Arkansas' Knowledge Economy Initiatives: Analysis of Progress and Recommendations for the Future

Prepared by: Battelle Technology Partnership Practice

November 2012

Contents

EXECUTIVE SUMMARY ES-1
Arkansas Currently Enjoys Clear Economic Returns From Existing Knowledge-Based Economy Initiatives ES-2
Arkansas is Poised to Take Critical Next Steps ES-2

Advancing Governor Beebe's Long-Term Strategic Plan for Economic Development: Continue to Build a Track Record of Success 1

The Long-Term Strategic Plan Focuses on Initiatives to Transition Arkansas to a High-Wage, Knowledge-Based Economy 1
A Track Record of Continuing Success: Overview of the Performance of Knowledge-Based Economy Initiatives in Arkansas 3
Critical Next Steps: Sustainable Funding To Provide Adequate, Predictable Resources for Arkansas' Knowledge-Based Economy Initiatives & Continuing to Address Specific Gaps and Challenges 4

Options for Advancing Sustainable, Adequate, and Predictable General Revenue Fund Support and Closing Key Gaps in Arkansas' Knowledge-Based Economy Initiatives 5

Attain and Sustain a Higher Level of Per Capita University Research Funding Compared to the National Average 5
Accelerate the Formation of Emerging Knowledge-Based Companies and Position Them for Success 7
Realize the Growth Potential from Companies That Have Participated in the Current Arkansas Knowledge-Based Economy Initiatives 8
Developing a Resource Pool of Top Talent and Putting It to Work in Arkansas 10
Summary of Recommended Options 11

Making the Case: Assessing Arkansas' Knowledge-Based Economy Initiatives 12

Industry Results 12
University-Based R&D Results 15

Making the Case: Tangible Economic Payoffs for Arkansas Being Realized with High Wage Industries Driving Arkansas Economic Growth 19

Making the Case: Addressing the Gaps in Arkansas' Knowledge-Based Economy Initiatives and Key Challenges to Synergy 21

Conclusion 29

Battelle is the world's largest nonprofit independent research and development organization, providing innovative solutions to the world's most pressing needs through its four global businesses: Laboratory Management, National Security, Energy Technology, and Health and Life Sciences. In 1991, Battelle created the Technology Partnership Practice (TPP). We focus Battelle's broad experience to better serve economic development organizations, universities, and nonprofit technology organizations across the U.S. For further information, please contact Mitch Horowitz at horowitzm@battelle.org.

Battelle does not engage in research for advertising, sales promotion, or endorsement of our clients' interests including raising investment capital or recommending investments decisions, or other publicity purposes, or for any use in litigation.

Battelle endeavors at all times to produce work of the highest quality, consistent with our contract commitments. However, because of the research and/or experimental nature of this work the client undertakes the sole responsibility for the consequence of any use or misuse of, or inability to use, any information, apparatus, process or result obtained from Battelle, and Battelle, its employees, officers, or Trustees have no legal liability for the accuracy, adequacy, or efficacy thereof.

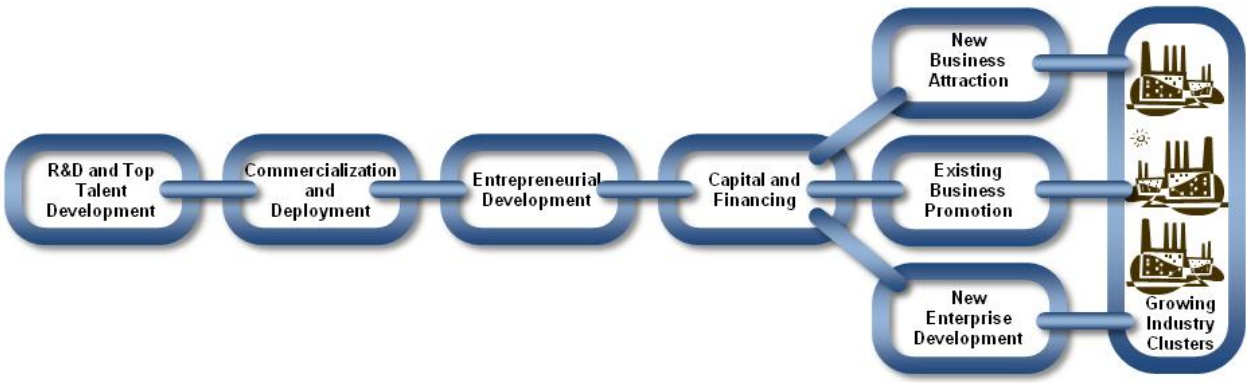
Executive Summary

In 2009, Governor Beebe announced a long-term, statewide economic plan to lead Arkansas in a transitional, systematic manner **to an economy supported by knowledge-based jobs to raise income levels and the standard of living for Arkansans**. Achieving success in knowledge-based economic development is a particularly complex and challenging goal. It requires having in place an interconnected value chain of economic development resources and services to develop and sustain economic growth.

By 2012, Arkansas had designed and implemented an interconnected program of economic development resources and services to develop and sustain its knowledge-based economy. It is a remarkable turnaround from the status of the state in 2004, as documented by the Milken Institute in its report to Accelerate Arkansas. The report, *Arkansas' Position in the Knowledge-Based Economy: Prospects and Policy Options*, noted that "Arkansas has been operating at the periphery of the knowledge-based economy,"[1] pointing out that while other states had been investing heavily and nurturing key institutions in the knowledge-based economy, Arkansas had not kept pace. In colloquial terms, Arkansas missed the boat.

By defining specific goals and formulating policies to promote the creation of knowledge-based jobs, Arkansas has been able to forge a value chain that links four critical activities: (1) R&D and top talent development, (2) commercialization and deployment, (3) entrepreneurial development, and (4) capital and financing. Successful integration of these activities is the key to Arkansas making significant progress in developing its business and technological competitiveness.

Figure ES-1: Links in the Knowledge-Based Economic Development Chain



Today, Governor Beebe and Accelerate Arkansas can take great satisfaction in the collaboration that is evident across key state agencies, including the Arkansas Economic Development Commission (AEDC),

[1] The Milken Institute, Arkansas' Position in a Knowledge-based Economy, 2004.

the Arkansas Science and Technology Authority (ASTA), and the Arkansas Development Finance Corporation. Arkansas has enjoyed clear economic benefits from activities to create a knowledge-based economy, and is now poised to take critical next steps to maintain momentum in this area.

Arkansas Currently Enjoys Clear Economic Returns From Existing Knowledge-Based Economy Initiatives

- ***Knowledge-based economy initiatives focused on research have received $61.2 million in state funding from 2008 through 2011[2] and leveraged an additional $191.8 million in non-state support.*** This represents an impressive return on state dollars invested in research: for each $1 in state funding the Arkansas programs have leveraged an additional $3.14. The economic multiplier effects related to leveraged non-state research funds amounted to $335 million in total economic output to the state and supported 2,820 job years over the period 2008 to 2011. These research-focused initiatives offer a foundation upon which Arkansas can grow its knowledge economy, bringing new technology capacities to the state, generating top talent among faculty, graduate students and postdoctoral fellows and providing opportunities for spin-off companies.

- ***Arkansas' knowledge-based economy activities have worked in concert since 2008 to assist 135 emerging companies, directly employing 1,259 workers.*** The full economic multiplier impact of these emerging companies participating in the state's commercialization/deployment, entrepreneurial development, and capital/financial initiatives is a total of 3,251 jobs throughout the Arkansas economy. These direct jobs created by emerging companies are found in industries offering significantly higher wages than the private sector average wage in Arkansas—on average over $70,000 a year. This is more than double the $34,014 average annual wage of the private sector in Arkansas.

- ***The Arkansas economy is being bolstered overall by growth in high-wage, typically knowledge-intensive industries.*** Job gains from 2007 to 2010 in these high-wage industries amounted to just over 6,000 jobs, which generated total employment impacts of 11,800 jobs. Over this same period of time, Arkansas experienced a decline in total private industry jobs.

Arkansas is Poised to Take Critical Next Steps

Although Arkansas enjoys economic returns from its current initiatives, that alone does not indicate a successful transition to a knowledge-based economy. **What Arkansas lacks today is a sustainable funding mechanism providing adequate, predictable resources for knowledge-based economy initiatives.** Many of the newly enacted knowledge-economy initiatives depend upon discretionary funding under the General Improvement Fund for support. The uncertainty of year-to-year funding through the General Improvement Fund is a major handicap. This lack of a sustainable funding

[2] The focus of the analysis generally encompasses 2008 through 2011 activities though data were reported to Battelle on a fiscal year basis by program area and there are some differences in time periods reported by program. Two programs, ASTA and ARA, reported data through FY 2012; ABI reported data through FY 2011.

mechanism is not new to Arkansas. It was a matter of great concern identified in Governor Beebe's 2009 Strategic Plan for Economic Development.

While job creation, direct and indirect, is a positive indicator, much work remains to be done to achieve a successful transition to a knowledge-based economy. Specific needs and challenges in services identified through the economic analysis by Battelle and consultations with key stakeholders are summarized below.

- ***Raising the value-added component along with the productivity of Arkansas industry is a major challenge for existing companies*** – Proven approaches to address this need include advancing industry–university partnerships to raise the deployment of technologies and shift to more innovative products.

- ***Lack of formal private equity investment in Arkansas may choke off the potential of growth-oriented emerging companies*** – Proven approaches to address this need include enlisting more established serial entrepreneurs able to win the confidence of venture capitalists in Arkansas, and advancing an Arkansas-based venture capital entity able to make seed and early stage formal venture capital investments and syndicate with national venture capitalists for later stage investments.

- ***Putting the state's growing resource pool of talent to work*** – Proven approaches to address this need include creating incentives for Arkansas industry to hire and create internships with top talent being generated in Arkansas, and furthering university entrepreneurial education and training at the undergraduate and graduate levels.

The key areas of focus for bringing existing programs up to scale and aligning new programs to the goal of advancing knowledge-based economic development in Arkansas are summarized below.

- ***Research:*** Attain a higher level of per capita university research funding

- ***Commercialization:*** Accelerate the formation of emerging knowledge-based economy companies and position them for success

- ***Investment:*** Realize the growth potential from emerging companies that have participated in the existing knowledge-based economy initiatives

- ***Top Talent:*** Put talent to work in Arkansas

Based on specific activities associated with these four areas, an annual funding level of $25 million is recommended in General Revenue Funds to support the knowledge-based economy initiatives in Arkansas. The chart below provides a summary of the goals and corresponding initiatives.

Proposed Recommendations for Sustainable Funding and Enhancements to Arkansas' Knowledge Economy Initiatives		
Goals	**Initiatives**	**Proposed Annual General Revenue Fund Request**
Research: Attain a higher level of per capita university research funding	Ramp-up in ARA Scholars More ASTA funding for young investigators Continued matching grants for federally funded research centers Industry-university partnership matching grants Signature shared use research and applications development facilities	$10 M in annual funding
Commercialization: Accelerate the formation of emerging knowledge-based economy companies and position them for success	Continue base support for existing initiatives: Innovate Arkansas, Risk Capital Matching Fund, ASTA Tech Development grants, ASTA Tech Transfer Assistance Grants, ASTA Seed Capital Investment Augment Innovate Arkansas for more intensive mentoring and outreach to funding sources Establish a university technology commercialization/proof of concept funding	$7 M in annual funding
Investment: Realize the growth potential from emerging companies that have participated in the existing knowledge-based economy initiatives	Partial state funding and tax credits towards creation of a $20 million to $30 million Arkansas-based, privately managed early stage investment fund Resources for advancing stronger management teams → consider an Entrepreneur in Residence approach	$7 M in annual funding (The state partial funding and incentives for creating a privately managed early stage seed investment can also be effectively done through a one time appropriation)
Top Talent: Put talent to work in Arkansas	Incentives for post-secondary internships with Arkansas industry Talent bridges for doctorate and post-doctoral level science and engineering graduates to industry. Further statewide university entrepreneurial education and training, targeting STEM graduate and undergrads	$1 M in annual funding

Advancing Governor Beebe's Long-Term Strategic Plan for Economic Development: *Continue to Build a Track Record of Success*

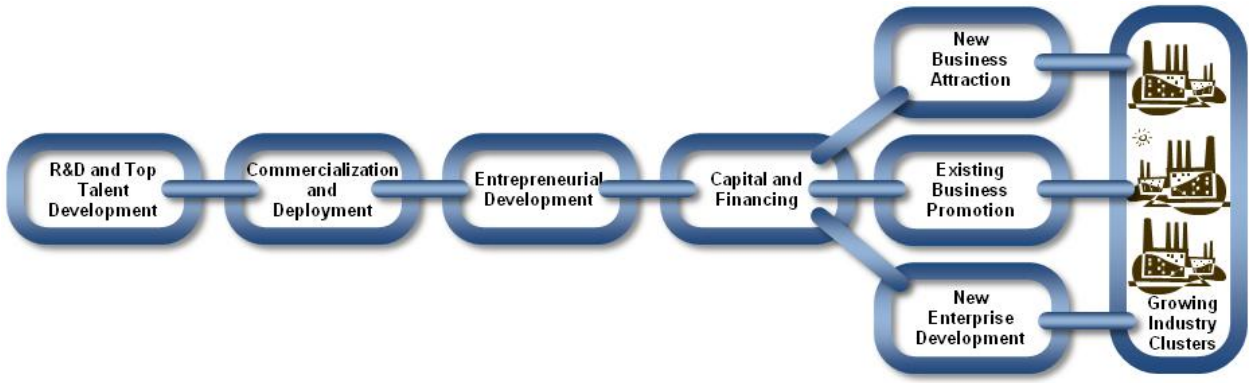
The Long-Term Strategic Plan Focuses on Initiatives to Transition Arkansas to a High-Wage, Knowledge-Based Economy

In 2009, Governor Beebe announced a long-term, statewide economic development plan that established a disciplined approach to lead Arkansas in a successful transition to the global economy of the 21st century. A central theme of the plan was the need for a ***transitional, systematic approach to an economy supported by knowledge-based jobs to raise income levels and the standard of living for Arkansans.***

Governor Beebe's economic development plan embraced and advanced the work of Accelerate Arkansas in supporting a number of "demand"-focused initiatives to drive economic growth in high-wage, knowledge-based industries, expand entrepreneurship focused on knowledge-based enterprises, and support job-creating research.

Achieving success in knowledge-based economic development is a particularly complex and challenging goal. It requires having in place an interconnected value chain of economic development resources and services to develop and sustain growth across new enterprise development, grow existing industry, and attract new businesses (see Figure 1). If any link in the chain is missing, knowledge-based economic gains in growth-oriented new and existing companies and high-quality job creation are hampered, if not derailed, as was the case for Arkansas as documented in the report by the Milken Institute in 2004.

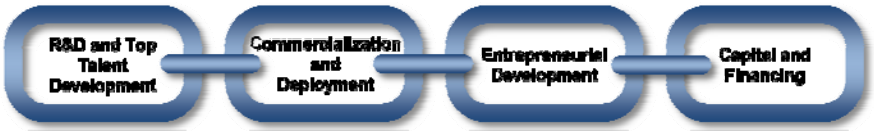
Figure 1: Links in the Knowledge-Based Economic Development Chain



The Milken Institute's evaluation of prospects and policy options for Arkansas in the knowledge-based economy noted that "Arkansas has been operating at the periphery of the knowledge-based economy."[3] The Milken Report further pointed out that while other states have been investing heavily and nurturing key institutions to improve their position in the knowledge-based economy, Arkansas had not kept pace.

However, by 2012, Arkansas had designed and implemented a comprehensive ecosystem of economic development initiatives, integrating the key factors in advancing a knowledge-based economy (see Figure 2 below). Today, Governor Beebe and Accelerate Arkansas can take great satisfaction in the collaboration that has developed across key state agencies, including the Arkansas Economic Development Commission (AEDC), Arkansas Science and Technology Authority (ASTA), and the Arkansas Development Finance Corporation (ADFC). More importantly, they are working together to promote the creation of jobs and the formation of new companies as part of a knowledge-based economy, further developing the state's business and technological competitiveness.

Figure 2: Arkansas Programs Integrate Key Factors in Advancing a Knowledge-based Economy



Arkansas Programs	ASTA Research Matching Grants Arkansas Research Alliance Arkansas Biosciences Institute Targeted Business R&D Incentive R&D Tax Incentives (with universities, in-house, in-house by targeted business, in areas of strategic value) ASTA Centers for Applied Technology Incentives NCTR MOU	ASTA Technology Development Program ASTA Technology Transfer Assistance Grant (SBIR and non-SBIR) Arkansas Risk Capital Matching (Technology Validation) NCTR MOU	Innovate Arkansas University-Affiliated Business Incubators	ASTA Seed Capital Investment Fund Arkansas Risk Capital Matching (Enterprise Growth) Equity Investment Tax Credit Arkansas Institutional Fund (ADFA) ADFA Co-Investment Fund

[3] The Milken Institute, Arkansas' Position in a Knowledge-based Economy, 2004.

A Track Record of Continuing Success: Overview of the Performance of Knowledge-Based Economy Initiatives in Arkansas

The state's programmatic efforts are generating clear economic returns to the state, as discussed in detail below in the section on Making the Case. A brief summary of success in this area follows.

Knowledge-based economy initiatives focused on research have received $61.2 million in state funding from 2008 through 2011[4] and leveraged an additional $191.8 million in non-state support. This represents an impressive return on state dollars invested in research: for each $1 in state funding the Arkansas programs have leveraged an additional $3.14. The economic multiplier impacts related to leveraged non-state research funds amounted to $335 million in total economic output to the state and supported 2,820 job years over the period 2008 to 2011.

These research-focused initiatives help build the foundation for the knowledge-based economy by bringing new technology capacities to the state, generating top talent among faculty, graduate students, and postdoctoral fellows, and providing opportunities to create spin-off companies.

More directly associated with new business development are the initiatives related to commercialization/deployment, entrepreneurial development, and capital/financial activities that Arkansas has advanced to date. Collectively, the 135 emerging companies participating in the knowledge-based economy initiatives since 2008 have generated 1,259 direct industry jobs. The economic multiplier impact of this job creation amounts to a total of 3,251 jobs throughout the Arkansas economy. These direct jobs are found in industries offering significantly higher wages than the private sector average wage in Arkansas—on average over $70,000 a year. This is more than double the $34,014 average annual wage of the private sector in Arkansas.

Emerging knowledge-based companies are part of a growing segment of the state economy, generating high-wage jobs in trade sector industries that drive economic growth in Arkansas. High-wage job gains in these industries amounted to just over 6,000 jobs from 2007 to 2010, which generated total employment impacts of 11,800 jobs in Arkansas.

[4] The focus of the analysis generally encompasses 2008 through 2011 activities though data were reported to Battelle on a fiscal year basis by program area and there are some differences in time periods reported by program. Two programs, ASTA and ARA, reported data through FY 2012; ABI reported data through FY 2011.

Critical Next Steps: Sustainable Funding To Provide Adequate, Predictable Resources for Arkansas' Knowledge-Based Economy Initiatives & Continuing to Address Specific Gaps and Challenges

What Arkansas lacks today is a sustainable funding mechanism that provides adequate, predictable resources for the state's knowledge-based economy initiatives. Many of the newly enacted initiatives depend upon discretionary funding under the General Improvement Fund for support. The uncertainty of year-to-year funding through the General Improvement Fund is a major handicap for Arkansas in its efforts to transition to a knowledge-based economy.

This lack of a sustainable funding mechanism providing adequate, predictable resources is not new to Arkansas. It was a matter of great concern identified in Governor Beebe's 2009 Strategic Plan for Economic Development. But at that time, policies and goals to support the transition to a knowledge-based economy were just being formulated; the related initiatives were under development and did not yet justify the creation of a more predictable source of funding.

Although Arkansas has realized tangible economic payoffs in its transition to an economy supported by knowledge-based jobs, there is still much work to be done. Specific needs and challenges in services identified through the economic analysis by Battelle and consultations with key stakeholders are summarized below.

- ***Raising the value-added component and the productivity of Arkansas industry is a major challenge for existing companies*** – Proven approaches to address this need include advancing industry-university partnerships to foster the deployment of technologies and shift to more innovative products.

- ***Lack of formal private equity investment in Arkansas may choke off the potential of growth-oriented emerging companies*** – Proven approaches to address this need include enlisting more established serial entrepreneurs able to win the confidence of venture capitalists in Arkansas, and advancing an Arkansas-based venture capital entity able to make seed and early stage formal venture capital investments and syndicate with national venture capitalists for later stage investments.

- ***Putting the state's growing resource pool of talent to work*** – Proven approaches to address this need include creating incentives for Arkansas industry to hire and create internships with top talent being generated in Arkansas and furthering university entrepreneurial education and training at the undergraduate and graduate levels.

Looking to future economic development, the winning proposition for Arkansas would include the provision for a sustainable, adequate, and predictable funding stream, and consideration of additional program efforts to address gaps in the state's current knowledge-based economy initiatives. These efforts represent the next critical steps in the Governor's Strategic Plan for Economic Development.

Options for Advancing Sustainable, Adequate, and Predictable General Revenue Fund Support and Closing Key Gaps in Arkansas' Knowledge-Based Economy Initiatives

When examining options to ensure sustainable, adequate, and predictable support for knowledge-based economy initiatives in Arkansas, it is important to consider ways to bring existing programs up to scale and ways in which new programs can be aligned to specific goals and outcomes related to advancing economic development in Arkansas. The key areas on which Arkansas should focus are:

- ***Research:*** Attain a higher level of per capita university research funding
- ***Commercialization:*** Accelerate the formation of emerging knowledge-based economy companies and position them for success
- ***Investment:*** Realize the growth potential from emerging companies that have participated in the existing knowledge-based economy initiatives
- ***Top Talent:*** Put talent to work in Arkansas

To assess budget options to ensure sustainable, adequate, and predictable funding, Battelle examines specific goals for Arkansas to reach over the next 5 years, and applies the recent track record to consider what actions Arkansas must take to reach these goals.

Attain and Sustain a Higher Level of Per Capita University Research Funding Compared to the National Average

In 2010, the latest year for which university research and development data are available for all states and the United States total, Arkansas stood at 46.3 percent of the U.S. average in per capita R&D. With $255.7 million in university research expenditures, the per capita level of university research funding in Arkansas stood at $87 compared to $189 for the United States.

A realistic goal for Arkansas to reach is a level above 50 percent of the U.S. average in per capita university research spending over the period 2011 to 2015. This would represent a significant increase above the state's level of 46 percent in 2010. Battelle estimates that U.S. average per capita university

research spending will reach $240 by 2015; consequently, the research funding goal Arkansas should reach is above $120 per capita by 2015, which is up from $87 per capita recorded in 2010.[5]

The population in Arkansas is expected to grow 5.7 percent to 3.09 million from 2010 to 2015, and the average annual growth in university research in Arkansas is expected to grow 2.1 percent from 2007 to 2010. Thus, the state would have to increase university research spending by $87 million by 2015 above what would be expected to reach a goal above the level of 50 percent of the U.S. average. Based on the state's recent experience in university research funding programs, where for each $1 in state funding an additional $3.14 has been leveraged, it is estimated that the state would need to spend at least $21 million in research support by 2015.

Over the FY 2008 to FY 2011 period, Arkansas averaged approximately $12 million to $13 million each year in research support funding, with the Arkansas Biosciences Institute leading the way at close to $11 million a year in funding. Thus, it would require State General Revenue Funds of approximately $10 million per year to surpass the state's current efforts and reach the level of $21 million.

The recommendations for distributing this appropriation of $10 million from the Arkansas General Revenue Fund include:

- Scaling up the Arkansas Research Alliance with $3.5 million in annual appropriations – This would enable the steady recruitment of two to three new scholars each year, plus allow for targeted funding for one-time expenditures for research infrastructure (specialized laboratory equipment) needed to attract scholars.

- Scaling up Basic Research Grants to $2 million in annual appropriations – This would enable ASTA to provide young investigator seed funds to establish their research programs and pursue larger federal and foundation research grants as well as consider faculty incentives to offer more undergraduate research projects.

- Maintaining the Centers for Applied Technology and Research Matching Grants at $1.5 million in annual appropriations to allow Arkansas to meet matching fund needs for larger federal grants and to target specific new research center development.

If possible, additional funding should be made available for:

- Industry-university partnership matching grants, with higher state contributions for industry consortium efforts. This can be applied to a range of activities, from pre-competitive research to more proof-of-concept and prototyping activities with industry, along with supporting technology networks that systematically connect industry and university research leaders. At least $1.5 million a year in State General Revenue Funds is suggested.

[5] This is based on an average annual growth rate of 6 percent in university research spending, which was the average growth from 2007 to 2010, offset by expected annual population growth of 1 percent per year from 2010 to 2015 based on the latest Census figures.

- Targeted signature shared-use research facilities to work with industry clusters, especially for pilot plant production and prototyping. This would be used to further complement the ARA Scholars and the Industry-University Partnerships efforts. At least $1.5 million a year in State General Revenue Funds is suggested.

Accelerate the Formation of Emerging Knowledge-Based Companies and Position Them for Success

For Arkansas to continue to record the success it achieved over the 2008 to 2011 period in supporting 135 emerging companies with 1,259 jobs through the commercialization, business formation, and angel investment stage, it needs to continue its existing levels of program activity. The General Revenue Fund requirement at the current service level stands at approximately $3.5 million a year. This includes funding for:

- Innovate Arkansas, under contract to the Arkansas Economic Development Commission, $1.7 million a year to continue providing strategic planning, market and technical evaluation, and coaching for entrepreneurs and their formative stage enterprise ideas.

- Arkansas Risk Capital Matching Fund, administered by the Arkansas Development Finance Authority, which has averaged annual investments—funded through appropriations to the Arkansas Science and Technology Authority—at $750,000 a year from 2008 to 2011 for Technology Validation funding to enable very early stage enterprises to address critical commercialization milestones involving activities such as proof of concept, prototype development, or market research, and for Enterprise Growth funding to co-invest with angel investors or institutional investors.

- ASTA Technology Development Grants at an annual average of approximately $100,000 a year to assist Arkansas companies in commercializing new technology-based products and processes through technology development activities involving royalty-based agreements.

- ASTA Technology Transfer Assistance Grant Program (TTAG) at an annual average of $125,000 a year, which provides hard-to-find small grants of up to $3,750 with company match requirements to assist Arkansas businesses in their efforts to develop or improve products or processes through the transfer of technical solutions and in pursuing federal Small Business Innovation Grants.

- ASTA Seed Capital Investment Program at an annual average of $750,000 a year to provide working capital to help support the initial capitalization or expansion of technology-based companies located in Arkansas. Typically these seed capital investments are in the form of royalty-based agreements, but other equity-type financing can be negotiated.

Other key programs integrated into knowledge-based economy initiatives for emerging companies, such as the Equity Investment Tax Credit, the Targeted Business R&D Incentive, the Arkansas Institutional Fund, and the ADFA Co-Investment Fund, make use of other mechanisms and do not require General Revenue Fund support.

To accelerate efforts to increase the number of emerging companies beyond the level of 125 to 150 every 4 to 5 years, and reach 250 to 300 emerging companies over the next 4 to 5 years at the commercialization, start-up, and angel financing stage, we estimate close to doubling of resources is required. This is because there are not many economies of scale in providing either entrepreneurial development support or financing support for commercialization and angel financing.

Innovate Arkansas, in its role as a key entrepreneurial development and screening function, might apply some of this additional support to increasing the level of mentoring services for the most promising entrepreneurs and their start-up companies, and to building up outreach capabilities to angel investors, which in turn will enable start-up companies to gain a stronger footing and grow faster.

As new funding is made available for financing support for commercialization, careful consideration should be given to establishing a more focused statewide program for university technology commercialization, particularly advancing proof-of-concept funding for promising technologies. A prime example is the Georgia Research Alliance's VentureLab, which supports serial entrepreneurs to "walk the halls" and identify promising university research activities for commercialization and then offers milestone-based technology development funding to advance the commercialization of those technologies and the formation of start-up companies. MIT's Deshpande Center is yet another example of a highly successful university-based commercialization effort.

Realize the Growth Potential from Companies That Have Participated in the Current Arkansas Knowledge-Based Economy Initiatives

The way to gain by far the greatest economic value in the years ahead is to ensure that companies emerge from the commercialization, start-up, and angel financing pipeline to become high-growth companies. Today 135 emerging companies in Arkansas' knowledge-based economy employ 1,259 workers, roughly 9 workers per company. The goal is to get from these 1,259 jobs to 5,000 or more over the next 5 years.

This is a realistic goal, but achieving it depends on getting the right types of financing in place at the right time. What is unproven in Arkansas is whether companies emerging from the angel financing start-up stage can attract the formal venture capital needed to advance beyond early stage series A and B financing to later stage growth financing. Currently there are 40 such companies out of the 135 that have received angel financing assistance in the form of the ASTA Seed Capital Fund, the Risk Capital Matching Fund, the Equity Investment Tax Credit, and the Institutional Fund.

The stakes are considerable. An analysis of available data on employment levels for venture-backed companies from the Thomson Reuters VentureOne database suggests the level of impact on employment growth that companies can have when they reach later stage venture financing. Going into the initial early stages of formal venture capital, the average size of a venture-backed company is around 15 employees. As a venture-backed company reaches expansion stage financing, the average size is 24 employees. At the later stage of venture capital financing, the average size is more than 300 employees.

If half of the emerging companies in Arkansas reach the expansion stage, that would translate into an additional 1,000 jobs. If then 20 percent of those expansion stage venture-backed companies reach later stage venture financing, that would represent close to an additional 4,000 or more jobs, with the additional upside of one or two of those companies making it very large.

However, it all starts with being able to attract formal venture capital investments to Arkansas. In this, the track record in Arkansas has been quite poor (see main report for more details).

The Arkansas Development Finance Authority (ADFA) has opened the door for outside venture firms to examine deal flow in Arkansas and consider investing in the state. Through the Arkansas Institutional Fund, which makes use of contingency tax credits, ADFA has been able to invest in six venture capital funds managed outside of Arkansas. To date, those funds have invested in four deals in Arkansas. In large part, this is because they are looking more for expansion and later stage deals, and Arkansas through its knowledge-based economy initiatives has brought a significant number of companies up through the angel financing stage; these companies are seeking early stage rounds of venture capital financing.

Based on Battelle's experience in other states, as long as Arkansas lacks a locally based early-stage venture capital fund, the prospects for substantial investment of initial rounds of venture capital in emerging companies are not promising. Venture capital is one of the more highly concentrated forms of financing; without local, early stage venture capital it is difficult to get the attention of other venture capitalists. One approach to address this situation can be seen in the Georgia Research Fund, LLC, newly formed by the Georgia Research Alliance to invest in Series A formal venture capital. Another approach can be seen in the long-term track record of Connecticut Innovations, a state authorized non-profit organization, to lead early stage Series A investments and then bring in other lead venture capital for follow on investments.

It is recommended that an Arkansas-based, privately managed early stage investment fund of $20 million to $30 million be created. The organizational form could be either as a non-profit or for-profit organization, following the Connecticut or Georgia examples. The initial size of investments would be up to $1 million for a Series A, with the option to follow up with up to $500,000 in the Series B round on a side-by-side basis with a lead investor. These investments would be structured as an equity investment. Priority in Series A would be placed on those investments that can attract other qualified investors, and Series B will only be invested if another qualified investor leads.

The Georgia approach of an upfront partial state appropriation to jumpstart the fund with incentives for private investor matching would be ideal. If this is not possible to do in one year, then a predictable, phased state investment approach should be pursued. It is recommended that $7 million one time state investment be made to jumpstart the formation of this new early stage venture capital investment fund for emerging companies coming through the state's knowledge-based economy initiatives.

In our discussions with key stakeholders in Arkansas on the challenges of attracting formal venture capital for emerging companies that are participating in its knowledge-based economy initiative, another concern was identified: the quality of the management teams. Venture capital investment decisions are based not only on the presentation of high-quality business plans and technologies, but also on the stewardship of high-quality

management teams. Lack of more experienced management to lead a company beyond angel financing is often a deal breaker. It is particularly difficult to attract management possessing such expertise without creating targeted mechanisms. One example is the Executive-In-Residence Program at the Pittsburgh Life Sciences Greenhouse. Established in 2002 to provide emerging life sciences companies with proven C-level leadership, nearly 300 emerging companies have benefitted from its support programs and services.

Developing a Resource Pool of Top Talent and Putting It to Work in Arkansas

A critical component of a competitive knowledge-based economy is a talented workforce with the education, skills, and adaptability required in the technology-oriented workplace of the 21st century. States must not only develop their future workforce by nurturing the full talent pipeline, from K–12 education and on through post-secondary, but also redevelop their current workforce, especially those who are displaced or otherwise in transition. Key pipeline indicators reveal a mixed record of recent performance in Arkansas.

While the educational attainment of the workforce in Arkansas is improving, it lags the level reported for United States as a whole, and the gap has been growing. In 2009, 19 percent of the Arkansas workforce had a bachelor's degree or higher, compared with 28 percent nationally. The levels have grown for both the state and the United States since 2000, but the increase for Arkansas was lower.

Increasing the value-added component to products and services in today's technology and knowledge-based industry requires innovation typically led by highly skilled science and engineering (S&E) professionals. Overall, Arkansas is outpacing the United States in S&E-related employment growth, although performance has been uneven across specific occupations. Since 2007, total employment of S&E professionals has increased in Arkansas by 6.5 percent, compared with 4.7 percent nationally. Demand for IT professionals has increased substantially since 2007, with state, private, and public sector firms increasing jobs in these fields by nearly 2,700 or 17 percent. Employment in the life sciences professions has grown, with an increase in jobs by 550 or 51 percent. However, demand for engineers and physical scientists has declined sharply in Arkansas.

To meet the demands of industry and develop a resource pool of top talent overall and especially in key science and engineering professions, Arkansas can adopt and scale up proven approaches to nurturing and attracting highly skilled workers. It is recommended that a set of Putting Talent to Work pilot initiatives be undertaken in the next biennium to:

- Develop incentives for Arkansas industry to create internships and hire top post-secondary students from Arkansas colleges and universities.
- Create talent bridges for doctorate and post-doctoral level science and engineering graduates to find job opportunities in industry.
- Promote statewide university entrepreneurial education and training at the undergraduate and graduate levels, particularly for STEM majors.

It is recommended that up to $1 million be appropriated for these Putting Talent to Work pilot initiatives.

Summary of Recommended Options

For the four goals identified, an annual funding level of $25 million is recommended in General Revenue Funds to support the knowledge economy initiatives in Arkansas. The chart below provides a summary of the goals and corresponding initiatives.

Proposed Recommendations for Sustainable Funding and Enhancements to Arkansas' Knowledge Economy Initiatives		
Goals	**Initiatives**	**Proposed Annual General Revenue Fund Request**
Research: Attain a higher level of per capita university research funding	Ramp-up in ARA Scholars More ASTA funding for young investigators Continued matching grants for federally funded research centers Industry-university partnership matching grants Signature shared use research and applications development facilities	$10 M in annual funding
Commercialization: Accelerate the formation of emerging knowledge-based economy companies and position them for success	Continue base support for existing initiatives: Innovate Arkansas, Risk Capital Matching Fund, ASTA Tech Development grants, ASTA Tech Transfer Assistance Grants, ASTA Seed Capital Investment Augment Innovate Arkansas for more intensive mentoring and outreach to funding sources Establish a university technology commercialization/proof of concept funding	$7 M in annual funding
Investment: Realize the growth potential from emerging companies that have participated in the existing knowledge-based economy initiatives	Partial state funding and tax credits towards creation of a $20 million to $30 million Arkansas-based, privately managed early stage investment fund Resources for advancing stronger management teams → consider an Entrepreneur in Residence approach	$7 M in annual funding (The state partial funding and incentives for creating a privately managed early stage seed investment can also be effectively done through a one time appropriation)
Top Talent: Put talent to work in Arkansas	Incentives for post-secondary internships with Arkansas industry Talent bridges for doctorate and post-doctoral level science and engineering graduates to industry. Further statewide university entrepreneurial education and training, targeting STEM graduate and undergrads	$1 M in annual funding

Making the Case: Assessing Arkansas' Knowledge-Based Economy Initiatives

Recognizing the importance of independent review, a consortium of state agencies and non-profit organizations retained the services of the Battelle Technology Partnership Practice to assess the performance of the ongoing knowledge-based economy initiatives in Arkansas. Battelle Technology Partnership Practice is one of the nation's leading knowledge-based economic development groups with significant expertise and experience in developing, designing, and assessing economic development initiatives across the nation.

Battelle developed a bottom-up approach to examining the performance of Arkansas' knowledge-based economy initiatives over the 2008 to 2011 period, measuring the results from a firm-specific and researcher/grant-specific perspective. Battelle screened program records maintained by state agencies, and supplemented this search with a review of corporate databases and direct outreach, to collect data on employment and private investment. On the industry side, Battelle identified 135 companies that have participated in Arkansas' knowledge-based economy initiatives. On the research side, Battelle compiled data relating to grant awards made and new researchers recruited to Arkansas through the state's knowledge-based economy initiatives.

Industry Results

Battelle assessed several performance parameters on how the knowledge-based economy initiatives have performed in serving industry over the 2008 to 2011 period, including:

- How well does the knowledge-based economy initiative link together in a synergy of resources to support companies rather than as isolated programs?
- Are private resources being leveraged by the state's support?
- What is the track record in direct jobs associated with companies receiving support and what is the total economic impact of those direct jobs?

The findings from the first four years since the initiation of many of Arkansas' knowledge-based economy initiatives serving industry, corresponding to the years 2008 to 2011, are very encouraging.

Specific Evidence Found of a Functioning Synergism for Knowledge-Based Economic Development in Arkansas

In the first four years, more than half of the 135 emerging companies participating in Arkansas' knowledge-based economy initiatives are getting support from more than one program.

This includes 20 companies receiving assistance in at least three of the four functional areas of R&D/Top Talent Generation, Commercialization and Deployment, Entrepreneurial Development, and Capital and Financing. The chart below depicts how these emerging companies receiving intensive services breaks out.

Figure 3: Participation of Emerging Arkansas Companies in Knowledge-based Economy Initiatives

4 emerging companies served by:	X	X	X	X
12 emerging companies served by:		X	X	X
3 emerging companies served by:	X		X	X
1 emerged company served by:	X	X		

These results clearly demonstrate that Arkansas is well on its way to having a well-conceived, integrated set of services across the continuum of activities to support knowledge-based economic development.

Substantial Private Sector Leverage Being Generated

Leverage is a well-established approach for evaluating whether state supported initiatives are functioning as a catalyst for broader private sector-led development.

Altogether, from 2008 to 2011 there was $30 million ($26.2M plus add in for Innovate Arkansas funding) expended by Arkansas' knowledge-based economy initiatives to support industry activity. From company reporting, an additional $77.3 million in private sector investment was made.

This results in a leverage ratio of $2.57 for every $1 of state programmatic support. This is a very encouraging leverage ratio for the first four years of activity; in the years to come it would be expected to grow as the emerging companies advance.

Greater than 1,000 Direct Jobs found in Emerging Companies Being Supported, Leading to Significant Total Economic Impacts

The 135 emerging companies assisted over the 2008 to 2011 period employ 1,259. While it was not possible to fully gauge how many jobs these emerging companies have added since being assisted, given the emerging nature of these companies it is likely that much of their growth is the result of the state assistance through the knowledge-based economy initiatives.

More impressively, these 135 emerging companies are having significantly broader economic impacts from the multiplier effect. Multipliers measure the effects on an economy from a source of economic activity (a change in demand or production)—in this case, the growth of emerging companies

participating in Arkansas' knowledge-based economy initiatives. The economic activity generated in the state is greater than the total of spending associated with the event or activity being studied because of the successive cycles of spending, earning, and re-spending. Part of this cycle of spending represents the indirect impacts from the purchase of goods and services by the emerging companies, and part of this cycle of spending represents the induced impacts from the personal spending of employees.

To capture the effects of these multiple rounds of spending, Battelle used the IMPLAN economic impact model. The IMPLAN model has linkages across 440 industry sectors, and is one of the most widely used input/output models in the nation to analyze the impacts of companies, projects, or entire industries. This tool was used to calculate the economic impact on Arkansas' economy of the 135 companies participating in the knowledge-based economic initiatives that were put in place in recent years.

The analysis focuses on impacts across four economic measures:

- **Output** – The total value of production or sales in all industries.
- **Employment** – The total number of full and part time jobs in all industries.
- **Personal Income** – The wages and salaries, including benefits, earned by the workers holding the jobs created.
- **Value Added** – The difference between an industry's or an establishment's total output and the cost of its intermediate inputs.

In turn, four types of economic impact effects are calculated for each of these economic measures:

- **Direct Effects** – The change in economic activity being analyzed.
- **Indirect Effects** – The changes in inter-industry purchases, for example the purchase of raw materials, in response to the change in demand from the directly affected industries.
- **Induced Effects** – The changes in spending from households as income and population increase due to changes in production.
- **Total Effects** – The combined total of direct, indirect, and induced effects.

The 1,259 direct jobs within the emerging companies served under the Arkansas knowledge economy initiatives span numerous individual industry sectors but combine to generate roughly 2,000 additional jobs through indirect and induced impacts (See Table 1). As of 2012, these companies currently support more than 3,200 jobs with workers earning $88.7 million in personal income amounting to an average of just over $53,000 per worker, and contributing nearly $757 million to the state in terms of economic output (includes direct, indirect, and induced impacts).

Table 1: Economic Impacts of Arkansas Companies Participating in Knowledge-Based Economy Initiatives, 2008–2011 ($ in millions)

Impact Type	Employment	Personal Income	Value Added	Output
Direct Effect	1,259	$88.7	$138.1	$514.8
Indirect Impacts	1,039	$50.8	$84.3	$142.2
Induced Impacts	953	$32.9	$60.3	$99.6
Total Impact	**3,251**	**$172.4**	**$282.7**	**$756.6**
Impact Multiplier	2.6	1.9	2.1	1.5

Source: Battelle analysis of Arkansas IMPLAN Input/Output Model.

University-Based R&D Results

A key driver of the knowledge-based economy is having high performing university R&D drivers. The evidence of the importance of research universities to advance technology-based economic development is overwhelming:

- The Milken Institute noted that research centers and institutes are "indisputably the most important factors in incubating high-tech industries" in a widely cited study, which found that 65 percent of the difference in economic success for regions from 1975 to 1998 is accounted for by the presence and growth of high-technology industries.[6]

- According to a study prepared for the U.S. Small Business Administration, "Research universities and investment in research universities are major factors contributing to economic growth in the labor market areas in which the universities are situated."[7]

- Studies by the Office of Technology Policy and others have found that all areas of technology-based economic development in the United States have strong concentrations of both university and private research.[8]

Having a robust university research base can be an economic driver in its own right. Since much of university research is funded through federal, industry, and foundation support coming from outside of a state, it is a wealth driver for the state and local economy in which the university resides. Typically, for each $1 million in non-state support attracted by university research, approximately 8 additional direct jobs are generated for research scientists, postdoctorates, and lab technicians.

Increasingly, however, states are focused on how their university research drivers do in the translation of their research activities into creating competitive technology advantages for their industries, advancing new product development, and generating new company formation. Often overlooked is the fact that having a high performing university research base also generates a significant base of top

[6] Milken Institute, America's High-Tech Economy, 1999.
[7] Bruce Kirchhoff, "The Influence of R&D Expenditures on New Firm Formation and Economic Growth," Maplewood, N.J.; BJK Associates, 2002.
[8] U.S. Department of Commerce, Office of Technology Policy, The Dynamics of Technology-based Economic Development; State Science and Technology Indicators, Washington, D.C., 2000.

scientific and engineering talent for a state—developed among the faculty, postdoctoral students, and graduate students—who can offer technical assistance and be a feeder to meeting industry's top scientific and engineering staffing needs. All in all, the notion of "job creating research" put forward by Accelerate Arkansas does a good job of capturing how advancement of university research fits into a focus on knowledge-based economic development.

Arkansas has several knowledge-based economy initiatives to spur university research and its associated development of top scientific and engineering talent. Notable are the ASTA Research Matching Grants, the Centers for Applied Technology, the Arkansas Biosciences Institute, the Arkansas Research Alliance, and the recently enacted MOU with the National Center for Toxicology Research (NCTR). Some have been in place for years, but others, such as the Arkansas Research Alliance and the MOU with NCTR, are of recent vintage.

Battelle used several performance parameters to assess how these knowledge-based economy initiatives to spur R&D performed over the 2008 to 2011 period, including:

- What was the non-state research funding leveraged beyond direct state support and what is its economic impact on the state?
- How was scholarly activity advanced?
- What is the track record in commercialization?

The findings from the period 2008 to 2011 demonstrate a real payoff to the state in its research funding just from non-state funding that is leveraged. In addition, signs indicate that these state investments are also paying off in scholarly activity and technology commercialization, but these are harder to quantify in direct economic terms.

$191.8 Million of Additional Non-State Research Funding Attracted to Arkansas from 2008 to 2011 Results in Significant Total Economic Impacts

Research-focused knowledge economy initiatives in Arkansas used $61.2 million in state funding from 2008 through 2011[9] and leveraged an additional $191.8 million in non-state sources to further support their research activities. This represents an impressive return to state dollars invested in research: for each $1 in state funding the Arkansas programs have leveraged an additional $3.14. Table 2 summarizes the state funding and additional funding leveraged by major program area and a leverage ratio.

[9] The focus of the analysis generally encompasses calendar year 2008 through 2011 activities, although data were reported to Battelle on a fiscal year basis by program area and there are some differences in time periods reported by program. Two programs, ASTA and ARA, reported data through FY 2012; ABI reported through FY 2011. ABI tracks additional leveraged received on a year-by-year basis across its cumulative grant funding to Arkansas researchers. Rather than using all leveraged funding received during the 2008–2011 time period across all grants made to date, Battelle used the 10-year ABI average leverage ratio of $3.20 in leveraged funds per $1 of state investment to estimate additional funds leveraged for ABI over 2008–2011.

Table 2: State of Arkansas Research Funding through Knowledge-Based Economy Initiatives and Additional Funds Leveraged, 2008–2011 ($ in millions)

Arkansas Organization	Total State Funding	Additional Non-State Funding Generated*	Leverage Ratio ($ Leveraged/$ State Funding)
AR Biosciences Institute (FY2008–11)	$46.6	$149.2	3.20
ASTA Programs (FY2008–12)	$13.9	$38.5	2.77
ARA Scholars (FY2008–12)	$0.7	$4.2	6.27
Total Research Initiatives	**$61.2**	**$191.8**	**3.14**

Note: Data may not sum to totals due to rounding.

*Leveraged funds for ABI are tracked on a cumulative basis and therefore include funds generated by grants from prior years. Because we are unable to separate out those dollars leveraged specifically by grants begun during the 2008–2011 time period, Battelle has instead used the 10-year average ABI leverage ratio to estimate additional funds leveraged over this period.

Leveraged funding from Arkansas research initiatives is a key contributor to the Arkansas economy. Over the 4-year period, these $191.8 million in direct R&D funds have contributed $335 million in total economic output to the state and supported 2,820 job years with respect to direct, indirect, and induced impacts (See Table 3). Since these funds were generated and spent over a multi-year period, employment is expressed as "job years," the concept where one job may be held by an individual for two years representing 2 job years.

Table 3: Economic Impacts of Arkansas University Research Funding Leveraged through Knowledge-Based Economy Initiatives, 2008–2011 ($ in millions)

Impact Type	Employment	Personal Income	Value Added	Output
Direct Effect	1,404	$91.7	$91.7	$191.8
Indirect Impacts	632	$22.8	$34.9	$61.4
Induced Impacts	784	$27.0	$49.6	$81.9
Total Impact	**2,820**	**$141.5**	**$176.2**	**$335.1**
Impact Multiplier	2.0	1.5	1.9	1.8

Source: Battelle analysis of Arkansas IMPLAN Input/Output Model.

The economic impacts can also be described in an average annual context in which these research programs leveraged $48.0 million annually and 351 jobs over 4 years. At these levels, the total annual average impacts amount to $83.8 million and 705 jobs.

In addition to the economic leverage and impacts described above, the Arkansas knowledge-based economy initiatives have emphasized recruitment of top research scientists, for which the benefits to the state are numerous. World-class scientific researchers can be thought of almost as individual innovative companies as they bring existing grants, often worth millions of dollars, and teams of other talented individuals with them into the state to conduct valued new research. Successful commercialization of that research can be a boon to the state in the form of new companies and skilled jobs. Among the funding and leveraged dollars presented above, both ABI and ARA have invested in faculty recruitment. ABI used $5.8 million to target recruitment of new faculty, which has already generated $10.7 million in additional non-state research funding. ARA has at its core a mission to recruit top-tier scientific talent to the state and has brought in three university researchers at a funding cost of under $700,000 and leveraged more than $4 million in additional non-state research funding since its inception.

Scholarly Activity Greatly Enhanced in Arkansas through Its Funding of Knowledge-Based Economy Initiatives

Key outcomes related to academic research activities go beyond research dollars and include the publication of research breakthroughs and discovery. During the 2008 to 2011 period, research supported through Arkansas knowledge-based economy initiatives generated 2,199 scientific publications, broken down as follows:

• **Arkansas Biosciences Institute**: 1,674 publications • **ASTA:** 479 publications • **ARA:** 46 publications.

Scholarly activity supported through state initiatives accounts for a significant share of all academic publications over the 4-year period. From 2008 through 2011, these 2,199 publications comprise 36 percent of all university publications.

Encouraging Results in Technology Transfer and Commercialization

Translating university R&D into viable commercial opportunities is the goal of many research grants and the success can be gauged through patents, licenses, and new company formation metrics.

Overall, universities in Arkansas are performing well compared to national averages in technology transfer activity relative to size of their research base. The chart below presents annual data for Arkansas universities and national averages for outcome activities from technology transfer—licensing per $10 million in research expenditures and start-ups per $10 million in research expenditures. In each of these measures, Arkansas consistently outperforms the U.S. averages.

Table 4: Arkansas University Technology Transfer and Commercialization Metrics, 2007–2009

	Licenses per $10M in Research Expenditures		Start-ups per $10M in Research Expenditures	
Year	**AR**	**U.S.**	**AR**	**U.S.**
2007	0.50	0.18	0.84	0.12
2008	0.31	0.04	0.78	0.12
2009	2.92	0.14	0.77	0.11

Source: AUTM annual survey; University of Arkansas, Fayetteville and University of Arkansas Medical Sciences are only universities reporting from Arkansas.
Note: University of Arkansas for Medical Sciences not available for 2010, so not presented.

Arkansas knowledge economy research initiatives are an important source of research discoveries leading to technology transfer activity in Arkansas. Over the 2008 to 2011 period, discoveries from these research program efforts have resulted in 48 patents applied for or issued, and they helped provide scientific breakthroughs to advance 4 new companies. This represents a substantial number of the overall technology transfer activities of Arkansas overall research base—approximately 25 percent of the patents and half of the start-up companies from university research.[10]

[10] Based on a comparison of average annual number of patents and start ups from Knowledge-Economy initiatives over the 2008 to 2011 period compared to the overall results from Association of University Technology Transfer Managers for universities reporting in Arkansas over the 2007 to 2009 period.

Making the Case: Tangible Economic Payoffs for Arkansas Being Realized with High Wage Industries Driving Arkansas Economic Growth

Governor Beebe's Strategic Plan for Economic Development makes clear that Arkansas' efforts to transition to a high performing, knowledge-based economy is more akin to a marathon than a sprint. As the plan notes: "the state cannot migrate overnight to a knowledge-based economy." This is why it calls for a transitional, systematic approach, which takes specific and measured steps along the way.

Although a period of four years is somewhat short for measuring the total economic impact of the initiatives, it is important to consider the progress being made and determine whether, at the scale of implementation thus far, the Arkansas economy is moving ahead or falling behind. So far, the bottom-line measures of income and high-wage job growth appear to be quite strong.

Rising State per Capita Income

State per capita income is a bottom-line measure of well being within a state and a way in which to gauge the overall success of the technology-based economic development policies and programs that a state has implemented. Although Arkansas has lagged the nation historically in terms of per capita income, it has recorded gains over the last decade and is narrowing the gap. Since 2001, Arkansas has outpaced the United States in per capita income growth, rising by 42.5 percent compared with a 33.7 percent gain nationwide. A closer look at the period since 2007 reveals even stronger recent gains, with growth at 8.5 percent compared with 5.5 percent for the United States. By 2011, Arkansas per capita income had reached just over $34,000 or 82 percent of the U.S. average of nearly $42,000. The late 2000s marked the very first time Arkansas crossed the 80 percent threshold.

It also is important to point out that the cost of living in Arkansas is lower than other states in the United States. Based on the ACCRA Cost of Living Index developed by the Council for Community and Economic Research, Arkansas is at 91 percent of the U.S. average in cost of living—thus, at 80 percent of the United States, Arkansas is closing in on parity on the standard of living it affords.

Table 5: Growth in Per Capita Income, Arkansas and United States, 2001–2011

Time Period	Arkansas	U.S.
2001–2011	42.5%	33.7%
2007–2011	8.5%	5.5%

Source: U.S. Bureau of Economic Analysis.

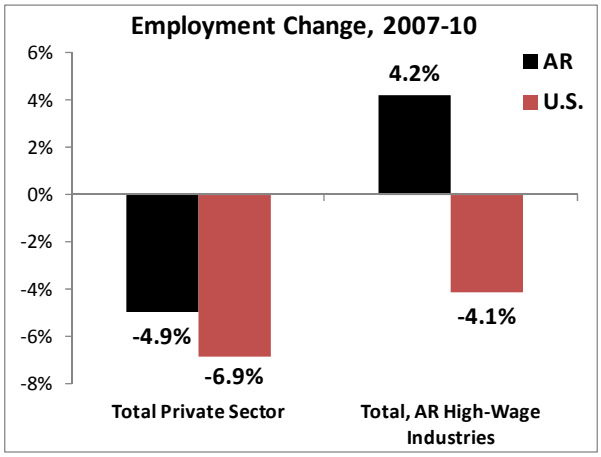
Growing High-Wage Industries in Arkansas – Generating Significant Gains for the State and Positioning the State in Specific Industry Clusters

To better understand recent dynamics around high-quality jobs driving value-adding activities in Arkansas, Battelle considered average wages for all state industries using the most detailed level of the NAICS system (6-digits) and worked to identify those that might be considered "high wage." Acknowledging the goal of Accelerate Arkansas to reach the U.S. average in per capita income by 2020, Battelle used a wage threshold in designating high-wage sectors equal to that for the overall U.S. private sector average in 2010—$46,000 or 30 percent greater than the average for the Arkansas private sector ($35,702). Battelle identified *89 detailed trade sector industries* in Arkansas that have at least a 0.05 percent share of total private employment (just over 400 jobs) and generate average wages above the national private sector average.

High-wage industries in Arkansas employed just over 149,000 in 2010 or roughly 30 percent of trade private sector employment in Arkansas. The average wage across these high-wage industries was $66,070, compared to the Arkansas trade sector average wage of $44,189.

What stood out were the strong overall employment gains across the state's high-wage sectors from the economic peak in 2007 through the difficult recession years and into the first year of the recovery in 2010. Arkansas outperformed the nation and experienced job expansion across its 89 trade sector high-wage industries even through the recession! Employment in high-wage sectors in Arkansas grew by 4.2 percent from 2007 through 2010; nationally, these same sectors had a 4.9 percent decline (see Figure 4).

Figure 4: Employment Trends in High-Wage Industries and the Overall Private Sector, Arkansas and the United States, 2007–2010



The high-wage sectors span numerous "clusters" of related industry activities from both a supply chain and "know how" perspective. These broader industry clusters include:

- Corporate Headquarters & Business Services
- Paper & Related Products
- Transportation & Logistics
- IT & Telecommunications
- Engineering & Architectural Services
- Biosciences
- Metals Manufacturing
- Chemicals Manufacturing
- Energy Extraction, Generation & Distribution
- Aerospace
- Finance & Insurance
- Automotive Supply Chain

The 4.2 percent gain in high-wage employment in Arkansas since 2007 translates into just over 6,000 new jobs over the 3-year period. The increase in these quality, high-wage jobs has broader economic ripple effects throughout the economy and combines to generate a total of 11,800 jobs across the Arkansas economy (includes direct, indirect, and induced impacts).

Making the Case: Addressing the Gaps in Arkansas' Knowledge-Based Economy Initiatives and Key Challenges to Synergy

Arkansas has realized tangible economic payoffs in its transition to a knowledge-based economy supported by high-wage jobs; however, much work remains to be done. Battelle has assessed the gaps in services and key challenges to synergy that lie ahead.

The evidence shows not only that recent knowledge-based economy initiatives have been paying off, but also that high-wage industries are growing in the state. Now is the time to reinvest and double-up on what is becoming a shining light for the state by continuing to advance Arkansas' efforts to achieve success with its knowledge-based economy initiatives.

Long-Term Challenge Ahead in Value-Added Component and Higher Productivity of Arkansas Industry Calls for Better Deployment of Technologies and Shift to More Innovative Products

Value-added per worker in Arkansas is currently 74 percent of that across the United States for its private, trade sector industries.[11] For the high-wage industries analyzed in this study and growing in Arkansas, the value-added per worker in Arkansas is 84 percent of that across the United States.

This lower value-added component reflects the need for improved deployment of technology by industry to raise productivity and the need to focus on more advanced products that generate higher value. In today's global knowledge-based economy, new realities of international competition, the increasing pace of development and rapid diffusion of technologies, and the growing convergence of technologies are reshaping the economic landscape and making closer industry–university ties a particularly important means to raise industry value-added. A new paradigm of open innovation has emerged in which leading companies are looking to universities and innovative emerging companies for new technologies, rather than investing as many resources in internal high-risk R&D work as in the past. As a result, more and more companies are looking for opportunities to partner with research universities.

Industry–university partnerships to promote economic development are not a new phenomenon, but the nature of these relationships has changed dramatically. The most common and, in Battelle's experience, one of the most effective means of fostering greater university and industry interaction is to provide matching grants for research partnerships. Such programs help build relationships between

[11] Value-added represents the difference between an industry's total output and the cost of its intermediate inputs; specifically it measures the industry or cluster's contributions to GSP. The measure of value-added per employee is often used as a gauge of overall industry productivity.

academic researchers and companies and provide support for activities that may lead to investments of private capital and commercialization of new technologies. As of 2008, 28 states had matching grant programs that provide an incentive for firms to support research projects at local research institutions.[12] Most of these programs solicit applications on a competitive basis and make awards to projects that are both technically sound and likely to have a positive economic development impact. All of the programs require that the company shares the cost of the research project, which is conducted by faculty and students on behalf of the company. The level of cost share can vary. Some programs vary the matching requirement based on the size of the company.

Other innovative approaches are being developed that focus on fostering broader and more systematic relationships and communications across and between universities that generate new discoveries, emerging technology companies focused on new product development, and larger companies seeking to meet the needs of existing and emerging markets. State governments have encouraged the creation of such mechanisms by providing both operational and capital funding that then seeks to leverage the state funds to attract additional private and federal funding.

The **Oregon Nanoscience and Microtechnologies Institute** (ONAMI) is an example of an industry–university partnership approach oriented more to the consortium model that was seeded with state dollars. ONAMI is a collaboration of four Oregon universities (Oregon Health and Science University, University of Oregon, Oregon State University [OSU] and Portland State University), a national laboratory (Pacific Northwest National Laboratory [PNNL]), industry, and the investment community. It is one of three "Signature Research Centers" created by the State of Oregon. ONAMI's mission is to accelerate research and commercialization of materials science and related device and system technology in Oregon.

ONAMI seeks to accomplish its mission by

- **Providing matching funds for federal and private collaborative research projects** undertaken by ONAMI principal investigators.
- **Providing industry with access to a collection of university-based shared/open user facilities** on a user-friendly, fee-for-service basis. These are world-class materials characterization and fabrication laboratories. Not only do the firms have access to sophisticated equipment, but they also have access to people with the expertise to run the equipment.
- **Providing commercialization funding and business development services**. ONAMI provides proof-of-concept grants that enable university researchers to conduct commercialization activities, and helps link entrepreneurs to sources of private capital. Efforts are underway to create a nanoscience and microtechnology-focused early-stage fund that would be similar to Seattle's Biotechnology Accelerator.
- **Holding periodic conferences and seminars** and providing opportunities for networking among industry and academic researchers. The ONAMI network includes 150 research affiliates at four universities and PNNL.

[12] *Technology, Talent and Capital: State Bioscience Initiatives 2008*, www.bio.org/local.

ONAMI received both capital and operating support from the State of Oregon. Between March 2006 and April 2011, ONAMI distributed $14.75 million in grants to Oregon universities, helping to attract more than $100 million in federal and industry R&D funding. Between 2004 and 2008, awards to Oregon's universities for nanotechnology and microtechnology R&D tripled, and seven new companies were created based on nanotechnology and microtechnology discoveries.[13] Companies working with ONAMI have raised more than $70 million for research projects to help dramatically grow research revenue in Oregon and accelerate commercialization of resulting technology.[14] ONAMI is housed in Corvallis on Hewlett-Packard's campus, and has provided many research and employment opportunities for OSU students and graduates.

States are also creating networks around targeted technology focus areas to promote industry-university collaborations. For example, the North Carolina Biotechnology Center (NCBC) supports intellectual exchange networks that are designed to foster a research and information-sharing environment for industry and academic partnerships, and professional networking opportunities in the State of North Carolina. Intellectual Exchange Groups (IEGs) are initiated by interested individuals or groups within the life science communities; and participants might be drawn from universities, the business community, or other constituencies. NCBC provides funding to the IEGs to cover the cost of meeting expenses. IEGs are expected to meet at least four times a year. Current IEGs supported by NCBC include the following:

- Bioprocessing/Process Development Group
- Laser Technologies Applications Group
- Next Generation Sequencing Group
- One Health Group
- Plant Molecular Biology Consortium
- RNA Society of North Carolina
- Smaller Eukaryotes Group
- Triangle Chromatography Discussion Group
- Triangle Immunology Interest Group.

The Arkansas Research Alliance has established a similar spirit of networking, holding three research conferences in areas of job-creating research to connect Arkansas industry executives and university research leaders. These three conferences have been in Smart Infrastructure, Healthy Communities, and Sustainable Agriculture. ARA research conferences have built a sense of community among university researchers and industry executives, have identified areas where recruiting research scholars will initiate growth and where investments in infrastructure can accelerate progress, have educated industry executives on Arkansas' research strengths, and have introduced university researchers to potential

[13] Sheila A. Martin. "Understanding the ONAMI Experience: Success Factors and Transferability Final Report, Institute of Portland Metropolitan Studies, Portland State University, October 2008.

[14] "Governor Visits ONAMI", Life@OSU, October 2011, http://oregonstate.edu/dept/ncs/lifeatosu/2011/governor-visits-onami, visited 10/04/2011.

business partners. But more sustained engagement along with pilot funding for collaborative projects would go a long way to fostering more on-the-ground activities to address raising industry value-added.

Another key to advancing industry-university partnerships is to further validate and advance university technologies so that they are ready to be commercialized. Far too often, academic research discoveries that are potentially interesting to industry remain at too early a stage for investment in further research and development. This is the much-cited "valley of death," which results from the failure of states and regions to realize their full economic development potential. To close this commercialization gap in university technology transfer, dedicated funding is needed for proof-of-concept and initial prototyping for promising university research discoveries. As new funding is made available, Arkansas should consider supporting an initiative such as Georgia Research Alliance's VentureLab, which supports serial entrepreneurs to "walk the halls" and identify promising university research activities for commercialization and then offers milestone based technology development funding to advance the commercialization of those technologies and the formation of start-up companies. MIT's Deshpande Center also offers an example of a highly successful university-based commercialization effort offering phased proof-of-concept and initial technology development funding.

Significant Formal Private Equity Gap May Choke Off Promising Gains in Growth-Oriented Emerging Companies

Formal venture capital and private equity investments have been stagnant in Arkansas. From 2007 to 2011, the number of Arkansas companies that received formal venture capital and private equity investments was 15, compared to 22 companies in the period from 2002 to 2006. This slight decline would not be of great concern, particularly in light of the economic difficulties of the 2007 to 2011 period, if national trends were not so different. In sharp contrast to Arkansas, deal volume in formal venture capital and private equity investments in the United States grew significantly in the 2007 to 2011 period, increasing nearly 30 percent; an additional 3,099 companies received funding in the 2007 to 2011 period compared to the 2002 to 2006 period.

Considering just formal venture capital, the National Venture Capital Association's 2012 Yearbook reports a total of 27 formal venture capital investments in Arkansas from 2000 to 2011, which is a fraction above 2 per year. Since 2007, the peak year of the expansion, the average is fewer than 1 per year.

The Arkansas Development Finance Authority (ADFA) has opened the door for outside venture firms to examine deal flow in Arkansas and consider investing in the state. Through the Arkansas Institutional Fund, which makes use of contingency tax credits, ADFA has been able to invest in six venture capital funds managed outside of Arkansas. To date, those funds have invested in four deals in Arkansas. In large part, this is because they are looking more for expansion and later stage deals, and Arkansas through its knowledge-based economy initiatives has brought a significant number of companies up through the angel financing stage; these companies are seeking early stage rounds of venture capital financing.

Based on Battelle's experience in other states, as long as Arkansas lacks a locally based early-stage venture capital fund, the prospects for substantial investment of initial rounds of venture capital in emerging companies are not promising. Venture capital is one of the more highly concentrated forms of financing; without local, early-stage venture capital it is difficult to get the attention of other venture capitalists. In one approach to address this situation, the Georgia Research Alliance capitalized its own venture fund—GRA Venture Fund, LLC—to invest in university spin-offs primarily coming out of its VentureLabs program. This new Georgia-based venture fund was kick started by a state commitment of $7.5 million in capital investment and income tax credits for investors of 25 percent. To date, the GRA Venture Fund, LLC has closed on $20 million with the tax credit being viewed as a key inducement for private sector involvement in the Fund. The GRA Venture Fund's investment focus is on Series A early stage venture capital investments, with its typical approach being to invest side-by-side with other early stage venture capital. In just over a year of activity, six investments have been made, with the Fund co-investing in four investments with venture capitalists outside of Georgia. Thus, the GRA Venture Fund, while being focused on return on investment, serves to provide an incentive for outside venture capitalists to make early stage investments in Georgia technology companies.

Connecticut addressed the same situation in a different manner. Since 1995, the quasi-public Connecticut Innovations (CI) has been a leading early-stage investor in the state, with a current portfolio of over 50 early-stage technology companies across biosciences, information technology, clean tech, and photonics, among others. In just the past three years, CI has invested in 75 early-stage companies. Typically, CI is the lead investor only in the early-stage Series A, and other venture capitalists lead in the next rounds. As an investment fund, CI reports a highly respectable annual rate of return on its investment funds of nearly 20 percent from 1995 to 2010—over a period of time where nearly no new state funding was provided to CI and all of its investment activity was self-financed.

It is recommended that an Arkansas-based, privately managed early-stage investment fund of $20 million to $30 million be created. The organizational form could be either as a non-profit or for-profit organization, following the Connecticut or Georgia examples. The initial size of investments would be up to $1 million for a Series A, with the option to follow up with up to $500,000 in the Series B round on a side by side basis with a lead investor. These investments would be structured as an equity investment. Priority in Series A would be placed on those investments that can attract other qualified investors and Series B will only be invested if another qualified investor leads.

The Georgia approach of an upfront state appropriation with incentives for private investor matching would be ideal. If this is not possible to do in one year, then a predictable, phased state investment approach should be pursued.

In our discussions with key stakeholders in Arkansas on the challenges of attracting formal venture capital for emerging companies that are participating in its knowledge-based economy initiatives, another concern was identified: the quality of the management teams. Venture capital investment decisions are based not only on the presentation of high-quality business plans and technologies, but also on the stewardship of high-quality management teams. Lack of more experienced management to lead a company as it moves beyond angel financing is often a deal breaker. It is particularly difficult to

attract management possessing such expertise without creating targeted mechanisms. One example is the Executive-In-Residence Program at the Pittsburgh Life Sciences Greenhouse, which was established in 2002 to provide emerging life sciences companies with proven C-level leadership. By having the Executive-in-Residence serve as a core function of its overall program efforts, the Pittsburgh Life Science Greenhouse was able to overcome difficult issues in recruitment, manage contingencies in the event a particular start-up company does not work out, and identify the next job for the Executive-in-Residence in the event a company is successful. Since 2002, 284 companies have benefitted from the Pittsburgh Life Science Greenhouse Executive-in-Residence support programs and services.

It is estimated that funding of $750,000 would be sufficient to attract up to four serial entrepreneurs to serve as initial Entrepreneurs-in-Residence. The expectation is that within 12 to 18 months these Entrepreneurs-in-Residence would likely be placed in the role of senior leadership in one of Arkansas' emerging companies. Until this occurred, the individual would serve as a mentor to existing firms, assist university technology transfer offices in identifying promising research for commercialization, and possibly assist in the new early stage investment organization.

Mixed Record on Growing Talent and Putting it to Work in Arkansas

A critical component of a competitive knowledge-based economy is a talented workforce with the education, skills, and adaptability required in the technology-oriented workplace of the 21st century. States must not only develop their future workforce by nurturing the full talent pipeline, from K–12 education and on through post-secondary, but also redevelop their current workforce, especially those who are displaced or otherwise in transition. Key pipeline indicators reveal a mixed record of recent performance in Arkansas.

While the educational attainment of the workforce in Arkansas is improving, it lags the level reported for United States as a whole, and the gap has been growing. In 2009, 19 percent of the Arkansas workforce had a bachelor's degree or higher, compared with 28 percent nationally. The levels have grown for both the state and the United States since 2000, but the increase for Arkansas was lower.

Table 6: Educational Attainment of the Arkansas Workforce, 2000 and 2009

Percent of Workforce with a Bachelor's Degree or Higher			
	2000	**2009**	**Change**
U.S.	24.4%	27.9%	3.5%
AR	16.7%	18.9%	2.2%

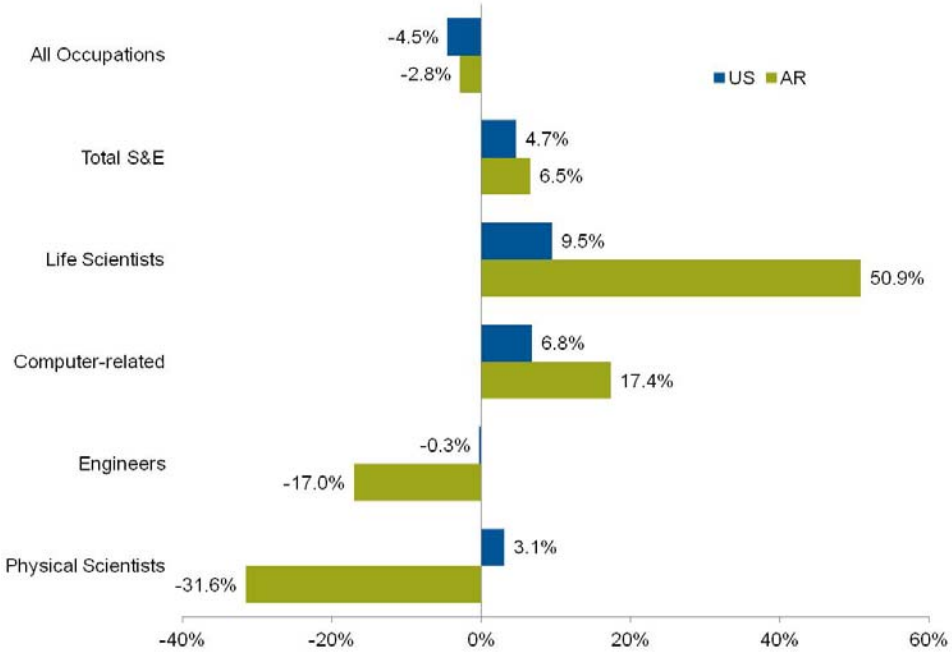
Source: U.S. Census Bureau, Statistical Abstract of the United States, 2012.

Increasing the value-added component to products and services in today's technology and knowledge-based economy requires innovation typically led by high skilled science and engineering (S&E) professionals. In 2011, Arkansas employed 26,520 in science and engineering occupations, particularly computer-related (the majority of S&E occupations at 69 percent), engineering, and life and physical sciences. However, the job concentration in these fields is well below the U.S. average; with a location

quotient of 0.56, the state has about half the concentration of S&E jobs that one would expect given the average seen across the United States.

Overall, Arkansas is outpacing United States in S&E-related employment growth, although its performance has been uneven across specific occupations. Since 2007, total employment in S&E occupations has increased in Arkansas by 6.5 percent, compared with 4.7 percent nationally. This occurred despite employment declines across total employment. Demand for IT professionals has increased substantially since 2007, with state, private, and public sector firms increasing jobs in these fields by nearly 2,700 or 17 percent. Employment in the life sciences professions has grown, with an increase in jobs by 550 or 51 percent.

Figure 5: Change in Science and Engineering Occupations in Arkansas and the United States, 2007–2011



Source: Bureau of Labor Statistics, Occupational Employment Statistics.

To meet the demands of industry and develop a resource pool of top talent overall and especially in key science and engineering professions, Arkansas can adopt and scale up proven approaches to nurturing and attracting high skilled workers. These include:

- **Develop incentives for Arkansas industry to create internships and hire top post-secondary students from Arkansas colleges and universities**. A 2010 survey of the 884 industry members of the National Association of Colleges and Employers revealed that 82.5 percent of employers

surveyed have an internship or co-op program and that more than 50 percent of interns accept full-time employment with the company for which they interned.[15]

Examples of statewide internship programs include InternNE in Nebraska and Ohio's Third Frontier Program. In Nebraska, internship grants provide a 40 percent match, up to $3,500 per internship, for up to 10 interns per year (5 at a single location). Up to $1.5 million is allocated for the Nebraska program, targeted to certain set of eligible businesses. An internship under the Third Frontier Program reimburses up to 50 percent of the intern's wages, or no more than $3,000 for a 12-month period. Ohio targets its internships to a set of high-growth technology industries such as biosciences, information technology, instruments and controls, advanced materials, and advanced energy, among others. Since 2002, more than 3,000 Ohio students have participated.

- **Create talent bridges for doctorate and post-doctoral level science and engineering graduates to jobs in industry.** Accelerate Arkansas has a pilot initiative for ASTA to award grants to Arkansas companies for hiring recent PhD graduates in Arkansas into postdoctoral fellowships. For many years, New Jersey's Science and Technology Commission provided such a program; in general, however, not many states have been active in this area. A talent bridge to jobs in industry would be a good fit to the knowledge-based economy initiatives, helping secure the future for STEM PhD graduates in Arkansas, assisting emerging companies in Arkansas in recruiting top talent, and building strong working relationships between the two. It would also be a good fit for established Arkansas companies, fostering the exploration of new technologies with recent PhD graduates and, through them, establishing a better connection to university faculty.

- **Further university entrepreneurial education and training at the undergraduate and graduate levels, particularly for STEM majors**. Entrepreneurial education at the undergraduate and graduate levels can be an important pipeline for Arkansas knowledge-based economy initiatives. It is particularly important to link entrepreneurial training to STEM education in order to provide students in highly technical disciplines the skills to help start and lead emerging companies. This is offered at the University of Arkansas, Fayetteville through their Graduate Certificate in Entrepreneurship; it carries a requirement of 12 credit hours and is targeted to non-business majors. Such a program should be made available to STEM graduate and possibly undergraduate students across the state; program activities would include hybrid distance learning and in-class learning, detailed lesson plans and professional development for faculty, mentoring opportunities with serial entrepreneurs, and active student business competitions. This approach would enable Arkansas to provide its growing base of STEM higher education graduates—the top talent in today's knowledge-based economy—access to advanced and innovative tools to create their own futures in Arkansas.

[15] See web site for National Association of Colleges and Employers.

Conclusion

Building on Governor Beebe's 2009 long-term, statewide economic development plan to lead Arkansas in a transitional, systematic manner to ***an economy supported by knowledge-based jobs to raise the incomes and standard of living for Arkansans,*** Arkansas has put in place a comprehensive ecosystem of economic development initiatives that spans across the driving factors for advancing the knowledge-based economy.

These knowledge economy efforts are generating clear economic returns for Arkansas:

- *Research-focused knowledge economy initiatives in Arkansas received $61.2 million in state funding from 2008 through 2011*[16] *and leveraged an additional $191.8 million in non-state sources to further support their research activities*. These leveraged non-state research funds have had economic multiplier impacts amounting to $335 million in total economic output to the state and supporting 2,820 job years over the 2008 to 2011 period.

- *135 emerging knowledge economy companies, employing 1,259 workers in Arkansas, have participated in the state's knowledge-based economy activities since 2008.* The total economic multiplier impact of these emerging companies is 3,251 jobs throughout the Arkansas economy.

- *Overall, Arkansas' economy is being bolstered by growth in high wage, typically knowledge intensive industries*. Job gains in these high wage industries in Arkansas from 2007 to 2010 amounted to 4.2 percent or just over 6,000 direct jobs, which generated total employment impacts of 11,800 jobs. Over this same period of time, total private industry jobs in Arkansas declined by 4.9 percent.

The bottom-line result is that Arkansas' per capita income—the bottom-line measure of the state's economic well-being—is rising at levels faster than the nation and for the first time is over 80 percent of the U.S. national average.

Continued knowledge economy investments will position Arkansas in the next five years to rise above the average of its neighboring states as it seeks the longer term goal of reaching and then exceeding national per capita income levels.

What is still missing in Arkansas today is having a sustainable funding mechanism providing adequate, predictable resources for these knowledge economy initiatives.

At the same time, there remain specific gaps and challenges in services identified through the economic analysis by Battelle and consultations with key stakeholders:

[16] The focus of the analysis generally encompasses 2008 through 2011 activities though data were reported to Battelle on a fiscal year basis by program area and there are some differences in time periods reported by program. Two programs, ASTA and ARA, were able to report data through FY 2012 while ABI reported through FY 2011.

- *Raising the value added and productivity of Arkansas industry is a major challenge for existing companies*
- *A lack of formal private equity investment in Arkansas may choke off the potential of growth-oriented emerging companies*
- *Putting the state's growing talent pipeline to work*

Among the key goals recommended in bringing existing programs up to scale and advancing new programs are:

- ***Research:*** Attain a higher level of per capita university research funding
- ***Commercialization:*** Accelerate the formation of emerging knowledge-based economy companies and position them for success
- ***Investment:*** Realize the growth potential from emerging companies that have participated in the existing knowledge-based economy initiatives
- ***Top Talent:*** Put talent to work in Arkansas

For these four goals identified, an annual funding level of $25 million is recommended in General Revenue Funds to support the knowledge economy initiatives in Arkansas.