force for the Creation of Knowledge-Based Jobs*, prepared by the Arkansas Department of Economic Development, September 2002.

expansion, infusions of risk capital, and employment growth for knowledge workers. As mature knowledge-based companies, they establish relationships with nearby universities that will provide them with sources of new, highly educated employees and innovations that will keep them competitive.

The Task Force developed a graphic that illustrated its observations and the important relationships for knowledge-based companies. The image was a circle divided into a continuum of quadrants. The two essential elements of its symbolism included quadrants representing four basic resources and the circular shape illustrating the necessary long-term continuity of relationships among the resources. The graphic, which has been modified to hint at the underlying complexity of knowledge-based economic growth, is shown in Figure 1.

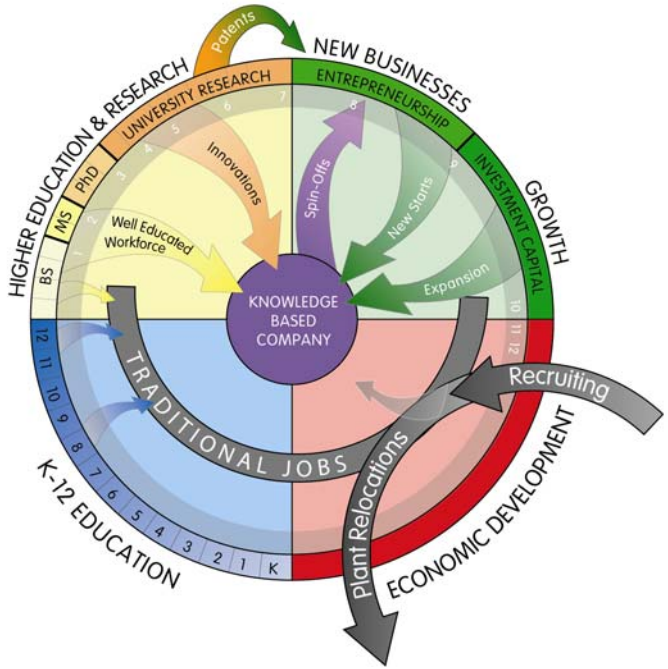

Figure 1. The Knowledge-Based Company Environment.

Figure 1 shows a circle of resources that is divided into quadrants. The lower left-hand quadrant of the circle represents public education grades kindergarten through 12th grade. The next quadrant in a clockwise direction represents higher education and university research, followed by a quadrant representing new business creation, growth, and financing. The fourth quadrant represents traditional economic development activities.

There are other features shown in Figure 1: a crescent of traditional jobs and a bull's eye for targeted knowledge-based companies are superimposed, along with arrows showing different resource flows. A 12-point scale, representing the 12 metrics from the Milken Institute's New Economy Index, is added for future reference.

Consider the continuum in Figure 1. Begin in the lower right-hand quadrant with traditional economic development activities, recruiting knowledge-based companies, and the recruiting incentives available. The incentives primarily involve financing for buildings, land, and equipment and support for training the workforce. These incentives are available for knowledge-based companies and the incentives are the kinds of tools with which economic developers are familiar. On further reflection, the Task Force concluded, first, that these incentives are the "direct descendants" of incentives for manufacturing firms with relatively large numbers of employees and, second, that these incentives are not, in most cases, offering what knowledge-based companies need in order to be successful. When manufacturing firms relocate, they do so to remain competitive by lowering costs, usually labor costs, but also the one-time cost of (1) financing the facilities into which they will move and for (2) training a workforce so it has the required skills. These are not the requirements of knowledge-based companies, which

need highly educated and skilled workers and innovations to incorporate into their products and services. In fact, the Task Force became convinced that many firms that could be recruited in 2002 are the very firms that will have to close their doors and relocate when competitive forces cause them to seek other locations where the labor cost are even lower. The arrows in the quadrant summarize these conclusions.

Consider next the quadrant dealing with K-12 education. The Task Force fully grasped the importance and value of public education to knowledge-based companies and the significant demands on public education to graduate students with ever increasing skill levels. The Task Force noted, for instance, that in 1940 the average number of grades completed nationally was eight; in 1970, it was 12 grades; and in 1990, it was almost 13 grades. A high school diploma was better than average at the beginning of World War II and about average when mankind first landed on the moon (marked by blue arrows). For more than the last decade, however, a high school diploma was less competitive and illustrates convincingly the current gap between high school graduates and the increasing average educational achievement in the nation. It is in this gap that the role of two-year colleges, in the higher education quadrant, has great value (marked by the yellow arrow). The Milken Institute's New Economy Index, though, doesn't consider or measure educational achievement lower than the baccalaureate (i.e., number 1 in Figure 1).

It is in the quadrant representing higher education and research that we see the levels of education and university research on which knowledge-based companies rely. Universities provide both the well-educated workforce (yellow arrow) and the innovations (orange arrow) that fuel the new economy. It is the company reliance on, and relationships with, these critical resources that make it so difficult to recruit

knowledge-based companies to a different location. (This is different from the situation encountered by companies that compete solely on the basis of lowest cost and which are interested in relocation assistance to places with lower wages.)

Where do knowledge-based companies come from? The Task Force concluded that they must be created and grown, as shown in the new business and growth quadrant. New knowledge-based companies (green arrow) coalesce around (1) intellectual property (the orange and green patents arrow pointed from university research to entrepreneurship) and entrepreneurs or (2) spin-offs (purple arrow) from existing knowledge-based companies. Under favorable market conditions and with the infusion of investment capital, such companies expand (green arrow).

The Task Force noted that the Milken Institute's New Economy Index (October 18, 2000), which includes 12 measures of the new economy, tracks the continuum of resources with three education metrics (the lowest of which is the baccalaureate), four research metrics, one intellectual property metric, and three new business metrics. These metrics are referenced in Figure 1 as numbers located just inside the outer ring of the four quadrants.

The Milken Institute's policy brief titled *Blueprint for a High-Tech Cluster*[3] by Ross C. DeVol concisely describes the elements needed to create cutting-edge industrial clusters. Among those elements are the following:

- Research facilities,
- Costs of doing business,
- A trained/educated workforce,
- Near-by outstanding educational institutions,

[3] Blueprint for a High-Tech Cluster: The Case of the Microsystems Industry in the Southwest, by Ross C. DeVol (Policy Brief Number 17, Milken Institute, August 8, 2000).

- A network of suppliers,
- Technology spillover,
- Venture capital,
- Quality of place, and
- Cost of living.

Clusters of industries built on these elements, according to DeVol, "are determining which metropolitan areas and states are achieving superior economic growth or falling behind." With knowledge about such elements, the Milken Institute developed the New Economy Index[4] to assess how well the states are faring in the new economy.

Table 1. Milken Institute's Indicators and Metrics for the New Economy (October 18, 2000)

No.	Indicator	Metric
1.	Educational Attainment	Percent of Population 25+ with BA or Greater (2000)
2.	Educational Attainment	Percent of Population 25+ with Advanced Degree (2000)
3.	Doctoral Scientists & Engineers	Percent of Population (1997)
4.	Academic R&D	Dollars Per Capita (1997)
5.	Federal R&D	Dollars Per Capita (1997)
6.	Industry R&D	Dollars Per Capita (1997)
7.	Patents Issued	Per 100,000 (1998)
8.	Business Starts	Per 100,000 (1999)
9.	SBIR Awards	Per 100,000 (1990-1998)
10.	VC Investment	As Percent of GSP (1999)
11.	IPO Proceeds	As Percent of GSP (1997-1999)
12.	Exports	As Percent of GSP (1999)

[4] See http://www.milkeninstitute.org/releases/capital.html for each state's ranking.

The indicators used in the New Economy Index are worthy of careful review. It is significant that the Index is made up of three educational indicators, four research indicators, patents, four new-business-related indicators, and exports. In the new economy, the things that matter most are college degrees, advanced degrees in science and engineering, research, intellectual property, new business starts and expansions, and participation in global commerce.

The continuum that educates scientists and engineers, produces intellectual property, and starts and expands new businesses is the system that enables economic growth.

The New Economy Challenge

The challenge for policy makers and community leaders in the new economy is to change policies, goals, and spending behavior so their constituencies can better compete in the new economy.

Their understanding of, and comfort with, traditional incentives for recruiting companies is the starting point. As their economic well being is challenged, the natural response is to modernize existing policies with Silver Bullet Solutions.

This comfortable starting point, however relevant it once was, has become largely inadequate when facing the complexity of science- and technology-based economic growth that integrates hundreds of detailed steps through periods of time that often extend beyond the term limits of elected officials.

Building a successful policy infrastructure to support economic growth will require that policy makers comprehend and incorporate knowledge acquired from the complex system

that incorporates education, research, entrepreneurship, capital, and community.

THE PRACTICE OF ECONOMIC DEVELOPMENT

The following chapters explore some of the differences between the practice of economic development and the concepts of economic growth. We begin with the traditional emphasis on jobs, how to increase their number, and the resources critical to this effort. We then consider incentives for manufacturing job growth and how such incentives create both a mindset and a pathway for the future, because new incentives are likely to follow the path established by the original incentive. Lastly, we assess whether industrial recruiting incentives work in the new economy.

Increasing the Number of Jobs

The predominant way to increase jobs in the rural South through the last 40 years of the 20th Century was to recruit and relocate larger firms and their related jobs from another location. There are two other ways to increase the number of jobs.

The second way became evident in the mid-1980s when data was found that showed the largest number of new jobs was being created through the expansion of smaller firms. While not as obvious, a large number of small firms could be more effective at job creation than a large firm that was not growing.

The third way to create jobs is through the entrepreneurial process of company creation. Starting a company with a very small number of jobs initially has the potential to create many more jobs as the firm expands.

The three ways to increase the number of jobs are to recruit, expand, and create firms.

Labor and Capital for Job Growth

In the process of increasing the number of jobs through recruiting, states have found that there are two critical resources.

The first is labor, which has long been recognized as a critical resource. The importance of labor was identified as a

limiting factor in the agrarian age and this importance carried over into the early industrial age and later economic eras.

The second critical resource is capital. In the transition from the agrarian economy to the industrial economy, money replaced land as the second critical resource. Land was not a limiting factor in industrial production; the availability of capital was.

The two critical resources needed for traditional job creation are labor and capital.

Technology for Job Growth

Technology began to manifest itself as the third critical resource, along with labor and capital, in the post-World War II years as automation and productivity gains. There was even concern in the 1960s that automation would reduce the number of jobs as robots replaced workers, but this concern passed, as more skilled workers were needed to keep automatic production systems operating. Just as the increasing number of industrial workers compensated for the declining number of farm workers in the late 1800s, increasing numbers of technicians compensated for the decreasing number of assembly line laborers in the post-war period.

Economists began to understand that the previously unexplained gains in productivity could be accounted for only by the deployment of productivity-enhancing technology. By 1987, when Robert Solow won the Nobel Prize for economics (for explaining productivity gains), the critical resources for economic well-being included not only capital and labor, but also technology as the third critical resource.

Skeptics in traditional industrial recruiting circles resisted the addition of technology as a critical ingredient in job creation. If technology was accorded any importance at all, it was as a sidebar item related to productivity. Its central importance in the overall economy was easy to overlook. After all, technology could be loaded onto a truck and moved anywhere.

The third critical resource for economic well being is technology.

Economic Development

The predominant job creation tool – industrial recruiting – largely defines Southern economic development through the last 40 years of the 20th Century.

The existing public policy infrastructure at the state level supports economic development and job creation with marketing budgets to attract the interest of companies considering a change of location. Public finance programs provide access to the capital needed by the recruited firms to purchase the site, construct buildings, and acquire necessary equipment, all of which can serve as collateral for the financing. Incentives for training help the recruited firm to fill the recruited jobs with local workers. Such industrial training sharpens the skills of workers and tailors the skill development to the specific needs of the company.

There is policy "spillover" to community economic development efforts, too. The community focuses on developing the physical infrastructure needed by prospective industry and results in sophisticated plans for industrial parks, complete with roads, power, water and sewer, railroad access,

slack water harbors, and even speculative buildings to which to attract new occupants.

The state and local activities that best define economic development focus on the labor, capital, and infrastructure needs of recruited firms.

Economic Development Incentives

Typical Southern economic development incentives are described under topics such as "Financing, Incentives & Taxation." The Arkansas Department of Economic Development web site [www.1800arkansas.com], for example, lists 21 various incentives offered by the Department, its sister state agencies, and local entities. (For those who wish to review the list of incentives, they are included at the end of this chapter.) A review of the incentives is informative.

Industrial recruiting is firmly embedded in the culture, knowledge, values, and promotional material of economic development, with frequent references to manufacturing, computer firms, distribution centers, and corporate headquarters.

There is a more recently developed strand in the ecology of economic development and it emphasizes job creation, for instance, in the context of small business loans.

Specialized incentives for biotechnology and emerging technologies are encouraging. While the incentives are targeted on important sectors with emergent firms, there is a question as to whether incentives based on income tax are the kind of incentives that such new companies need. When an existing manufacturer is recruited to a new location, it is reasonable to

expect that the firm will have the same kind of sales and income that it previously enjoyed. Emerging firms, on the other hand, usually have little or no income in their early years of operation, so income tax incentives are not particularly helpful.

It appears that sometimes the path of least resistance is to expand the eligibility requirements for existing incentives. This seems to be the case with some incentives that are available to a variety of firms: manufacturers, biological research, motion pictures, distribution centers, business headquarters, and coal and lignite extraction operations. In other cases, it seems that the economic development incentives for new technology-based firms are modeled after the incentives for recruited firms.

Underscoring the importance of appropriate design, the Arkansas Department of Economic Development's Task Force for the Creation of Knowledge-Based Jobs has also discussed incentives. The activity that best defines the Department is industrial recruiting. The Task Force determined that, perhaps with a few exceptions, the success rate of recruiting knowledge-based firms from out of state would be low because such firms require a readily available, well-educated workforce that the state does not have in most target locations. The few exceptions appear when the knowledge-based firm needs risk capital more than it needs access to a specific source of educated workers and innovations, that is, when it encounters the "virtual valley of death."

The Task Force's conception is that the Department's existing industry programs are based on traditional incentives for manufacturers, including tax incentives for job creation and worker training. These incentives are well received by the existing manufacturing clients who understand the need to modernize and transform themselves into world-class performers. The efforts to make the incentives available to a broader range of firms, such as emerging technology

companies, by expanding the eligibility requirements to include energy, biotechnology, and nanotechnology sectors are a start, but fall short of what is needed to attain the critical mass of activity necessary to build the knowledge-based sector of the state's economy. The Task Force proposed that it would be more effective to craft new incentives especially for knowledge-based firms, not to modify industrial development incentives originally designed for manufacturers. During the 2003 legislative session, the Arkansas Department of Economic Development prepared the Consolidated Incentives Act of 2003 that addressed many of the Task Force concerns.

Economic development incentives are most effective when tailored to the unique needs of the targeted firm.

Table 2. Arkansas Department of Economic Development Incentives (as of December 16, 2002).

The financing incentives include:

- Industrial Revenue Bonds
- Bond Guaranty Programs
- Economic Infrastructure Fund
- Small Business Loan Program
- Economic Development District Revolving Funds
- ASTA Investment Funds
- Arkansas Capital Corporation
- Venture Capital Investment Fund
- Tax Increment Financing

The investment and job creation incentives include:

- Advantage Arkansas (Arkansas Enterprise Zone Program)
- InvestArk (Economic Investment Tax Credit Act)
- Create Rebate Program
- Arkansas Economic Development Act

The specialized incentives include:

- Biotechnology Development and Training
- Child Care Facility Tax Incentive
- Emerging Technology Development
- Customized Training Incentives
- Recycling Equipment Tax Credit
- Motion Picture Incentive
- Tourism Development
- Tuition Reimbursement Tax Credit

Is Economic Development Enough?

Industrial recruiting, especially in the South, was a successful strategy to diversify an agricultural economy being transformed by mechanization. It was also a way to employ displaced agricultural workers. Industrial recruiting continues as the cornerstone of current economic development efforts. Its processes, programs, and incentives are well understood at the state and local levels. In the industrial recruiting environment, there are incentives for putting together the critical resources of labor, capital, and infrastructure necessary for job growth. But is this enough?

There appear to be at least two important changes with which economic developers need to contend. First, the economy has been changing; there is an ongoing ecological shift from something that is well understood (i.e., recruiting) to something for which the understanding is just beginning to emerge. Second, there are two other paths to job growth – company expansion and new firm creation – that may have been overlooked because of the focus on recruiting.

Even if economic development incentives have been modernized, they should be examined to see if the incentives help companies survive in the current environment. For example, nanotechnology is an emerging area of commercial interest with broad applicability. Nanotechnology is identified in Arkansas as being eligible for economic development incentives. Suppose that the original incentive was (1) designed for manufacturers recruited to the state, then (2) amended to include manufacturers that were already in the state and undergoing expansion, then (3) expanded to include emerging technology companies as well as existing companies undergoing expansion, and then finally (4) was amended to include nanotechnology in the definition of emerging

technology. The assumption is that the needs of the emerging nanotechnology companies are the same as the needs of traditional manufacturers and the same as the original needs of recruited manufacturers. The incentive is essentially the same, but the environment has changed over time and the actual needs of the nanotechnology firm may go unmet.

An economic development strategy that steadfastly focuses on industrial recruiting risks overlooking (1) changes in the economic environment and (2) the job creation potential from company expansion and entrepreneurship.

A Lesson in 21st Century Economic Development

At the request of personnel at the Arkansas Department of Economic Development, staff from the Arkansas Science & Technology Authority visited a company in Fayetteville. An out-of-state buyer had just purchased the printed-circuit board manufacturer and the new owner was considering moving the operation, either across town to be in proximity of the University of Arkansas' Engineering Research Center or to an out-of-state location. The company leadership wanted to know what the state could do to keep these high-tech jobs in Arkansas. The other state, of course, had recruiting incentives to lure the firm.

It turned out that only the city had any incentives that could apply in the situation at hand, and those incentives revolved around real estate development and tax increment financing.

The policy framework that provides recruiting incentives is inadequate when it comes to the challenge of keeping high-

wage, high-skill jobs from being relocated out of state. The jobs at issue are the kind that other states are seeking to recruit. While incentives to finance land, buildings, and equipment are still useful recruiting tools, this experience illustrates that the state and its communities need another set of policies for in-state firms that employ knowledge-based workers and need a steady stream of innovations to remain globally competitive. The possible move of the firm to closer proximity of the Engineering Research Center underscores this.

These 21st Century incentives probably include mechanisms for upgrading sophisticated skills of knowledge workers, incentives for university-based research and development, and technology transfer made possible by innovative projects and by hiring new graduates with cutting-edge know-how.

Incentives based on traditional economic development are not enough to stimulate creation and growth of new knowledge-based firms nor to keep local knowledge-based firms from being recruited elsewhere.

Growing Knowledge-Based Industry

In 2001, the Arkansas Department of Economic Development created the Task Force for the Creation of Knowledge-Based Jobs to give advice to the Department concerning the needs of knowledge-based companies.

The Task Force defined a knowledge-based company as one that, "earns revenue in the marketplace through the intellectual activities of its employees, who have some form of specialized training and are paid at a relatively high average wage [two

times more or greater] when compared to the community average."

The Task Force developed a mission "to recommend ways to expand the number of knowledge-based jobs and companies" and determined that this would be "accomplished by (1) increasing knowledge-based employment in existing businesses, (2) increasing the number of new knowledge-based start-up businesses, and (3) attracting new knowledge-based businesses from outside the state."

All three ways are important. The appropriate one should be employed when opportunities arise and the need is clear.

It is interesting to note that the preponderance of discussion during Task Force meetings was on the resources most crucial to the creation of new knowledge-based companies. Based on the Task Force discussions, creating new companies appears to be the most productive way to increase the number of knowledge workers in the new economy.

The Task Force discussed many things, including critical resources, but three stand out as the core strengths that need to be built.

1. Education. The discussion about education was extensive. The Task Force returned to this topic repeatedly, underscoring education's – especially math and science education's – fundamental importance to the economy and to knowledge-based companies.

2. Research. Investments in research pay off in terms of improved science and engineering education and the intellectual property that results from the discovery process.

3. Entrepreneurs. They commercialize research results, create and grow companies, and hire knowledge workers.

The key resources for creating knowledge-based companies are education, research, and entrepreneurs.

Economic Development versus Economic Growth

There are many differences between the practice of economic development and the concepts of economic growth.

- Economic development in practice is about jobs. The concepts of economic growth are about innovation and maximizing the potential of individuals through education.
- Economic development is about industrial recruiting and manufacturing expansion. Economic growth is about transferring technology and quality management to existing firms and creating new firms around new technology.
- Economic development is about labor, capital, and infrastructure. Economic growth is about knowledge workers, risk capital, and research and development.
- Economic development is about incentives based on the needs of recruited manufacturers. Economic growth is about incentives tailored to the unique needs of entrepreneurs and knowledge-based companies with growth potential.
- Economic development's focus on jobs is not enough to keep local firms from being recruited elsewhere. Economic growth's focus is on knowledge workers and innovation, the two of which are enough to anchor firms to a location.

The key resources for creating knowledge-based companies are education, research, risk capital and entrepreneurship.

The differences are summarized in Table 3.

Table 3. Economic Development versus Economic Growth

Economic Development is about:	Economic Growth is about:
• Jobs	• Innovation and human resource development
• Industrial recruiting, manufacturing expansion	• Creating new firms
• Labor, capital, and infrastructure	• Technology transfer and quality management
• Manufacturing incentives	• Incentives tailored to the unique needs of the company
• Hoping not to have firms recruited elsewhere	• Anchoring firms to a location
• Well-understood processes to develop the economy	• New ways of growing the economy

Multi-dimensional economic growth is more important to the economy of a state and its communities than one-dimensional economic development.

THE KEYS TO ECONOMIC GROWTH

The transformation of thinking about economic growth began in the early 1980s as policy makers wanted to know what made places like the Silicon Valley, Boston's Route 128, and the Research Triangle Park so successful. In the following chapters, we explore some of the thinking that shaped a different approach to job creation and lay the groundwork for the roles of research, education, and risk financing in growing the new economy.

So Long as I Get Somewhere

There are many times in the context of organizational and strategic planning[5] that one hears about Lewis Carroll's *Alice's Adventures in Wonderland*. In the story, Alice is in a position where she needs to make a decision. Her approach to making the decision is described as Alice speaks to the Cheshire cat. This is where we pick up the story.

`Cheshire Puss,' she began, rather timidly, as she did not at all know whether it would like the name: however, it only grinned a little wider. `Come, it's pleased so far,' thought Alice, and she went on. `Would you tell me, please, which way I ought to go from here? '

`That depends a good deal on where you want to get to,' said the Cat.

`I don't much care where--' said Alice.

`Then it doesn't matter which way you go,' said the Cat.

`--so long as I get somewhere,' Alice added as an explanation.

`Oh, you're sure to do that,' said the Cat, `if you only walk long enough.'

The decision-making lesson is that if you don't care where you will end up or what you will do, or if you confuse being busy with making progress, then it really doesn't matter what decisions you make about your future.

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[5] This Chapter is reprinted from *The Information Technology Career Pathway*, a report prepared by the Arkansas Science & Technology Authority for the Winthrop Rockefeller Foundation, 2002.

Another way to look at the lesson is that if you do care what you will do, then it matters greatly what decisions you make.

Decisions are important.

New Breeds of Programs

In the early 1980s, states began experimenting with technology development and business financing programs aimed at replicating the kind of economic successes that had occurred in a handful of locations around the country.

The successes did not follow the industrial recruiting path suggested by conventional wisdom. Instead, the economic well being of these locations was related to entrepreneurial firms spun out of nearby universities, the availability of risk capital to get the firms off the ground, and well-educated graduates to work in the firms.

The critical resources were labor and capital, but they were different from the labor and capital for which traditional industrial recruiting incentives were developed.

In Arkansas in 1985, for example, the General Assembly added several new programs to the then two-year-old Arkansas Science & Technology Authority. The Basic Research Grant Program was aimed at building university research capacity. The Applied Research Grant Program was aimed at building partnerships between universities and existing firms and the program included a research and development tax credit. The Seed Capital Investment Program provided a new source of risk financing (which stopped just short of unconstitutional equity financing) to technology firms that might otherwise have to leave the state to find early-stage financial support. The

Arkansas Development Finance Authority was created out of the housing agency and given expanded revenue bond financing tools to support economic development. The programs at both the Science & Technology Authority and Development Finance Authority complemented the Arkansas Industrial Commission (created in the late 1950s), which later became the Arkansas Department of Economic Development.

In subsequent legislative sessions, the General Assembly authorized additional programs to bring a wider variety of technology assistance to existing firms. A pilot program sponsored by the National Institute of Standards and Technology (NIST), in the U.S. Department of Commerce, turned into the state-supported Technology Transfer Assistance Grant Program. A second NIST project resulted in a plan that became institutionalized in the state-federal Manufacturing Extension Partnership.

Other incentives have been created or modified over time. The Arkansas Development Finance Authority offers long-term, fixed rate financing; negotiated property taxes; and a bond guarantee program. Local governments have access to Tax Increment Financing and there is an Arkansas Technical Careers Student Loan Forgiveness Program for students who pursue specific two- and four-year degrees important to the state and then work in the state. The Science & Technology Authority added a creative and flexible Technology Development Program and modified the Technology Transfer Assistance Grant Program to be used for SBIR Phase Zero support. It also modified the Applied Research Grant and Technology Development Programs so that they could leverage Phase I and Phase II SBIR awards from federal agencies.

The Department of Economic Development's Task Force for the Creation of Knowledge-Based Jobs reviewed many of these and other research, education, and financing programs and

found that many of the mechanisms needed to foster economic growth exist, though they generally operate in isolation and on a small scale.

Twenty-first Century economic growth must be fostered by a 21st Century policy infrastructure that builds collaborations and a 21st Century budget with enough scale to make a difference.

The Knowledge Worker

The specific label that one might put on "the worker" has changed over time. In his 1982 book *Megatrends: Ten New Directions Transforming Our Lives*, author John Naisbitt described the history of the United States in the simple terms of dominant workforces during the agrarian, industrial, and service economies. Naisbitt said that we had gone from a nation of farmers, to a nation of mechanics, to a nation of clerks.

In the wake of *Megatrends*, new developments have accelerated the transformations in our lives and economy. Former Deputy Secretary of the U.S. Department of Commerce Robert Mallett said that, "By the year 2006 we predict almost half the workers in the United States will work for industries that either produce information technology or use it intensively."

Mallett's projection suggests that we are on the threshold of the economic era beyond that of Naisbitt's clerk. The emerging dominant workforce is that of the knowledge worker, the employee whose value to the employer is not embodied in skill, that is what the worker can do, but rather in what the worker knows, thinks, and communicates. In the new economy, the

image of the knowledge worker coincides with information technology and its uses and influence on the firm.

The knowledge worker, by the way, is not limited to a particular economic sector. There are knowledge workers in agriculture, manufacturing, administration, and virtually all other sectors of the economy. In the new economy, knowledge-workers are critical for success.

The assets of a knowledge-based company walk out of the business every day.

The Importance of Innovation and Human Capital

The contemporary economic process is driven by innovation and the rapid economic adoption of innovations, both of which are facilitated by well-educated and highly trained workers. This is why innovation and human capital are seen as the limiting factors in the new economy, and it is why the production and expansion of these resources is so important.

During the earlier agricultural and industrial periods, innovation as an economic driver was overshadowed by capital and labor (largely equipped with agricultural and industrial skills), the well-recognized components of economic well being. After World War II and with the beginning of the space race, the role of technology in the economy began to emerge and was especially evident in productivity enhancements. Today, information technology is generally accepted as synonymous with the New Economy and analysts are beginning to focus on innovations and well-educated workers as the more meaningful factors in modern economic well being. Indices

developed to measure the capacity of state and regional economies include such things as proximity to research universities, expenditures for research and development, entrepreneurial activity, and access to risk capital.

Higher education's infrastructure is more important than ever because it educates knowledge workers – including entrepreneurs – and supports the research infrastructure that generates innovations.

New Economy Indices

The Milken Institute's New Economy Index was discussed at length in the chapter titled, "Understanding the Complexity of Economic Growth." The beauty of the New Economy Index is its simplicity, having only 12 metrics: three educational indicators, four research indicators, patents, four new-business-related indicators, and exports.

The Milken Institute (http://www.milkeninstitute.org/) has developed a more robust set of metrics in its 2002 publication *State Technology & Science Index: Comparing and Contrasting California*. The Index contains 73 indicators organized in five composites that assess (1) R&D inputs; (2) risk capital and infrastructure; (3) human capital investment; (4) technology and science workforce; and (5) technology concentration and dynamism. It is not insignificant that the report spells out specific steps that California can take to increase its ranking – **from third place.** As Michael Cassidy, president of the Georgia Research Alliance points out; the top ranked states are not sitting idle waiting to be overtaken by lower ranking states, they are working hard to increase or maintain their rankings. The

lesson is that states that do not strive to improve will be overtaken or see the gap between them and the leading states increase.

The November 1, 2002 special issue of the State Science and Technology Institute's electronic *SSTI Weekly Digest* addressed innovation indices (see http://www.ssti.org). It reviewed seven national indices and report cards and summarized their utility as follows.

> When done well and often, innovation indices and science and tech report cards actually can serve several beneficial ends for the tech-based economic development community. They can:
>
> - be useful tools for developing awareness … [and] may help increase the population's recognition of the need to embrace the mindset and change necessary to thrive in an economy that is more knowledge-based, technologically more sophisticated, and globally more competitive.
> - help to identify the areas which warrant the most immediate attention so that limited financial and human resources can be targeted to those programs and policies most beneficial toward reaching the state or community's goals. The marriage of indices to policies and programs to address any lower-than-desired scores can lead to new, innovative partnerships that help to break down archaic and arbitrary political, jurisdictional and functional boundaries. Attention can be shifted to how to achieve the end results rather than which entity gets the most money.
> - offer the political opportunity and supporting evidence to engage in longer-term policies and programs

than typically can result when leaders are motivated by short election cycles. …

- assess the direction of a region's or state's economy if the index includes multi-year data and is done regularly to measure change.
- provide data to support elements of a geographic area's branding and other promotional marketing strategies.

Indices of economic performance are based on new economy indicators that emphasize educational achievement, research, entrepreneurship, and capital formation.

Chicken or Egg Dilemma

The Arkansas Association of Colleges and Employers met at the University of Central Arkansas in Conway (December 7, 2001). Dr. Jeff Collins, an economist from the University of Arkansas, Fayetteville, was the opening speaker. He began with several observations:

- Arkansas ranked 50th in the Milken Institute's recent New Economy rankings.
- Economically, we are not going to look back to the way things were. The economy is shifting from "making stuff to knowing stuff."
- Kids don't like math because it is hard, but you get paid for doing what's hard, so take math.
- Southern economic growth is driven by research, by knowledge.

He contrasted the incentives offered by the Arkansas Department of Economic Development with Milken's New

Economy Index. His conclusion was that the incentives were not the ones needed to move the state up in the standings and suggested that the state is facing a chicken or egg dilemma.

The "chicken" in the dilemma is analogous to the factors emphasized by industrial recruiting efforts: labor, capital, and the infrastructure needs of recruited firms. The "egg" is analogous to the factors emphasized by the New Economy Index: educational achievement, research, and entrepreneurship. The dilemma is that the current situation suggests the state cannot build a high-ranking economy with the tools it currently employs.

Perhaps the dilemma is not in the chicken or the egg, but in deciding where to invest limited public resources. Keeping the chicken metaphor, perhaps the state has both the chicken and the egg, and the roast chicken dinner, and the table scraps as well. Suppose that it all begins with the egg, which is analogous to the factors emphasized by the New Economy Index: educational achievement, research, entrepreneurship, and capital. Suppose the chick hatching from the egg is analogous to entrepreneurial businesses and that the growing chickens are existing businesses using an educated workforce and consuming innovations from research and development. Suppose further that the roast chicken dinner is analogous to recruited industries competing on the basis of low costs and needing inexpensive labor, capital, and traditional physical infrastructure. The state feasts on the roast chicken dinner (i.e., jobs) until there is nothing left but the table scraps (when the jobs relocate to a location where costs and wages are even lower).

The apparent dilemma is having to choose between buying a roast chicken dinner (i.e., industrial recruiting) or an egg (i.e., research and development), but this dilemma doesn't actually exist because the state already has both the egg and the chicken, and chicken dinners and table scraps, too. The investment in

eggs will turn into chicks that mature and become roast chicken dinners on which the state can feast.

The chicken or egg dilemma is a false dilemma because both are needed. The chicken dinners can be either purchased (i.e., recruited) or grown (through R&D). The challenge is optimizing the state's investment in both.

The state needs to plan the transition from buying roast chicken dinners to investing in the incubators that will turn its abundant supply of eggs into chickens. It already has the roast chicken recipes.

Seeds for the New Economy

Making investments that matter in the new economy is a theme of many recent efforts. There is remarkable symmetry among them. Consider the similarities in the following three strategies.

Investing in Innovation[6] is a description of the strategy for Australia. The strategy recognizes history, in which Australia mined its rich natural resources, developed its agricultural base, and took advantage of its being a global transportation crossroads. The new strategy, however, emphasizes innovation and new knowledge-based industries based on a foundation of strong basic science, major new investments, and cultural change. The 12-point plan calls for the following:

1. Investing in science and technology;
2. Creating Cooperative Research Centers focused on discovery and commercialization;

[6] Based on the editorial "Australia: Investing in Innovation," by Suzanne Cory in *Science* Sep 21, 2001: 2169. For the full text, see www.sciencemag.org/cgi/content/summary/293/5538/2169 .

3. Training a new breed of young scientists and equipping them with knowledge about intellectual property and a "realistic approach to commercialization;"
4. A strategic review of research;
5. Increasing expenditures for basic research over five years with increases beyond the fifth year based on success in reaching specific commercialization outcomes;
6. Stimulating new knowledge-based industries with tax incentives for industry investment in research and development;
7. Providing competitive funds to fill the gap between discovery and the investor-ready stage;
8. Attracting international investment and partnerships;
9. Locating R&D development based on the incentive of high quality and cost-effectiveness of science;
10. Retaining scientific excellence through salary reform that will limit the brain drain and attract the next generation of scientists;
11. Planning to double the current investment in research and development over 10 years and focusing on *information and communications technology, environmental management, biotechnology, and health services*; and
12. Moving boldly and quickly to secure its future as a knowledge-led nation.

Meeting Challenges in the New Economy describes the approach of the Oklahoma Center for the Advancement of Science and Technology (OCAST), which uses the following strategies, among others: increasing research funding flowing into the state, human resources development, and capital investment.[7] Specific areas of emphasis and measurement are:

- University Federal Research and Development,

[7] The SSTI Weekly Digest for October 26, 2001, a publication of the State Science and Technology Institute (www.ssti.org).

- Industry Research and Development,
- SBIR Awards,
- Increased Science and Engineering Graduate Enrollment, and
- Venture Capital invested.

The 2001 Southern Governors Association annual meeting[8] had as its theme "The Triple Crown of the South's New Economy: Research, Development, and Technology." Alfred R. Berkeley, Vice President of NASDAQ, brought a market perspective to the meeting and said that the Triple Crown theme is the right path. Capital, science, and skilled labor drive improvements in living standards. Public policy matters because it drives capital, science, and skills. He added that increased investment in R&D is incredibly important and the job creation in institutions that conduct research and development can be as good as the job creation in large manufacturers. We need to think in the long term. The key to skilled labor is education in math and science. In the plenary session titled "Seeds for the New Economy," a panel of Nobel laureates was asked to answer the following question: How do you create the "industry of the mind?" Their priorities, which emerged during their discussion, were education, investments in research and new knowledge, commercializing research (which requires venture capital), and creating the new economy infrastructure (which emphasizes broadband connectivity and laboratories).

Each of these strategies, *Investing in Innovation* at the national level, the *2001 Southern Governors Association* at the multi-state regional level, and *Meeting Challenges in the New Economy* at the state level, has similar core features.

- Investing in the new economy infrastructure: scientific research centers;
- Increasing investments in research and discovery;

[8] September 9, 2001, Lexington, Kentucky.

- Training young scientists, emphasizing education in math and science, developing skills in intellectual property and commercialization, creating jobs in science, retaining scientific excellence, and attracting the next generation of scientists;
- Providing and attracting risk capital;
- Encouraging knowledge-based industries to invest in research and development; and
- Attracting R&D firms based on high quality science.

Lastly, the strategies underscore the importance of acting boldly, moving quickly, and thinking in the long term.

There is consensus that the things that matter the most in the new economy are investments in the research infrastructure, the science and engineering workforce, and risk capital to support commercialization by knowledge-based companies.

A Vision for Economic Development

There is no shortage of best practices – many of which have been pioneered in Arkansas – that can be used to take advantage of opportunities in the new economy. The key factors are also clear; they involve people, scientific research, technological innovation, and equity financing.

In the area of developing the state's human resources, emphasis should be given to hands-on science education in middle schools; regional high-tech high schools; application of problem-based/experiential programs in math, science, and pre-engineering; and scholarships, undergraduate research support, and internships for science and engineering students in college.

In the area of scientific research and technological innovation, emphasis should be given to expanding start-up research support for young science and engineering faculty and the establishment of centers of excellence in research. The latter effort would rely on the recruitment of three world-class investigators to give the center critical mass and would "connect" with the human resource development pipeline.

In the area of equity financing, emphasis should be given to establishing (and expanding the existing) research and development tax credits to encourage "angel" investors to invest in early-stage companies built around emerging technologies; an increased seed capital investment fund to support early-stage companies; organization and provision of incentives for angel investors; and implementation of the Venture Capital Act of 2001.

Taken together, such activities provide a vision of the economy and establish propensities toward future choices.

Implementing best practices at scale will cause the state to acquire increasing knowledge and know how and set the path for growing its own economy.

Increasing Returns to Knowledge

Another aspect of knowledge is its importance to the economy. *New Growth Theory, Technology and Learning: A Practitioners Guide* by Joseph Cortright[9] is summarized by two concepts, first that technological progress is a by-product of economic

[9] Impresa, Inc., 2001, Reviews of Economic Development Literature and Practice: No. 4, U.S. Economic Development Administration. [See http://www.impresaconsulting.com/ngt.htm .]

activity and second that knowledge and technology have increasing (not diminishing) returns that drive the growth process. This suggests enlightening implications for economic development. Cortright's major points are that knowledge drives economic growth, and that history, institutions, and geography matter.

- **Knowledge Drives Economic Growth**

The cornerstone to New Growth Theory is that new ideas and new knowledge are an integral part of economic growth, not an external variable to be used in mathematical models that explain growth as a consequence of bringing together capital and labor. The real world example of software companies illustrates how important knowledge is, how it is an intrinsic part of economic well being along with capital and labor, and how it and its returns grow with subsequent versions of a software product. Knowledge has three special characteristics: knowledge (1) is intangible, (2) can be shared and reused at nearly zero cost, and (3) allows the possessor, in Cortright's words, "to extract greater use out of finite resources."

- **History, Institutions, and Place Matter**

An interesting aspect of New Growth Theory is that the increasing returns associated with knowledge produce "*path dependence*," that is, chance events happening at the right time can have a long-term influence on the economy as subsequent technological developments (or extensions of knowledge) lock on to the path established by chance. The QWERTY typewriter key pattern is an example of such path dependence. The conclusion is that history matters. The implication is that one acquires new knowledge by following familiar methods shaped by previous experiences, improving on them, and surviving in the marketplace, but one is always at risk of being succeeded by superior know-how arrived at by an abrupt, leapfrogging improvement. Thus, the new business with a new product that

redefines the market becomes the driving force of the economy. The resulting economic changes occur because the new businesses displace old ones, a process called "*creative destruction*" by economist Joseph Schumpeter.

Cortright quotes economist Paul Romer as saying, "The most important job for economic policy is to create an institutional environment that supports technological change." He goes on to explain the importance of institutions is their being where formal and informal rules are determined, and it is the rules that shape and limit transactions, values, reputations, social constructs, and the kinds of knowledge that are created. Institutions matter. The power of institutions is explained in two important regards that are summarized here:

1. *Institutions shape incentives* for the creation of new knowledge (where "the cumulative learning of societies guide people's interpretations of economic and political problems and opportunities") and
2. Dynamic adjustment to changing circumstances is required for continuing progress (that is, "institutions have to change over time to produce the incentives and rules required by new markets and technology" and that "*adaptive efficiency* ... is the critical factor shaping economic development").

"New Growth Theory," according to Cortright, "emphasizes the central role that new ideas play in driving economic progress."

Cortright once again quotes economist Paul Romer to introduce the importance of geography in New Growth Theory. According to Romer, "As the world becomes more and more closely integrated, the feature that will increasingly differentiate one geographic area (city or country) from another will be the quality of public institutions. The most successful areas will be the ones with the most competent and effective mechanisms for supporting collective interests, especially in the production of new ideas." Place matters. *Knowledge spillovers*, where some of

the benefits of new ideas are shared with persons other than the creators, are important differentiators of place because of four characteristics of knowledge.

1. Knowledge is partly codifiable, and partly tacit (that is, some knowledge can be written down and some knowledge is learned from experience and is more difficult to share with others, especially at a distance).
2. *Tacit knowledge is less mobile*.
3. Diversity and specialization shape knowledge spillovers (that is, innovation leads to the addition of new kinds of services, products, and work).
4. *Local institutions and cultures shape knowledge flows* (that is, they can encourage the kind of social capital that results from trust and reciprocity or they can encourage a more restrictive kind of social capital).

- **Five Lessons**

There are five lessons that derive from New Growth Theory that are applicable to economic development.

1. Investments in research and education are critical.
2. Creating knowledge is central to economic growth.
3. The challenge is to find the strategic opportunities to influence economic growth and then to nurture them and help them to develop.
4. Every community has different opportunities. Communities have an important role.
5. Everyone can create knowledge. Especially young, technologically savvy individuals.

History, institutions, and geography influence dependence on, incentives for, and spillovers from knowledge, which drives economic growth. Communities and their economies are based on their use of knowledge. We are what we know.

The Keys to Economic Growth

Technology-based economic development was proposed as a new model for growth in the 1980s. The results are in: technology-based economic development works and is competitive with traditional programs. This new approach requires a well-educated workforce and research innovations in order for firms to be successful in global competition.

The new economy metrics emphasize educational achievement, research, risk capital, and entrepreneurship, all of which correlate with higher per capita incomes.

States that have relied heavily on industrial recruiting as the tactic for economic development need to begin planning their transition from recruiting jobs to investing systemically in the institutions that will turn knowledge into new companies, wealth, and jobs built on education and know how.

Twenty-first Century economic growth must be fostered by a 21st Century policy infrastructure that rewards collaborations and a 21st Century budget with enough scale to make a difference.

There is consensus that the things that matter in the new economy are investments in the research infrastructure, the science and engineering workforce, and commercialization by knowledge-based companies.

The increasing returns of knowledge, where history, institutions, and geography influence dependence on, incentives for, and spillovers from knowledge, drive economic growth. Communities and their economies are based on their use of knowledge. There is an economic contest between communities, regions, and countries; those that adopt new developments have a competitive advantage over those that don't.

RESEARCH & DEVELOPMENT

It is clear that research infrastructure, research activities, and innovations derived from research are central to economic well being. On the one side, research relies upon education and the curiosity of inquiring students and, on the other side, research delivers innovations with commercial potential and relies upon entrepreneurship and risk capital investments to take new products to market.

The Central Role of Research

If the keys to future economic growth are the continuum of education, research, and entrepreneurship / risk capital, why begin the discussion with research instead of education?

The reason is that research is centrally located between education and entrepreneurship and offers unique views and perspectives on both education and entrepreneurship.

In the simplest terms, education is primary to, but not sufficient for, economic growth. Research is central to economic growth and the essential bridge between education and entrepreneurship. Entrepreneurship / risk capital delivers economic growth by combining (among other things) knowledge workers who are products of education and innovations that are products of research.

In the context of economic growth, and looking "upstream" from research to education, research needs the pre-college educational enterprise to prepare students with competencies in science, technology, pre-engineering, and mathematics. At the collegiate level, research needs science and engineering students with interests in doing research and a supportive research infrastructure.

Looking "downstream" from research to entrepreneurship / risk capital, research needs a place where intellectual property is packaged into deals and brokered with risk financing opportunities leading to commercialization. Research and commercialization go hand-in-hand. Without research, there are no deals; without deals there is no deal flow; without deal flow, there is no need for risk capital.

Research is central to economic development because it draws on education, is focused on growth of knowledge, and delivers innovations to the commercialization process.

The Value of Research

There are many perspectives from which the value and utility of research can be viewed.

The perspective from universities is that research is part of the mission of higher education. Research investments are sought by faculty to improve the teaching component of the mission.

The perspective from federal agencies is largely related to the mission – either narrowly or more broadly defined – of the agencies funding research.

The perspectives about the value and utility of research change over time. During the Cold War, for example, the dominant perspective was National Defense; research investments were directed to university and government laboratories and the deliverables were largely improved military and intelligence-related technology. The perspective in the post-Cold War years has shifted to the view that research investments are essential for economic growth.

There are three different perspectives that could be used in discussing research and its value.

First, there is the perspective of the scientists who are engaged in research. To them, research, in its most basic form, is about inquiry. To them, the value is that research allows them to know more about their field of scientific interest, to visit places never visited before, to see relationships that are not obvious through casual observation. Research enables them to

add to society's body of knowledge and to pass this knowledge on to the next generation.

The scientists' perspective is unique because it derives from their academic and life's work and is built upon the accumulation of earlier work.

Second, there is the perspective of society, usually as represented by government. This view is that research, as a percentage of government spending, is valuable as an investment because the results of research benefit society. When the knowledge from research is applied, society receives better drugs and health care, more affordable food and fiber, a safer and better understood environment, a more secure nation, among other broad ranging and important benefits.

Society's perspective is more complicated than the scientists' view for several reasons. Society does not have the depth of interest in research that scientists do, nor does it share the disciplinary enthusiasm of scientists. Lastly, society is concerned with a much broader view of competing issues, many of which are easier to understand and in need of urgent attention; research is only one issue, strategically important, but rarely viewed as urgent. It is the intuitive public understanding that contemporary advances in health care and telecommunications are the result of investments in research. This understanding leads to the positive public attention that research continues to receive.

Third, there is the economic perspective. The traditional economic view has been similar to the societal view; research is important in the longer-term, but there are other activities in the broader view of the economy that offer important short-term payback. This traditional view is being revised by emerging realities of the new, information-age economy, which will be sustained by investments in technological innovation and human capital; research results are the feedstock for both.

The economic perspective sees intuitively the economic value of research. Locations with the most enviable economies are places rich in infrastructure for conducting research, usually in university or government laboratories, and the financial and human capital needed to convert research results (i.e., intellectual property) into new products and processes. The perspective of the new economy is that the research infrastructure and its associated human capital are essential cornerstones for continued economic well being.

Research is a fundamentally important policy area that often gets overlooked because the American research, development, and commercialization system has been so effective. Americans take for granted the benefits that the system delivers, and lose sight of the years, sometimes decades, of thoughtful investment and dedicated work that goes into producing those benefits.

Research is an important and valuable activity in the view of scientists, society, and technology-based economic development.

A World of Propensities

Sir Karl Popper (1902-1994) was a noted mathematician and philosopher of science. He is the author of the propensity theory of probability, an extension of the classical theory of probability. An example illustrates his work.

In classical terms, each face of a die has 1 chance in 6 of being thrown; that is, each face has an equal probability of turning up. This is a simple, powerful notion that leads us to accept that each throw of the die is precisely the same as all other throws of the die. This notion, however, does not apply to

a loaded die, and it is on this point that Popper makes his contribution.

When a small lead weight is inserted under one surface of a die, the situation is changed and there is no longer an equal probability that any one face will turn up. The precise probabilities have been changed and there is a tendency, what Popper calls a propensity, for one face to turn up more often than any other. Popper's point is that "a tendency or propensity to realize an event is, in general, inherent in every possibility" associated with the loaded die.

Popper extends his propensity theory to other areas of life. Life, in Popper's view, is more like the result of throwing loaded dice than regular dice; that is, life is more likely to be determined by propensity than by fixed probabilities. His basic conclusion is that the future is open to all kinds of possibilities. He goes on to say:[10]

> Situations and possibilities certainly change if we prefer one possibility to another or if we see a possibility where we had not seen one before. Thus our very understanding of the world changes the propensities. … So do our wishes, our preferences, our dreams, our imaginings, our theories.
>
> It is not the kicks from the back, from the past, that impel us. Rather it is the attraction, the lure of the future and of its attractive possibilities that entice us.

The lesson is that if one cares about what one wants to do, then every situation – every decision – is open to all kinds of possibilities.

[10] *Changing Our View of Causality; A WORLD OF PROPENSITIES* by Sir Karl Popper, April 27, 1988 (a monograph).

Decisions matter.

R&D Planning

Given the value of research and its centrality between education and economic development, state and local investments in research and development are too important to leave to chance. Individual research efforts, campus strengths, and research programs funded by federal agencies will combine to produce innovations and well-educated workers. The strategic economic development question is this: Will the innovations and workers produced be the ones most sought by local knowledge-based companies?

The individual interests of scientists, the research strengths of campuses, and the research missions of funding agencies are all important considerations when building research infrastructure. The tactic of matching research strengths to funding opportunities is essential to successful competition for research awards. Again, however, a strategic economic development question is: Who decides the economic value and priorities for state (or local) investments in building research infrastructure?

A large number of states have realized the importance of research as an economic development driver. Those that have supported statewide research programs have built the know-how necessary to establish the R&D partnerships with research universities. The states also recognize that the opportunities to support research far exceed the limited state resources made available for that purpose.

A growing number of these states are now focusing their research support in a few areas that have strategic value to the

state's economy, that is, the state-supported research produces innovations and human capital resources important to knowledge-based firms inside the state or considering relocation to the state.

The Arkansas Science & Technology Authority's Board, for example, adopted a Research and Development Plan in 2002. The plan was consistent with a vision that the economic well-being of the state, its communities, and its citizens is enhanced through the wise and appropriate application of science and technology to security, health, education, government, business opportunities, agriculture, and environmental protection.

For the purpose of R&D planning, the Authority assumed several things: the context for R&D planning is economic growth, which is driven by investments in innovation and human capital. The key partners in achieving economic growth are existing and emerging knowledge-based firms, research universities, and the public education infrastructure. The *economic development* roles of the key players are to create businesses, high paying jobs, and wealth by commercializing innovations and to produce innovations and knowledge workers.

To help direct its limited research and development funds, the Authority proposed to focus its existing research and commercialization programs on the best research and development opportunities for existing and emerging technology firms. The research areas of strategic importance include:

1. Advanced Materials and Manufacturing Systems,
2. Agriculture, Food, and Environment Sciences,
3. Biotechnology, Bioengineering, and Life Sciences,
4. Information Technology, and
5. Human Resource Development in these areas.

It is important to focus scarce state resources on research areas of strategic value to economic growth.

Implications of an R&D Plan

There is value in the processes that lead to the preparation of a research and development plan and the plan has intrinsic value. The real significance, however, is the many propensities of a research and development plan that is implemented.

The plan would guide the majority of investments made through existing programs, to position the state to take advantage of emerging economic opportunities in those specific areas.

The plan would guide the state's investment in statewide university research infrastructure and some of the investment in education and career pathways, to improve the connections that lead to good jobs, in state, for knowledge workers and graduates.

The plan would generate innovations and innovators. These are the results of focused research activity, supported by programs, investments in infrastructure, and maintenance of career pathways for knowledge workers.

The plan would also be an incentive for capital formation. Money is mobile. It can be invested in the community or it can be invested outside the community. As discovery and innovation flow from research, the opportunities for commercialization increase, and there is a propensity for local risk-capital pools to form.

The plan would encourage new collaborations in strategic areas. The investments made in strategic research would "ripple

upstream" to education and "downstream" to business development and capital formation.

The propensities of the R&D Plan are more important than the plan itself. The key is to act upon the plan and let the effects ripple through the economy.

Implications for Existing Programs

The propensities of a research and development plan would include a tighter focus on strategic areas and an emphasis on these areas in terms of programmatic investments. For example, basic research support and research matching investments would be targeted, as would investments in applied research, centers for applied technology, R&D Tax Credits and in other state programs. These investments could leverage funding from other sources, such as SBIR awards from federal agencies. Finally, one would expect focused technology development and seed capital investments to follow and provide the "deal flow" for later stage venture capital investments.

The propensities for economic development departments might include a similar focus and influence strategies for existing industry. Recognition that the key resources for creating knowledge-based companies are education, research, entrepreneurship, and risk capital would be a useful starting point. The implications for the state's recruiting effort might be a shift toward a more strategic recruiting focus.

The focus of existing economic development programs will shift to leverage, complement, or otherwise take advantage of a research and development plan.

Implications for Research Infrastructure

A research and development plan that identifies areas of strategic value could guide the state's investment in university research infrastructure. The investment could influence the kind of laboratory buildings, equipment, and research centers a university would seek, especially if state matching funds were required and available.

A model for this approach was developed in Georgia as the Georgia Research Alliance. The philosophy for the model is based on the Milken Institute's finding that research centers and institutions are indisputably the most important factors in incubating high-tech industry. Georgia developed a process to create an environment in universities where R&D can be turned into economic development by connecting business, universities, and government. The critical drivers for success of the model are (a) a *strategy* and *process* and (b) investments in *infrastructure* and *endowed chairs*. These critical drivers are briefly described.

- Strategy: Focus on providing world-class infrastructure in economically relevant areas and attracting the best researchers in these areas to endowed chairs at research universities.
- Process: (1) Ask research university[11] presidents to prepare a research portfolio, with a value of up to $30 million for

[11] According to the National Science Foundation/Division of Science Resources Statistics [Survey of Research and Development Expenditures at Universities and Colleges, Fiscal Year 2000; Table B-31. R&D expenditures at universities and colleges, by State, control, and science and engineering field: fiscal year 2000] Arkansas had $130,894,000 in research expenditures at the following universities:
Arkansas State University ($1,203,000); Arkansas Tech University ($419,000); U Arkansas Pine Bluff ($4,151,000); U of AR at Little Rock

infrastructure and endowed chairs. The portfolio is intended to be an incentive for research coordination among campuses and an incentive for individual campuses to invest non-portfolio campus resources in strategic research areas. The rule of thumb is that 40 percent comes from the portfolio, 60 percent from non-portfolio resources. (2) Convene a joint council of university presidents and business leaders to review the portfolio and reach consensus on the highest priority investments. (3) Ask the CEOs from the council to take the consensus portfolio as a recommendation to the Governor for the executive budget. (4) Then, as part of the budget process, the Governor recommends all or part of it to the legislature's joint budget committee, the budget committee makes its recommendation to the General Assembly, which appropriates funds directly to the institutions as outlined in the portfolio. The public funds flow, however, only as the campuses document the required matching funds.

- Infrastructure includes laboratory buildings and major research equipment. The return on such investments is impressive. The Georgia Center for Advanced Telecommunications Technology (GCATT), for example, houses five endowed chairs, has generated $13 million in sponsored research in 2 years, houses 21 companies employing 695, and acquired risk financing totaling $328 million. There are seven such clusters with scholars and faculty from all of the Georgia Research Alliance campuses comprising a cluster, directed by two leaders, both of whom are eminent scholars.

($3,400,000); U of Arkansas Main ($70,817,000); U of Arkansas Medical Sciences ($49,074,000); U of Central Arkansas ($1,758,000); and Philander Smith College ($72,000).

- Endowed Chairs represent the brain trust for future economic development. The funding to endow a chair is $750,000 in portfolio funds and $750,000 in non-portfolio, often private, support to the recipient university. This is actually not enough funding for a start-up package at this level, so there may be "a dowry" of $2 million over a few years for the chair to use to outfit labs (the dowry is for equipment, not to support specific research projects). The dowry is highly leveraged, with the rule of thumb being that 40 percent comes from the portfolio. In Georgia, 30 chairs have been filled over ten years.

A research and development plan can influence the investments in university research infrastructure, endowed chairs, and research centers of excellence.

Implications for People and Jobs

A research and development plan that identifies areas of strategic value could guide some of the state's investment in public education (K-12) and career pathways. The research investments themselves might in fact support efforts along such pathways. This might improve the connections within public education and between public education and the workplace, leading to better in-state jobs for graduates and knowledge workers.

Each of the strategic areas has a connection to clusters of existing or emerging firms inside the state. Each of the firms has the potential to employ knowledge workers educated or trained for such positions. The implication is that there are in-state jobs associated with each of the strategic areas. The

challenges are to forge and to reinforce the connections – within the educational system, including public education, higher education, and workforce training, as well as between the educational system and knowledge-based firms. The strengthened connections create career pipelines.

There are some things already in place, such as Smart Start, Smart Step, the EAST (Environmental and Spatial Technology) Initiative, and the Arkansas School for Mathematics and Sciences.

There are some other things that could be put in place or perhaps be better coordinated. Some of these include:

- Student Decision Making might be improved by making employment opportunities known to students early enough so the students could better decide on the kind of classes they need to take in high school and college to be employable in knowledge-based companies in the state.
- Science Fairs might be better supported and supported in earlier grades as a way to "groom" younger students for later competition in science fairs and for undergraduate research.
- Two-year colleges might better position themselves as intermediate institutions, encouraging students to use the two-year college as step along a particular career pathway and building relationships between their students and local knowledge-based companies that might recruit such local talent back home for employment.
- Undergraduate Research could improve the research and analytical skills of university students, especially if the research opportunities were related to the needs of in-state firms that might see hiring such a graduate as "technology transfer."
- Student Internships with knowledge-based companies have the potential to place students in real-world situations in

which they can apply their education and training while giving the firm the opportunity to observe and evaluate prospective employees.

- Traineeships for Graduate Research provide a way to support discovery at the highest levels of scientific and engineering investigation. Such investments, when coupled with entrepreneurial exposure might lead to new business creation and commercial opportunities.
- Endowed Chairs are a way to attract and support high-performing research scientists and engineers and acquire federal and other research support.

A research and development plan has the potential to influence career pathways through the plan's targeted investments and relationships.

Implications for Innovations

A research and development plan that identifies areas of strategic value could guide, and would certainly add leverage to, the state's investment in research. The return on this investment would be innovations, one of the key drivers of both new and existing knowledge-based companies.

An important consideration is the unimpeded flow of innovations from the laboratory to the marketplace. Traditionally, the movement of students to the workforce and the transfer of technology through intellectual property (IP) agreements have accomplished this exchange.

Some, however, perceive intellectual property, as a difficult issue, especially when the IP is developed at state-supported universities. Some in-state companies believe, for example, that

the taxes they pay to their state should be sufficient payment for them to get technical support from state-supported university resources. Other companies that have worked through intellectual property agreements with universities find the experience unpleasant enough that they say they will avoid repeating such arrangements. One story from a southern state takes a peek at both sides of such an IP agreement. On the university side, the agreement transferred the intellectual property from the campus to the company, generated revenue from the company, and was viewed by the university as a model for such arrangements. On the company side, the university had something the company wanted and the company negotiated the best deal that it could, but the experience was such that the company would not go back to the university for additional work, choosing instead to go to a private laboratory where the work could be done for hire without the need to negotiate an intellectual property agreement. The university thought it had a model agreement; the company found it to be a big hurdle.

In discussions about intellectual property at the Southern Technology Council, one thought was that universities could generate more revenue by doing work for hire and giving the intellectual property away than they get from licensing intellectual property.

An implication that derives from the strategic value of innovations is that the traditional flow of innovations may need to be reexamined. In a more strategic approach, the IP agreements may vary depending on the nature of the innovation.

It appears that there are at least four kinds of innovations. Perhaps the most common is the kind that derives from federally funded basic research. The second kind is the result of the university doing work for hire. The third kind involves joint projects where parties participating in the project each bring

something of value to the collaboration. The fourth kind of innovation is the result of strategic efforts.

The IP agreement should probably be drafted with the nature of the innovation given primary consideration. Using the traditional mechanism for transferring federally funded innovations from basic research may not be the appropriate model for an innovation funded by a company seeking that particular innovation. Using an inappropriate template for the IP agreement presents a significant barrier to the free flow of innovations. Consider the following.

Barry Holtz, one of the founders of the biotech company Large Scale Biology, was the keynote speaker at the Arkansas Biosciences Institute's October 24, 2002 research symposium. He explained what his company does, what its products are, and how the products are developed. Almost all of the products are the result of collaborations; the collaborations always involve universities (usually more than one), the company, and, in some cases, the federal government. He said the strengths of the collaborations are (1) basic research, which is a must to businesses like his, and (2) the large-scale resources of universities. The problems at universities, he continued, are threefold: (1) intellectual property strangulation, (2) lack of collaboration, and (3) lack of business development expertise. He said that his company does research, but it is very narrow and focused on product development because the product is the end game. The mission of universities is education and research – eclectic, broad based, and large-scale research. Universities do not do a good job crafting IP protection, probably because they do not see the end game – the product – the same way companies that make money off the product do. If the IP is poorly crafted – and companies spend a lot of money to get it done right – there are no licenses and no royalties.

If there are four kinds of innovations, then there may be four kinds of IP agreements.

A research and development plan changes the nature of intellectual property agreements from occasional by-products of basic research to strategic economic goals.

Implications for Capital

A research and development plan that identifies areas of strategic value can focus investor attention on new opportunities for wealth generation. The potential return on investment – the return that derives from creating new businesses to commercialize innovative new products – can stimulate the formation of private equity capital.

There are important intermediate steps that need to be taken between research and commercialization. Research results are the beginning. The following steps include the entrepreneurial vision of a commercially viable product or service, the proof of concept, development and protection of the product or service, creation, development, and growth of the business.

In the context of economic growth, research should be followed by private equity capital investments in order to get the innovative product or service to the marketplace. In the context of economic growth, research and development and capital formation go hand in hand. If the goal is to grow the economy, then it makes no sense to have one without the other.

The economic value of a research and development plan becomes real when private equity capital is invested in the commercialization of innovative new products and services.

Implications for Collaboration

A research and development plan that identifies areas of strategic value simultaneously identifies venues for strategic collaborations.

A focus, for example, on information technology in a research and development plan sends the signal that information technology has strategic value. As used here, *strategic* implies a term of effort over a longer period of time and *strategic value* means value beyond the tactical benefits within interested, but isolated, institutions. Strategic value suggests that new collaborations in information technology are useful and valuable beyond the programmatic value of individual projects. Strategic value implies movement toward the goal of commercialization and requires recognition of the next "big thing" that venture investors sense will take off in the marketplace.

The implication is that the investments made in strategic research would have a "ripple effect" upstream toward education; "downstream" toward product development, business creation, and capital formation; and outward to nearby existing programs. The ripples have propensities to generate synergies and leverage through collaborations, joint ventures, partnerships, and cooperation as programs and institutions participate in seeding and sustaining the strategic effort.

The research and development plan elevates strategic research areas to a level where they suggest visible goals, the achievement of which represents a collaboration that succeeds.

Research Influences the Whole System

It is important to focus scarce resources on strategic areas. A research and development plan provides this focus and has important propensities that may be more important than the plan itself. The key is to act upon the plan.

The focus of existing programs will shift because of the emphasis a research and development plan can give. Because of programmatic support guided by a research and development plan, the plan may influence the investments in university research infrastructure, endowed chairs, and research centers of excellence.

A research and development plan can influence career pathways by highlighting areas for science fair projects, undergraduate research topics, investments from knowledge-based firms, and relationships with like-minded partners.

A research and development plan changes the nature of intellectual property agreements from occasional by-products of basic research to strategic economic goals and incentives for knowledge-based companies.

The economic value of a research and development plan becomes real when private equity capital is invested, creating new companies, new knowledge-based jobs, and the commercialization of new products and services.

Research influences the entire system of economic growth.

ENTREPRENEURSHIP AND CAPITAL FORMATION

Investor attention on strategic research and new opportunities to make a return on investment from commercializing innovative new products can stimulate the formation of private equity capital.

Risk capital is essential for the creation of new businesses.

Entrepreneurial Motivation

There are many motivations for one to become an entrepreneur, but it is important to recognize three specific entrepreneurial motivations. First, there is the entrepreneur who is motivated to start, own, and operate a business by which to support a family or a particular life style. Second, there is the entrepreneur who is motivated to create businesses and does so serially, creating one business, then another, and so on. Third, there is the entrepreneur who is motivated to start, expand, and operate a growing business. These three motivations – to create a family business; to create multiple businesses; and to create and grow a successful business – underscore a couple of important distinctions.

One distinction is based on those start-up companies with the potential to export. They are more important in the context of the new economy because such companies satisfy what Trent Williams calls the "value added imperative" to export goods and services while importing cash and bringing wealth to the community.

Another distinction is that the start-up companies with growth potential, and thus the potential to increase wealth and the number of jobs, tend to be knowledge-based companies or technology-based companies that either incorporate technology into their products or use technology extensively in their production processes.

While all entrepreneurial businesses have value because they contribute to a community's economy, the motivation of the entrepreneur and the distinctions that can be made about their companies have important implications regarding the size of the

company, the amount of capital required, and the sources of capital that can provide financing.

For example, and as a rule of thumb, the life-style entrepreneurs will have firms that do less than $10 million in business and can usually raise start-up capital from family and friends. Most people would probably view these firms as traditional small businesses. Serial entrepreneurs tend to start firms, sell them, and start over; they may or may not grow them to a large size before selling them off. Firms that entrepreneurs grow to $10 million to $30 million in business require risk capital from angel investors and high-net-worth individuals. Lastly, entrepreneurs who build corporate empires doing more than $30 million in business require a full range of risk capital investments, culminating in angel investors and venture capitalists.

The formation of a new business begins with entrepreneurial motivation.

Entrepreneurs

Entrepreneurship is important in the process of economic growth. Entrepreneurs have the vision of a commercially viable product, prove the concept, develop and protect intellectual property, and create the business.

Entrepreneurial enterprises, especially those in the earliest stages of development, are not likely to be the targets of economic developers and industrial recruiters. Therefore, if a community wants to have such firms in its mix of local businesses, then the community will have to "home grow" them. This may require making entrepreneurial skill training

part of the educational curriculum in public education and in higher education. It may be particularly important to make the introduction to entrepreneurship part of degree programs – such as science and engineering – in order to enlighten technology-oriented entrepreneurs.

Prizes in student business plan competitions, sponsored by financing organizations, colleges and universities, and state agencies, have been used as incentives for multidisciplinary student teams to prepare business plans and begin thinking like entrepreneurs.

Communities should recognize that entrepreneurs might need assistance in getting their businesses started and the entrepreneurs' motivations are likely to influence the kinds of start-up help they need.

The start-up companies of life-style entrepreneurs, for instance, will often need assistance with business planning and market analysis. This kind of assistance is often offered through Small Business Development Centers (SBDCs) that offer skill building to aspiring businesspersons through training programs.

Serial and empire-building entrepreneurs probably require more specialized one-on-one assistance. Because their businesses are more likely to involve technological innovations, these entrepreneurs may need more help in areas involving applied research, product development, and engineering design, which may be different from the services traditionally offered by SBDCs.

One is not born an entrepreneur, but is motivated to follow an entrepreneurial path. The formation of a new business is one of the steps along the way.

Private Equity Capital

Those beginning to negotiate the entrepreneurial pathway encounter the need for money early and the resources that the founder puts into a new business represent the earliest stage of risk capital. It is usually followed by money from family and friends who know and trust the founder. This financing is called start-up or pre-seed capital.

Depending on the motivation of the entrepreneur and the kind of business that develops, expansion or seed capital will be needed from angel investors and high-net-worth individuals. These funds are needed to grow the business to a level where it is making sales and generating revenue. One or more additional rounds of risk financing may be needed from venture capitalists, who are looking strictly at the investment's rate of return. These investors generally have an exit strategy that guides them toward the point when they will get their investment and returns out of the deal through a sale, merger, or initial public offering of stock in an equity market.

While publicly supported programs may have made earlier investments in research and development stages, the main sources of private capital for entrepreneurial firms include the founder, family and friends of the founder, angel investors, venture capitalists, banks, non-financial institutions, and equity markets. There are no hard and fast rules about which sources invest at particular amounts or at particular times or at particular stages of business development, but there is some "fuzzy" logic that makes the equity capital infrastructure easier to understand, as shown in Table 4.

Table 4. Types of Risk Financing

Type and Source of Financing	Timing	Amount	Stage
Pre-seed Capital Founder Family & Friends	First 5 years	Less than $500,000	Start Up (R&D)
Seed Capital Business Angels		More than $300,000; less than $3 million	Expansion
Venture Capital Venture Capitalists Banks Non-financial Institutions		More than $2 million	Venture Capital
Stock Market IPOs & Equity Markets			Mature

Risk capital is essential for the creation, growth, and development of new businesses.

The Challenge for Technology Firms

There are special challenges for entrepreneurial firms that are commercializing new technology. Those interested in technology-based economic development have seen many good ideas emerge from university and federal laboratories. They have also seen the rewards that entrepreneurs receive from selling new products in the marketplace, which is often the basis for their interest in commercializing technology in the first place.

Entrepreneurs interested in replicating the success of taking an emerging idea from the laboratory to the marketplace and

harvesting the rewards of entrepreneurship frequently encounter barriers along the way.

To begin with, the technology is probably based on basic research and still close to the laboratory from which the technology came. The entrepreneurial spirit may exist in the laboratory, but the culture of discovery is much different from the culture of entrepreneurship. For example, laboratory discovery is embedded in basic research and the funding sources for basic research are almost exclusively in government agencies.

One researcher once explained his problem this way. "I made a laboratory discovery that I thought would be useful in a local industry. When I contacted the company, they wanted to see a prototype, which I didn't have." Small steps from the laboratory toward the marketplace can be relatively expensive. The company wasn't willing to sink its money into proof-of-concept prototyping because of risk and uncertainty. "So," the researcher continued, "I contacted my [government] funding agency with the hope of extending my research, but the program manager told me I was no longer doing basic research and that I should seek corporate support. I was caught in a Catch 22."

Another illustration involves an aspiring entrepreneur who came into the office of the Arkansas Science & Technology Authority one day. He was an engineer who had had an idea for a new product and accumulated a base of knowledge about the technology he intended to use. He had tested the feasibility of his application and developed a prototype of the product. Since he wasn't all that familiar with how to commercialize a new product, he had purchased a book to guide him through the process of starting his own business.

"I was able to follow the steps in the book," he said. "I wrote my business plan, but when I got to the point where I needed to use the plan to raise money, I didn't know where to begin."

These are not unusual experiences. Both individuals had encountered what Richard W. Marzewski[12] describes as, "Those middle stages of technology transfer [which] become a virtual 'valley of death,' with the roadside strewn with the bones of once-promising technologies that never reached the useful product stage."

The key point in the context of financing new, technology-based, entrepreneurial businesses is that the lack of risk capital is a barrier to be overcome. Insufficient sources of risk capital will stunt the local growth of innovative capacity and entrepreneurial efforts that help grow a community's economy.

The financing world's virtual valley of death will drive fledgling firms from the community in search of capital, depriving the community of the benefits of entrepreneurial success, economic growth, wealth creation, and knowledge-based jobs.

Bridging the Virtual Valley of Death

Richard W. Marzewski's virtual 'valley of death' is approached during the late stages of research, when support from government agencies withers because the research is no longer basic in nature. On the other side of the valley of death, profit-making enterprises are looking to reduce risk by requiring working prototypes, iron clad intellectual property protection, and competitive advantage.

If policy makers attempt to bridge the gap, they can build from both directions. They can craft public policy to extend

[12] R. W. Marzewski, "Bridging the Virtual Valley of Death for Technology R&D" *The Scientist*, January 20, 1997.

public support beyond the doors of the laboratory and they can provide risk-reducing incentives for private investments that reach closer to the laboratory.

Hopefully the policy bridge will meet and provide sufficient capacity to move innovations from the laboratory to the marketplace.

The public policy infrastructure in Arkansas has provided an on-ramp to the bridge in the form of assistance for entrepreneurs. Such help includes technology transfer assistance, support for writing Small Business Innovation Research proposals, applied research cost sharing, and support for technology development beyond the basic research stage.

Another part of the bridge has been explored in other states. The mechanism is an intermediate non-governmental/non-profit organization that moves promising technology across the capital gap by further developing the technology, reducing the risk for next-stage investors, and paying close attention to market demand.

Another stage of investment that might come from government-funded development programs is seed capital. Depending on the state and its unique legal and constitutional framework, seed capital investment programs make early-stage, equity or near-equity investments in commercializing innovative products or technologies.

The Seed Capital Investment Program of the Arkansas Science & Technology Authority, for example, is a public financing tool created in 1985 with a one-time appropriation of $1.8 million to keep entrepreneurial firms from having to leave the state in search of next-stage financing. The program uses relatively high-interest-rate loans (but not too high because of a usury cap) and royalties as the preferred constitutional investment structures. In the first 17 years of the program, $4.4 million has been invested in over thirty firms and has

contributed to the creation of over 1000 knowledge-based jobs. In recent years, there has been an increasing pace of investments.

Bridging the capital gap begins on the public-sector side with the construction of the public policy infrastructure that paves the way from the laboratory and keeps entrepreneurial firms from wandering in search of early-stage risk capital.

Pre-Seed Capital

The earliest stage of private investments comes from the founder of a business and the founder's family and friends. This capital is the pre-seed or start-up financing for an enterprise. The incentives for making the investment are the opportunities to start and run one's own business and the potential of significant financial gain.

The public policy infrastructure can supplement this kind of financial support for entrepreneurial businesses through public programs that extend start-up support beyond the laboratory and begin to bridge the virtual valley of death.

Another way to support entrepreneurial businesses is to provide incentives for the early-stage investments in new technology companies. Such incentives might focus on research and development activities of the business, perhaps through a research and development (R&D) tax credit for relevant expenditures made by the company during its first five years of existence. The public policy could target angel or start-up investments in specific economic sectors, in emerging technologies of strategic value, in research and development projects that are reviewed and approved by the state under a

statutory research and development program, or a combination of all of these. For example, a taxpayer in Arkansas who supports cost-sharing applied research is eligible for a 33 percent tax credit on the investment. The tax credit could be extended to include taxpayer investments in technology transfer, Phase Zero support for writing Small Business Innovation Research proposals, support for technology development, and even for investments that match the public investment in seed capital.

Another Arkansas incentive that was added in 2001 forgives the capital gain on certain investments in small technology-oriented businesses or clients in a business incubator. One hundred percent of investments held for five years or longer enjoy the capital gain forgiveness.

Public policy should create appropriate tax incentives for private investments in early stage research and development activities of young, technology-based enterprises.

Seed Capital

The growth of entrepreneurial firms at the expansion stage of development is most likely dependent on risk financing from angel investors.

Bank loans, secured by some form of collateral, may not be possible to get, and, if available, require debt service payments that put a drain on cash that could otherwise be used to grow the business. Angel investors, on the other hand, have their own money to invest, can meet the financing needs of the firms in return for equity, and can be more patient than a bank in waiting to get their return. Angel investors have probably been

successful in their own business activities and appreciate good business practices and processes. Angels also tend to understand the impact of new jobs on their economy and community. Lastly, they may bring to the table their associates and contacts who may be co-investors in the business opportunity.

Despite the obvious benefits, angel investors may not be easy to approach about support, unless they are in the category of family and friends. They tend to protect their privacy and may be reluctant to invest for a variety of reasons. They may not be familiar with evaluating the risk of, and putting a price on, the business opportunities described in the business plans they see. More specifically, the deals they see may not match their own skills and interests. Then there is the matter of trust in the people associated with the opportunity, including the entrepreneur and the business' management team.

It appears that angel investor know-how could be a limiting factor that determines whether or not the angel will make the investment. They might have a higher comfort level with some education and training, which is relatively simple and low cost.

A starting point might be the National Association of Seed and Venture Funds (http://www.nasvf.org/), which offers seminars and workshops for early-stage investors. Attending "Seed Investing as a Team Sport" might show them how to evaluate and place a valuation on an opportunity, structure investments, develop an exit strategy, let them learn from successful investors, and unearth opportunities to co-invest with others. NASVF also has its "Swing for the Fences" seminar to educate the investors about what they are getting into on the front end.

Another incentive might be tax breaks for early-stage investments. Some states provide tax credits for the initial investments in certified state or sub-state regional investment corporations. Another incentive might be special tax treatment

of capital gains from early-stage investments. For example, the Arkansas Capital Gains Exclusion Act passed in 2001 should be an incentive for angels to invest because 100 percent of the capital gains are excluded from taxation if the investment in certain qualified investments is held for five years.

The development of angel networks might be enhanced by support from state programs. For example, knowledge that the state's implementation of a research and development plan will lead to an increased deal flow might enhance angel investor interest. A support structure for angels might include mechanisms to highlight opportunities that are likely to arise from the increased activity in strategic research areas outlined in the plan. Information about other early-stage investments by public programs, an angel investor hotline, and other sources of know how could also be supportive of angel investors.

Incentives are needed for angel investors, as well as efforts to organize, educate, train, and support them.

Venture Capital

Venture capital is the financial resource needed next by successful entrepreneurial companies enjoying rapid growth. This type of financing is larger in scale than the earlier stage seed and angel investments, comes with more demands for equity participation by the investors, and is driven by an exit strategy to grow the equity and generate large returns, for example, from an initial public offerings of stock or from being merged or acquired.

Venture capital investors are typically institutional in scale. Nationally about 83 percent of venture capital investments

come from pension funds, institutional investors (such as banks and insurance companies), and large foundations. Adding wealthy individuals to the institutional investors raises the percentage of total VC investments to 95 percent. The investments are made by fund managers, who create the venture fund, raise the venture capital, evaluate the deals, make the investments, and monitor and mange the portfolio until the fund is liquidated.

It is in a state's best interest to encourage a reliable venture capital system to grow innovative businesses and benefit from the resulting knowledge-based jobs, wealth creation, and economic growth. Without venture capital, such benefits will accrue to the locations that have venture capital and use it to lure growth-oriented firms. The effort to create a venture capital infrastructure requires that there is a flow of deals. This involves research and development spinning off innovations, seed capital and angel capital investments to nurture entrepreneurial firms and move the innovation closer to the marketplace, and aggressive support from institutional investors. The role of government is to provide the appropriate incentives to the different investors to attract them to venture funds and encourage them to invest in risk. If creating a venture capital industry is important enough, then government might also assist in the effort to raise the venture funds.

There are several incentives to consider. Perhaps the most important is the one that reduces the risk of loss for venture investors.

The federal government has provided such an incentive for venture funds that organize as Small Business Investment Corporations (SBICs), which qualify for federal matching funds to reduce the overall risk. States provide similar incentives, often as tax credits for the initial investments in certified state or sub-state regional investment corporations.

The Arkansas Venture Capital Act of 2001 is another example of a state incentive for venture capital formation. In this case, a fund of funds is established with a guarantee against loss of the initial investment in the fund of funds. The fund of funds then invests in privately managed venture capital funds that bring additional capital to the state.

Another incentive is to provide a statutory definition of "the prudent man" who invests institutional, foundation, or pension funds. This is sometimes accomplished by establishing a ceiling percentage of the institutional funds that are permissible to invest in venture capital and below which is considered prudent.

The typical incentive for public pension funds is to require the pension fund managers to invest some small percentage (up to 2.5 percent in Arkansas) in venture capital funds managed in the state. Such policy establishes the framework for making the investment and goes hand-in-hand with the prudent man rule that sets a maximum. Some such incentives also address the need for the pension funds to invest in venture funds that focus some proportion of its venture investments in the state's early-stage technology businesses.

An incentive for wealthy individuals involves a beneficial tax treatment for early stage investments. This incentive is the capital gains exclusion for risk capital investments in certain technology-based, early-stage companies. It is the same incentive used to encourage angel investors.

The establishment of venture capital funds will have a major, dramatic impact on knowledge-based businesses, jobs for knowledge workers, wealth creation, and economic growth.

Other Quasi-Public Incentives

When industrial recruiting was the new approach to building the rural economy, a companion policy in some instances established a quasi-public financing mechanism to make loans to relocated businesses, in the event that local banks were unable to do so.

Over time, two things happened. First, public policy was added at both the state and federal levels to enable economic development activities and to provide incentives for investments in particular geographic locations or in specific industrial sectors. Some of the quasi-public financing mechanisms took advantage of these new policies, usually by creating subsidiaries (an SBIC – Small Business Investment Corporation – for example) specifically designed for the new incentive.

Second, as states began addressing the virtual valley of death, the quasi-public financing mechanisms found themselves well positioned to organize risk capital funds. These efforts also led to new subsidiaries specifically designed for venture capital investments.

As a result, some of the quasi-public financing mechanisms have become comprehensive sources of capital, from higher-risk loans to near-venture or venture capital.

Quasi-public sources of financing may exist in a one-stop-shop, but may reflect disconnected funding programs rather than an integrated system of finance.

The Rainbow of Risk

In 1985, Belden Daniels described the rainbow of risk in public finance in the context of a thoughtful new approach to statewide economic development planning. (See Figure 2.) Basic and applied research funding was at the high-risk end of the rainbow, followed by seed capital, risk capital, and fixed asset financing, the latter of which was at the lower-risk end of the rainbow.

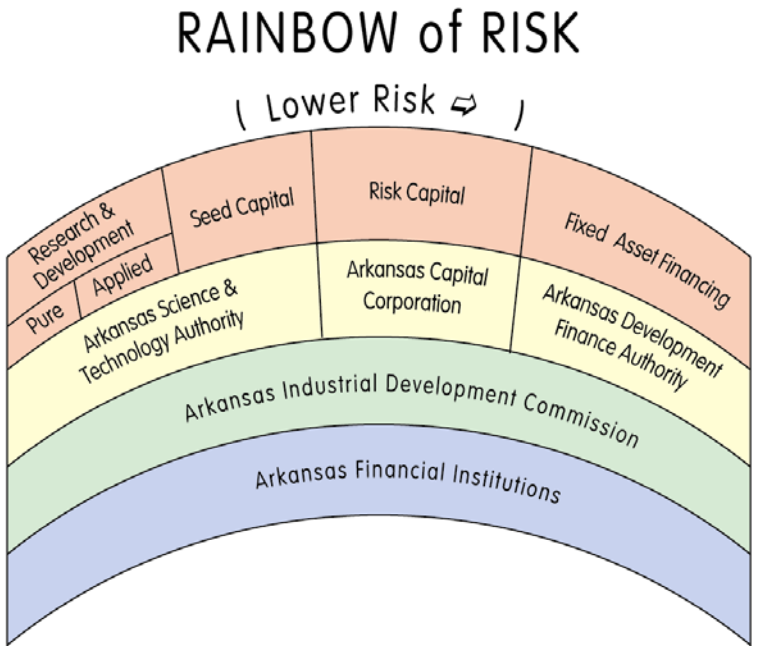

Figure 2. The Rainbow of Risk (circa 1985).

There is a better view of the spectrum of risk today because there is an operating history in many areas of public finance

today that did not exist in 1985 and some gaps that existed in 1985 have since been filled.

The spectrum still begins with basic research anchoring the higher-risk end, where government almost always provides the funding.

The formation of a new business begins with entrepreneurial motivation and represents another step along the spectrum of risk. It begins with the start-up investment of the entrepreneur and the entrepreneurs' families and friends. This kind of risk capital is essential for the creation, growth, and development of new businesses.

Enhanced public programs can extend public support beyond the doors of the research laboratory and public policy can provide incentives for private, higher-risk investments closer to the laboratory.

The financing world's virtual valley of death is a barrier to entrepreneurial success, economic growth, wealth creation, and knowledge-based jobs.

Bridging the virtual valley of death begins with the construction of an on ramp from the laboratory followed by seed capital investments that keep entrepreneurial firms from wandering in search of early-stage risk capital. New non-governmental organizations based on a public/private partnership can successfully operate between the laboratory and the marketplace. Such organizations can span at least part of the financing gap and reduce the risk to downstream investors.

Public policy can create appropriate tax incentives for private investments in early-stage research and development activities of young, technology-based enterprises.

Incentives are also needed for angel investors, as well as efforts to organize, educate, and train them.

The establishment of venture capital funds will have an impact on knowledge-based businesses, jobs for knowledge workers, wealth creation, and economic growth.

Quasi-public sources of financing may offer a one-stop-shop, but the range of financing may reflect disconnected funding programs rather than an integrated system of finance.

These components of the new spectrum of risk are shown in Figure 3 and are superimposed on a miniature version of the circle used to describe the Knowledge-Based Company Environment.

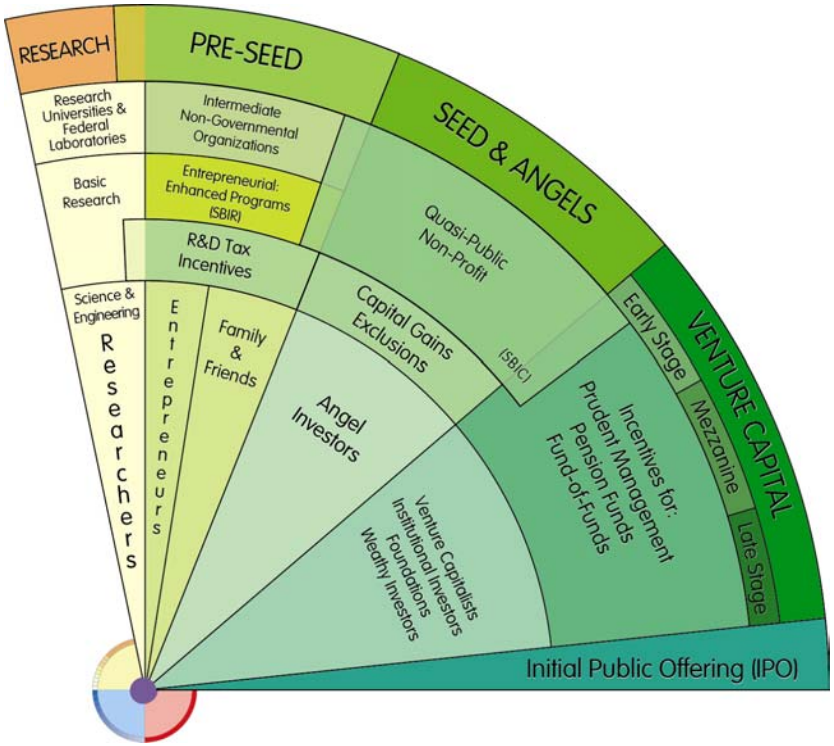

Figure 3. The 2003 Rainbow of Risk.

CHANGE

A Chinese proverb warns, "If we do not change direction, we are likely to end up exactly where we are headed."

Integrated Community Networks

The process of developing Integrated Community Networks (ICNs) is based on a simple, three-point concept that has broad applicability in communities. Frank Knott introduced this concept to nine Arkansas communities in 1999 and 2000.

The first concept is that, "Connectivity is the great enabler." The notion is that, in the Internet age, being connected enables one to do new things that were not previously possible. Part of this is embodied in the altered meaning of time and distance that the Internet causes. Time changed from "9 to 5" to 24/7/365; around the corner, in Internet space, is the same as around the globe. Another part of being connected is bringing people together in collaborative efforts.

The second concept is that, "Collaboration is the required behavior of the 21st Century." This builds on the notion that there are so many opportunities, there are so many things to do, that the only way to take advantage of them, to accomplish them, is to work with others in collaborations, partnerships, joint ventures, and other creative relationships.

The third concept is that of "Changed spending behavior." This concept is all about money and the lack of money. It is closely linked to the other two ICN concepts. Connectivity, particularly broadband connectivity, is expensive and being able to afford it will require collaborations with others who view connectivity as a common solution to multiple issues. Investments in connectivity from the telecommunications line item in the budget might reduce expenditures in budget lines unrelated to telecommunications – say in travel. The concept of changed spending behavior recognizes such offsets and

encourages budgeting that increases spending for connectivity by finding savings in other budget lines, rather than routinely increasing each line incrementally.

The concepts of connectivity, collaboration, and changed spending behavior have a wider application in transforming monolithic models for economic development into connected, collaborative economic growth efforts built upon changed spending practices.

If an institution or community wants to participate in the 21st Century economy, then it needs to use 21st Century principles and mindsets and make 21st Century investments based on a 21st Century budget.

Eight Steps to a Vital Economy

Frank Knott, president of ViTAL Economy, Inc.,[13] uses the firm's "Formula for a Vital Economy" to help communities create their connected economies. The formula includes "Eight Elements of the ViTAL Economy," a set of processes that empower communities to create new economic benefits and change their usual way of doing business. The eight copyrighted steps follow:

1. Envision. This step is about building awareness about the connected future.
2. Pinpoint. This is about benchmarking.
3. Strategize. This is the planning step.
4. Position. This step is about communication and repositioning the community.

[13] See www.vitaleconomy.com for more details.

5. Mobilize. This is where the community begins to implement the plan.
6. Amplify. This is the growth stage where the seriousness of the effort becomes apparent and enables institutional managers to participate.
7. Finance. This is about capital and the legal and financial framework needed to organize the financing structure along the lines of micro loans, angel investors, venture capital, SBICs, and industrial revenue bonds. The financing structure starts locally and links nationally. All levels know one another. Eighty percent of the risk is at the front end; this is not about banks.
8. Engrain. This is the step, facilitated with software, where the knowledge base required to create the connected economy is established.

Notice that action items define the eight integrated steps.

A community needs to desire a connected economy, seek the know-how necessary to build it, and have the will to create it.

Macroshift

Sometimes the ability of knowledge to influence events causes unanticipated major consequences, or as the scientist Louis Pasteur said, "Chance favors only the prepared mind."

Macroshift: Navigating the Transformation to a Sustainable World by Ervin Laszlo[14] is a book with a deep insight into the

[14] The Official Report of the Club of Budapest; Berrett-Koehler Publishers, Inc., San Francisco; 2001.

things that influence major change. For Laszlo, a macroshift is defined as a "transformation ... in which technology is the driver and the values and consciousness of a critical mass of people the decider." In the book's foreword, Arthur C. Clark explains Laszlo's vital point; "the future is not to be forecast, but created."

One theme of Macroshift is that it is difficult to predict the future. To some extent, the future is an extension, or an extrapolation, of the recent past and the present. The tomorrow one expects will be similar to today; the environment is basically the same, but some things change from day to day. The accumulation of such small changes is a trend. It is possible to track various changes as trends and to project them into the future. Trends illustrate the changes that cause some persons to be better off and some to be less well off. Trends, however, are not infinite; they have limits.

Sometimes the world changes, the trend line becomes irrelevant, and the trend no longer projects accurately. When a trend encounters such a limit, the system that the trend describes approaches a period of instability. In some situations, the system becomes supersensitive and "even immeasurably small fluctuations produce measurable, macroscopic effects."

People and living systems use information to maintain the system. A key point of Laszlo's is that,

> In periods of relative stability the consciousness of individuals does not play a decisive role in society's evolution, but in periods of chaos it does. When a human society reaches the limits of its stability, it becomes supersensitive and is highly responsive to the smallest fluctuation.

A macroshift has four phases.

The first phase is the Trigger Phase. This is marked by the introduction of innovations, new technologies, and systems. The innovations cause efficiencies that in turn effect changes.

The Transformation Phase is second. During this phase the trigger brings about irreversible changes that cause complexity in the environment and in social relationships.

The Critical Phase follows, when altered relationships put pressure on established culture, values, and ethics. The situation is marked by a subtle order that is especially sensitive to fluctuations. Sustainability is not possible so the path followed will be different from pre-existing trend lines.

The fourth and last phase is the Macroshift. The macroshift, in the simplest terms, is a branching or bifurcation that leads one way or another: either to breakdown or to breakthrough. The breakdown is marked by an inability for things to change, or change that is too slow. Breakthrough is marked by a need to change, to improve. A successful macroshift is possible only if a critical mass of people evolves stabilizing mindsets, values, and ethics. Success depends on the creativity and flexibility of the dominant institutions.

In the context of economic development, are we headed toward a macroshift – toward a breakdown or a breakthrough?

A New Model for Economic Development?

In the mid-1980s, reports began appearing about how job creation was more substantial in small technology-based firms than in Fortune 500 companies. The attention of economic developers and policy makers was directed to these reports and

the Southern Growth Policies Board highlighted these findings at one of its conferences. The people attending the conference represented a mix of professionals, including traditional industrial recruiters and persons from the emerging science- and technology-based development organizations.

After a session at which a presenter discussed some of the new data about job creation in smaller firms, an executive from one of the new state technology organizations was leaving the auditorium thinking that he was at the right place, at the right time. The presentation had energized him. He was from one of the Southern states that had began experimenting with technology development, business incubators, and business financing programs aimed at replicating the kind of economic successes that had occurred in a handful of locations around the country. The programs focused on the small, entrepreneurial companies that would grow employment. What he accepted on faith had just been documented at the session. He was walking out the door shoulder to shoulder with an industrial recruiter from a neighboring state when he overheard the recruiter say, "Can you believe that nonsense?"

The comment was somewhat typical of the time. There was skepticism about the new technology organizations and their programs because they had no track record. There was no trend line for the new programs, but information – knowledge – about industrial recruiting could be used to maintain the system. The technology-based economic development programs were experiments and the results were not yet in, but the programs were a foreshadowing of the transformation that was to come.

Technology-based economic development was proposed as a new model and there was understandable resistance to change. Today it is clear that technology- and knowledge-based economic development works.

Why Good People Don't Change

Even when new knowledge indicates the benefits of doing things differently, people often resist change.[15] As Richard Hooker, a 16th century theologian, pointed out, "Change is not made without inconvenience, even from worse to better." Sometimes, however, the reluctance is not just because of inconvenience, or fear, or stress, or needing new skills; sometimes, good people don't change and the reason is not at all clear.

Robert Kegan and Lisa Laskow Lahey[16] address this situation in their article, "The Real Reason People Won't Change." The reason they present is a "hidden *competing commitment*" that stalls one's ability to change. Often the person is unaware of the competing commitment, the associated behaviors that support it, and the assumptions that sustain it.

When you encounter inexplicable resistance to change, look for the competing commitment.

Scale, Vision, and Spending Behavior

The October 21, 2002 edition of the *Arkansas Democrat-Gazette* carried a front-page story titled "Oklahoma takes high-tech turn." The story, the second in a series, illustrates the difference scale can make in publicly funded programs.

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[15] This Chapter is reprinted from *The Information Technology Career Pathway*, a report prepared by the Arkansas Science & Technology Authority for the Winthrop Rockefeller Foundation, 2002.
[16] *Harvard Business Review*, November 2001 (pp. 85-92).

The Oklahoma Center for the Advancement of Science and Technology was patterned after the Arkansas Science & Technology Authority. The Authority has a nearly 20-year history; OCAST has been in existence 15 years. The newspaper account explains that OCAST has allocated $125 million during its lifetime. Over 19 years, the Authority has invested a total of $51.4 million.

This is a significant difference in scale. The Arkansas organization averaged investments of $2.7 million per year versus an average of over $8.3 million per year in Oklahoma. The Oklahoma allocations are slightly more than three times as much per year as in Arkansas. It is clear from the experience of both states that technology-based economic development works.

The October 20, 2002 edition of the newspaper carried the first article of the series, titled "State's economy failing to keep pace with region." It describes Arkansas' traditional reliance on industrial recruiting, which began in 1957 with the establishment of the Arkansas Industrial Development Commission, and includes details about the current effort to attract an automobile assembly plant to Arkansas.

Perhaps it isn't so much a lack of vision or mission for economic development, issues that the story raised, but perhaps it is a reluctance to change the state's spending behavior because of a conflicting commitment to economic development activities such as marketing, promotion, and recruitment, instead of to research, development and entrepreneurship.

Technology-based economic development works. It isn't a matter of vision or mission; it is a matter of addressing the conflicting commitment, changing spending behavior, and investing at the scale large enough to make a difference.

Urgency

Science, engineering, and technology are important. They seldom rise to the level of crisis or become the subject of urgently needed policy initiatives, but they are important. For many years, the authors argued that science, engineering, and technology were second in importance behind education. They have recently shifted their thinking.

Science, engineering, and technology are of primary importance to economic well being and are central to 21st Century economic growth. For many convoluted reasons, public education has demonstrated that, despite having the largest share of the state's budget, it cannot successfully provide students with meaningful exposure to the opportunities offered by science, mathematics, engineering, and technology. One downstream effect of this shortcoming of public education is too few students selecting science and engineering professions to sustain the Nation's technology-based economy.

U.S. science, engineering, and technology professions have taken steps to intervene and assist public education because their very survival as American professions requires it.

Policy makers have taken the initial steps of creating the public policy infrastructure and making investments in math and science education, science and engineering degree programs, university research, technology-based economic development, and risk capital formation. We know these policies and investments work and are required. We must invest at scale and we must do it now.

As Will Rogers said, "Even if you're on the right track, you'll get run over if you just sit there."

APPENDIX

The Challenge of Terminology

When the authors explained that they were writing a book about the differences between economic development and economic growth, Jim Clinton, executive director of the Southern Growth Policies Board, cautioned that economists have a vocabulary and language unique to their profession. The authors, not being economists, were likely to run the risk of having this work reviewed by economists and criticized as not being a serious effort because the authors used the language of economics incorrectly. The authors recognized this as a real risk and acted to address this shortcoming.

Most policy makers and economic development professionals know economic development when they see it. They live it, do it, and write and talk about it, but they usually don't define it.

The U.S. Department of Commerce, Economic Development Administration, defines economic development this way:[17]

[17] See: http://www.doc.gov/eda/html/2a1_whatised.htm

> Economic development is fundamentally about enhancing the factors of productive capacity – land, labor, capital, and technology – of a national, state or local economy.

The EDA goes on to explain that there is debate about whether place-based or people-based goals are best and reviews nine economic development theories: (1) Economic Base Theory, (2) Staple Theory, (3) Sector Theory, (4) Growth Pole Theory, (5) Neoclassical Growth Theory, (6) Interregional Trade Theory, (7) Product-Cycle Theory, (8) Entrepreneurship Theories, and (9) Flexible Production Theories. Each theory uses a unique definition of development.

(1) In Economic Base Theory, "local economic development is equivalent to the rate of economic growth measured in terms of changes in the local levels of output, income, or employment."
(2) In Staple Theory, economic development is "sustained growth over the long term."
(3) In Sector Theory, "the level of development depends on sectoral diversity."
(4) In Growth Pole Theory, "Economic development is the structural change caused by the growth of new propulsive industries."
(5) In Neoclassical Growth Theory, "Economic development is defined as an increase in the rate of economic growth, measured in terms of changes in output or income per capita."
(6) In Interregional Trade Theory, "development is economic growth that leads to greater consumer welfare."

(7) In Product-Cycle Theory, development is "continual creation and diffusion of new products."
(8) In Entrepreneurship Theories, "The essential dynamic driving the development process is innovation."
(9) In Flexible Production Theories, "Development is not just quantitative growth but also qualitative change in industrial mix, firm structure, and sources of competitiveness.

"An economy . . . can be *developing*, but not *growing* by certain indicators."

The EDA material continues with a discussion of economic development vs. economic growth.

> [E]conomic development and economic growth are not necessarily the same thing. First, development is both a prerequisite to and a result of growth. Development, moreover, is prior to growth in the sense that growth cannot continue long without . . . innovations [in institutions, behavior, and technology] and structural changes [of the economy] . . . . But growth, in turn, will drive new changes in the economy, causing new products and firms to be created as well as countless small incremental innovations. Together, these advances allow an economy to increase its productivity, thereby enabling the production of more outputs with fewer inputs over the long haul.

The authors agree that economic development and economic growth are related but different things. Their approach is that economic development builds layer upon layer, from the

foundation up and involves a process that focuses on job creation; economic growth draws on the highest levels of education and innovation, creating higher-levels of employment opportunity and involves a process that focuses on discovery, engineering, and entrepreneurship.

Be certain your economy is growing, not just developing.

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