INSTITUTE FOR PUBLIC POLICY AND BUSINESS RESEARCH
THE UNIVERSITY OF KANSAS

TECHNOLOGY TRANSFER AND INDUSTRY LIAISON FOR KANSAS ECONOMIC DEVELOPMENT

A Report to the

KANSAS TECHNOLOGY ENTERPRISE CORPORATION

by

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March 1989

Report No. 161

ACKNOWLEDGEMENT

This research project was funded by the Kansas Technology Enterprise Corporation. The authors gratefully acknowledge the assistance of Dr. William G. Brundage, President of KTEC.

We would also like to thank the officials in Ohio, Iowa, Indiana, Virginia, and Pennsylvania who gave of their time and knowledge during our investigation of their state's programs. We are also grateful to the many Kansans who participated in this project. Administrators from all state Regents institutions, public community colleges, and Washburn University participated in the evaluation of the state's academic institutions. In addition, over 300 firms completed surveys that examined business needs. Many also provided valuable suggestions and insights through personal letters and conversations.

Special thanks go to Jan Beecham whose compilation of this report contributed greatly to its quality. We also wish to thank Steven Maynard-Moody, Larry Hoyle, Karen Ye, and Mary Brohammer for their assistance with the design and processing of the business surveys.

The views presented in this report are those of the authors and do not necessarily reflect those of any other individual or organization, or the University of Kansas.

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EXECUTIVE SUMMARY

In this era of rapid technological change and of revolutionary changes in the global marketplace, the survival of Kansas industry depends on its ability to innovate and adjust to its ever-changing environment. Since innovation depends upon the development of and access to existing and new technology, programs that provide technology transfer and technical assistance enhance firm innovation, gestation, competitiveness, and thus survival. This report offers a comprehensive model of technology transfer and higher education-private sector liaison for Kansas economic development. The model takes into account the nature and characteristics of Kansas industry, the capacity of Kansas higher education, the experience of other states with similar programs, and the state's economic development goals of business development, retention, and expansion.

THE TECHNOLOGY TRANSFER PROBLEM (Part II)

An examination of U.S. and Kansas economic performance indicates that while similar problems and challenges face, the state and the nation, the state's problems tend to be more severe (Part II, A). The key findings of the examination of the U.S. economic performance are:

1. The U.S. economy is characterized by rapid technological change, international competition, and increasing importance of small businesses and entrepreneurs as sources of jobs.

2. The U.S. trade imbalance indicates industry is not meeting the challenges of foreign competition despite recent improvements in productivity. High-technology manufactured product groups have done better in global markets than other manufacturing industries.

3. The U.S. innovation indicators (non-defense R&D spending, patents issued, number of scientists and engineers in the workforce) show that the ability to lead in innovation and improve productivity is challenged by other countries' gains.

The key findings of the examination of Kansas' economic performance are:

1. Although the Kansas economy has changed from an agricultural to a mixed one, growth in non-agricultural sectors has not kept up with employment needs.

2. Growth of the Kansas economy lags behind that of the U.S. Kansas ranks 36th in jobs created, 32nd in new companies formed, and 32nd in number of fast growth companies.

3. The state, as a whole, has not done well in attracting new, technologically based industry; so the state continues to depend upon a small set of industries.

4. The state ranks 38th in number of scientists and engineers in the workforce, does not have strong R&D traditions, and thus does not have a comparative advantage in technology based industry.

5. Kansas lags in nonagriculture export performance.

These findings clearly indicate that Kansas faces great challenges in revitalizing its economy. Kansas's industry has been facing these challenges and dealing with them despite geographic isolation, lack of international and even national exposure, and lack of access to technological innovations.

To assess how Kansas industry is faring in the state's difficult economic climate, surveys of Kansas manufacturers' and advanced technology firms' business and technological problems were conducted (Part II, B). Firms reported that they have difficulty in predicting technological changes, identifying technology appropriate for their needs, obtaining resources (technical, managerial, and financial) to implement technology. They also reported having difficulty developing new products, planning marketing strategy, finding qualified employees, and coping with government regulations. While firms indicated that they need assistance with technological and managerial problems, they frequently do not utilize academic institutions' resources. Perceived barriers that hamper utilization of academic institutions' resources include lack of familiarity with academic institutions, lack of expertise at institutions, faculty out of touch with business problems, and overall difficulty in making contacts.

Because Kansas has no federal research laboratories or private research institutions and because institutions of higher education are the sole sources of technology development and expertise within the state, the state's technology transfer and industry liaison program must be anchored in its universities and colleges. Current technology transfer activity at academic institutions is fragmented, uncoordinated and spotty, and not linked to other state initiatives such as the entrepreneurship of new business ventures. However, institutions are willing to explore and adopt mechanisms for constructive relations with industry, and have been moving in this direction over the past decade (Part II, C). Key findings include:

1. The state does not have abundant science and technology resources. Nevertheless, the research universities have sound academic programs in science and technology that could provide a foundation for productive technology transfer and liaison if appropriately linked and encouraged.

2. Existing technology transfer programs are for the most part reactive, fragmented, and limited in impact. There is an increasing willingness on the part of Kansas higher education to be involved, although there are significant barriers to involvement in applied research and technology transfer.

3. Management assistance related to technological innovation and development is presently limited. There is an increasing emphasis on production management, productivity, and quality that can be built upon for industry liaison.

4. Little scientific and technical information emanates from the state's higher education institutions to Kansas industry.

5. Schools of business at the research institutions have not had a focus on meeting the needs of small- and medium-sized firms and in technology related management, other than through the limited capabilities of their Small Business Development Centers. On the other hand, non-research institutions have substantially and productively expanded their involvement in general management assistance through their SBDCs and other mechanisms.

6. The science and engineering capacity of the 19 public community colleges in Kansas is restricted by resource and mission limitations. All the community colleges in the state have considerable business/management assistance capacities which are mainly small- and medium-sized business oriented.

TECHNOLOGY TRANSFER PROGRAMS IN OTHER STATES (Part III)

In 1988, 36 states had technology offices, 30 had some form of technical/managerial assistance programs, 29 had established technology/research programs, 25 were involved in technology transfer, and 15 were involved in information/networking programs. Over the last few years, states have focused on the expansion of technical/managerial assistance, technology transfer programs, and technology/research programs. To better understand how to design and implement a comprehensive state technological initiative, the programs of Indiana, Iowa, Virginia, Pennsylvania, and Ohio were examined in detail. This examination revealed:

1. Programs are shifting from university control to private, nonprofit organizations to improve economic impact.

2. Private sector majorities on governing boards guarantee that programs are responsive to business needs.

3. Programs cover basic research, technology transfer and development, and technology and business assistance.

4. Technology transfer and technology assistance is focused as much, or more, on existing industry as on new business formation.

5. Programs that are technically and fundamentally different are separated to allow each program to target particular markets and provide specific services and expertise for that market.

6. Successful programs are proactive and are networked with relevant resources and programs.

7. Programs with limited state restrictions and minimum formal structures encourage flexible market-driven organizations. Funding is used as the primary control mechanism.

8. State funding provides core support and the basis for extensive leveraging. Matching funds are required for program support.

The following major implications for a Kansas model can be derived from the study of approaches taken by other states:

1. Technology transfer and industry liaison occurs at three levels: **basic research** which generates new knowledge; **applied research and technology development** which relates to the commercial application and extension of state-of-the-art knowledge; and **technical assistance** which is the transfer of existing "off-the-shelf" technical knowledge.

2. The three technology dimensions listed above are best served by having separate mechanisms that focus on each level but that are coordinated and networked into a cohesive system.

3. A technology transfer and liaison program for economic development will only be successful if it is multilevel and market driven. Programs must either be based upon meaningful institution-private sector partnerships or be private-sector controlled. A grass roots, decentralized, partnership/consortium, bottom-up formulation of specific organizational arrangements, that respond to state determined program objectives and principles, seems to lead to more responsive, flexible and creative mechanisms.

4. State funds should be used to leverage private sector involvement, to ensure economic development objectives, to encourage creative

responses to need, and to ensure all regions of the state are served.

5. Academic institutions' capacity and expertise should be tapped only in those dimensions where their strengths lie and not in ways that distort or conflict with their basic mission.

6. Management-related expertise and assistance is extremely important and must be interwoven into the overall model. Conceptually, it parallels the technology dimensions.

PROPOSED TECHNOLOGY TRANSFER MODEL FOR KANSAS (Part IV)

The technology transfer model for Kansas has been based upon the nature of the need, the relevant characteristics of the state, and the key lessons that emerged from the experiences of other states. In addition to the Centers of Excellence which would focus on basic research with commercialization potential, it is recommended that the state support three Advanced Technology Centers to foster applied research and development and six Regional Technical Service Centers to provide technical assistance.

The Advanced Technology Centers (ATCs) would be composed of a partnership of industry and higher education anchored at the state's research universities (KU, KSU, WSU). The primary economic development goal would be to enhance new product and process development through technology development, applied research, and transfer of "state-of-the-art" technology. The generic tasks of the Centers would be to facilitate, link, leverage, and broker joint private sector-university advanced technology interrelations. Specific activities would include:

* arranging research and development on behalf of private firms;
* facilitating access of private firms to science and technology information and expertise, and developing university researchers' awareness of private sector research and development needs;
* facilitating problem identification and high level technical assistance to bring technological innovation to the marketplace;
* supporting technology-driven incubator development;
* facilitating assistance and support for technology-oriented entrepreneurship;
* fostering associated education and training programs.

Core funding for organization infrastructure would come from the state, through KTEC. Funding should also be provided through a "matching" requirement from private and other sources, with a clear expectation that Centers would leverage funding support from diverse sources. The Centers would be sponsored by private sector-university consortia and would be nonprofit corporations. The Board of Directors would have a private sector majority, including small business representation. Other than requiring that the program be market driven, the particular arrangement for each Center should largely be determined by the parties to that particular partnership in accordance with their circumstances and context. Although each Center would target development within specific fields of advanced science and technology, activities would not be restricted to those fields. Each Center would have a statewide mandate, making and accepting referrals to other Centers or programs whenever necessary.

Six Regional Technical Service Centers (RTSCs) would be geographically dispersed throughout the state. Each would be sponsored by a nonprofit consortia of regional interests, including business, colleges, universities, and economic development organizations. Their economic development goal would be the retention and expansion of Kansas industry, particularly small- and medium-size manufacturers and technology-oriented service firms. Regional Centers would help firms identify and solve production or other technical problems, improve production processes and product quality, and take advantage of advanced production techniques and technologies. Services would be provided by experienced in-house professional staffs on a fee basis and by networking a pool of specialized business and manufacturing consultants (both academic and nonacademic) to include:

* technical consulting;
* assistance in evaluating competitive ability and need;
* assistance in identifying and applying appropriate new technologies;
* development of assistance capabilities for selected technologies and regional industries;
* provision of information and data services through networking and links with research institutions;

* assistance in business, finance, and management through network and consulting services;

* provision of education and information regarding modern manufacturing techniques and concepts.

The state, through KTEC, would provide core funds to support the basic organization. Additional matching funds would be generated through regional industry sponsorship (as distinct from individual firm membership), fees for services, and other sources.

Other educational and support programs should be funded to respond to business needs. These include:

* Technical and resource information services and networking capacity (use libraries at universities to serve scientific, technical, and management information needs);

* Industrial associates program (increase industry and academic researchers' contact);

* Management development and productivity centers (focus on production quality, productivity, and competitiveness issues);

* Create mechanisms for industry to access university resources (e.g., computers, libraries, databases, testing instrumentation);

* Encourage faculty to commercialize research discoveries with incubator development and patent assistance.

Relative to other states' programs, this is a low cost model. Full year funding by the state for a minimum threshold programs would be about $M2.9 and apportioned as follows: three Advanced Technology Centers, $M0.9; six Regional Technical Service Centers, $M1.5; other educational support programs, $M0.5.

The proposed Kansas program will have these virtues. It is consistent with the state's development strategy of supporting internal business retention and formation, and focuses where the need is greatest, namely existing small- to medium-size firms and start-up firms. It is comprehensive since it is designed to respond to needs at all technology levels. Yet, through its multi-level approach, the research, development, and assistance programs respectively will have full opportunity for success. The program involves the higher education institutions, a key resource for the state, and does so at levels appropriate to their mission and capacities. The broadest possible private sector participation is encouraged through consortia sponsorship, matching, and private-public control to ensure a market-driven program. It is a relatively cheap, cost-effective, and action oriented program; the resources are commmited to "hands-on" activity, not "bricks and mortar," and it can be implemented quickly. It is a statewide program; any firm with a problem should be able to secure appropriate assistance from the networked system.

I. INTRODUCTION

"The objective of an economic strategy is to foster timely adaptation to change and transition. The harsh reality is that those industries that develop and apply new knowledge and technologies the most rapidly and efficiently will be the ones with the competitive edge. For Kansas, this will involve providing support for innovation and the application of science and technology to the existing economic base as well as building upon existing strengths to develop new industry. ....The central focus of any economic development policy must be the modernization and expansion of the state's economic base." (Redwood/Krider, Kansas Economic Development Study, 1986)

The Redwood/Krider report identified a number of significant barriers in Kansas that inhibit the development of modern technology-based enterprises, small business entrepreneurship and innovation, and the expeditious transfer of technology to Kansas industry. These included, in particular, inadequate R&D by small-size Kansas industry, insufficient links between Kansas business and university research, impediments in the state tax structure, and a lack of capital in general and seed/venture capital in particular.

In 1986 the Kansas legislature moved on two fronts to enhance existing industry competitiveness and new business formation. One set of legislative initiatives involved such measures as tax credits for R&D expenditure, tax credits for seed and venture capital pools, and programmatic activities through the Kansas Department of Commerce to support small business development, business retention, and entrepreneurship. The other initiative related to the establishment of a science and technology authority, KTEC, (K.S.A. 74-8102) for the purpose of

> "fostering innovation in existing and developing businesses, especially the creation, growth and expansion of Kansas enterprises in a diversified range of primary sectors, which develop value-added products, processes and services,"

The legislation defined four primary ways of achieving this purpose:

1. Financing basic research, applied research and development, and technology transfer at Kansas educational institutions that meet competitive standards of excellence as measured by national and international peers and that create collaboration between Kansas educational institutions and Kansas enterprises.
2. Awarding applied research matching grants to Kansas educational institutions and Kansas private enterprises in order to move innovation and applied research toward commercial application.
3. Engaging in seed capital financing for the development and implementation of innovations or new technologies for existing resources, technology-based and emerging Kansas businesses.
4. Providing technical referral services to small, new, emerging or mature businesses and encouraging Kansas educational institutions to establish technical information data bases and industrial liaison offices that are easily accessible by both private and public sector Kansas organizations.

KTEC has implemented programs for most elements of its mandate, including support for basic and applied research through Centers of

Excellence, applied matching research grants/SBIR matching grants, and research equipment acquisition, and a seed capital program for new technology driven firm start-ups. While these programs include elements of technology transfer and university-industry liaison, they are specifically and primarily geared to enhancing pockets of research excellence with commercialization potential and to supporting selected advanced technology start-ups with high potential. They do not constitute a systematic and comprehensive program of technology assistance to scattered small- to medium-sized Kansas industry, existing and forming; they were not designed to do so.

In the long run, the very survival of Kansas industry, in this era of rapid technological change and of revolutionary changes in the global marketplace, depends on its ability to innovate and adjust to its changing environment. The objective of a technology assistance program is to enhance firm innovation, gestation, and competitiveness, and hence survival through the development of, and access to, known and new technology.

The specific challenge to achieve this enhancement is to devise mechanisms that facilitate this transfer of knowledge and information from where it resides to where it is needed. A variety of such mechanisms have been implemented in other countries and states, with the common element being the utilization of the technological and related management resources and expertise that inherently resides in the higher education system.

The purpose of this study is to devise and recommend a comprehensive model of technology transfer and higher education-private sector liaison for Kansas that will link the particular capability of the state's higher education system in science and technology in an optimal manner with the particular needs of Kansas industry for technical and associated management support.

To develop a model that is appropriate for Kansas, research has been undertaken in two broad areas. First, we identify the salient characteristics of Kansas industry and higher education that must be recognized in formulating the model. With respect to Kansas industry, these include the vulnerability and sensitivity of Kansas firms to global competition and technological change, the importance and nature of manufacturing, particularly in rural areas, the small business structure of Kansas industry, and trends in net business formation. Mail questionnaire surveys were sent to both manufacturing and advanced technology firms to obtain industry input on their technology needs, the manner in which these needs are currently met, and their perceptions as to how that process might be enhanced through linkages with higher education. Concurrently, through interviews and the identification of indicators, a generalized assessment was made of the capacity and willingness of Kansas universities and colleges to undertake technology transfer, and the nature and effectiveness of existing liaison programs (Part II).

The second thrust involved extensive research of the approaches that had been undertaken elsewhere to enhance industry innovation and competitiveness through technology transfer and liaison. Most states, and indeed many other countries, have already implemented programs of this nature. Five states were selected for intensive on-site review because (i) their programs had already been in place for some time, (ii) they represent a diversity of approaches to technology transfer, (iii) they have tended to be the more successful, and (iv) because some similarities existed to the

Kansas situation. These were Indiana, Iowa, Ohio, Pennsylvania, and Virginia. Structured interviews and on-site visits to these programs were made to identify and evaluate factors that underpin successful higher education-industry linkages for technology development and assistance. This research provided key lessons for the formulation of a Kansas approach (Part III).

A model of technology transfer for Kansas that takes into account the nature and characteristics of Kansas industry, the capacity of Kansas higher education, and the experience of other states with similar programs, is proposed in Part IV of this report. The core of the program would be the formation of Advanced Technology Centers anchored at the three research oriented universities to broker technology development, and six Regional Technical Service Centers throughout the state to provide technical and related management assistance. The key factors are identified that underlie this model as being the best fit for Kansas and as having the potential to be the most effective in achieving the state's economic development goals of business development, retention and expansion.

II. THE TECHNOLOGY TRANSFER PROBLEM

Before a model of technology transfer and higher education-private sector liaison can be proposed for Kansas, the economic problems and challenges facing the state must be identified. The state's economy does not exist in isolation. It is part of a larger national and global economy; and the interrelationships of the three levels (global, national, state) need to be examined in order to fully appreciate the forces affecting the state's economic performance. The following section of this report examines the forces affecting the state's economic performance, then defines specific problems and needs of Kansas industry, and finally examines resources of the state's academic institutions that are or could be used to attack the problems.

A. U.S. and Kansas Economic Performance

1. Global Markets and U.S. Productivity

World trade has expanded enormously in the past two decades, resulting in the unavoidable reality of a global marketplace. One measure of the existence of a global marketplace is economic interdependence of countries. Economic interdependence can be measured by the relationship of imports to GNP (Table 1). The number of nations with large numbers of imports illustrates that countries buy and sell products with great frequency. This exchange of products creates a marketplace that includes all countries and affects all economies by expanding competition from domestic to world-wide sources.

Table 1
Economic Interdependence as Measured by the Percentage of Imports to GNP, 1980

Industrial Nations:	Population (millions)	**% Imports to GNP**
U.S.	221	9
Japan	116	11
West Germany	61	21
Italy	57	24
United Kingdom	56	26
France	53	17
Sweden	8	29
Switzerland	6	28
Norway	4	31
Developing Nations:		
India	651	7
Brazil	119	9
Pakistan	79	19
Philippines	48	23
Egypt	41	26
Korea	38	33
Malaysia	13	40
Malawi	6	34
Honduras	4	40

Source: Dominick Salvatore, "International Economics"

The U.S. economy and U.S. industry has not fared well in the face of increased global competition. U.S. exports grew fivefold between 1970 and 1984, while world trade grew sevenfold. Fifteen to twenty percent of U.S. industrial production is exported. While only a small portion is exported, most U.S. products face stiff competition for domestic markets from foreign manufactured products. Seventy percent of U.S. production competes with foreign products. The U.S. has lost market share in most industries (Redwood & Harnish, 1988). In six of the last 12 years, the U.S. has imported more than it has exported, creating a negative trade balance (Table 2).

Table 2
U.S. Imports/Exports
(In millons of dollars)

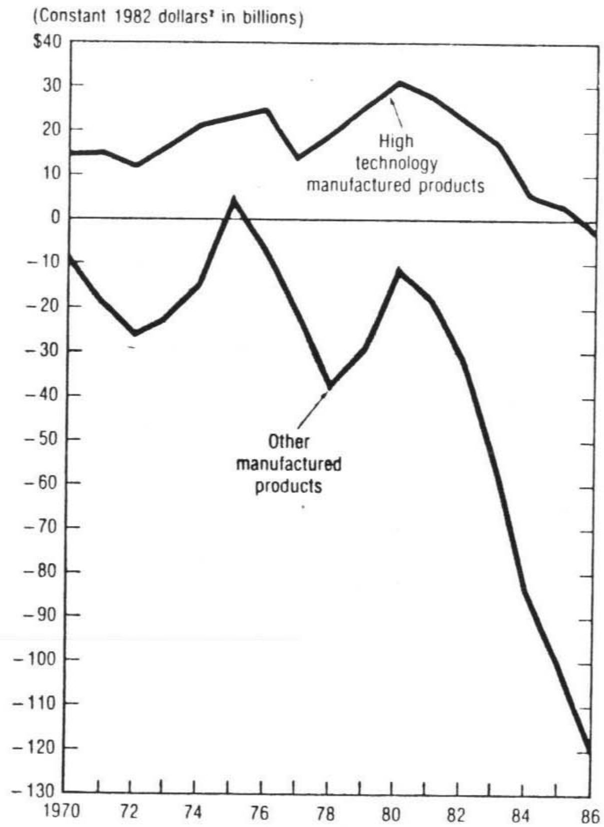
	Exports of Goods and Services	**Imports of Goods and Services**	**Trade Balance**
1970	65,674	59,901	5,773
1975	155,729	132,745	22,984
1977	184,276	193,764	<9,488>
1978	219,994	229,869	<9,875>
1979	286,796	281,659	5,137
1980	342,485	333,020	9,465
1981	376,499	362,155	14,344
1982	349,570	349,292	278
1983	334,422	371,188	<36,766>
1984	360,778	455,612	<94,834>
1985	359,458	460,550	<101,092>
1986	372,807	498,501	<125,694>

Source: U:S. Statistical Abstract, 1988.

The trade imbalance is an indication that U.S. industry has not been meeting the challenges of foreign competition. Figure 1 shows that U.S. trade in high-technology manufactured products declined over the past several years and became negative for the first time in 1986. The trade balance for other manufactured products has also had a negative balance and continues to decline.

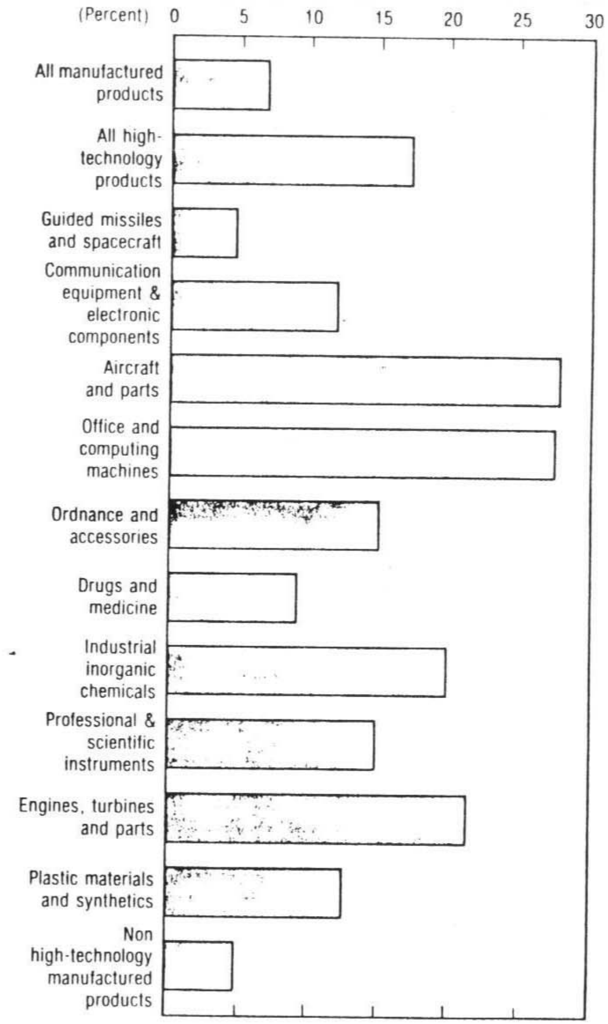
While only 5 percent of lower-technology manufactured products were exported, more than 16 percent of U.S. high-technology products were exported (Figure 2). Several industries export 20% or more of their total shipments (e.g., aircraft and parts, office and computing machines, industrial inorganic chemicals, engines, turbines, and parts).

Figure 1
U.S. Trade balance in high-technology and other manufactured product groups



¹Exports less imports
²GNP implicit price deflators used to convert current dollars to constant 1982 dollars

Figure 2
U.S. exports as a percent of shipments, high-technology products, 1985



Source: Science & Engineering Indicators - 1987

U.S. productivity is below that of many of the world's industrialized nations for much of the 1960s, 1970s, and 1980s (Table 3). For 1986, however, the U.S. figures for productivity showed a 3.5% growth rate, which was the highest in the world and was the first time in 27 years the U.S. had received the highest ranking.

Table 3
International Productivity Growth

Country	Average Annual Change 1960-1987	Average Annual Change 1979-1987
United States	2.8%	3.3%
United Kingdom	3.7	4.7
Germany	4.4	2.3
France	5.0	3.0
Japan	7.7	5.1

Source: Neef & Thomas. 1989. Monthly Labor Review.

Although productivity improved in 1986, the impact of the previous decades of decline are still affecting competition. For example, Table 4 shows that important variables contributing to productivity, such as plant investments, quality control, process development, and technological innovation, are still unfavorable for the U.S.

Table 4
U.S. vs. Japan: Manufacturing Comparison

	U.S.	Japan
Private investment in Plant & Equipment (% of GNP):	10.2%	17.0%
Average Age of Industrial Base:	17 yrs.	10 yrs.
Average Annual Hours/Worker:	1,898	2,152
Time Between Orders & Shipments for Machine Tools:	5-6 mos.	1-2 mos.
Rework Rate in Electronics	8-10%	0.5-1%

Source: Department of Defense, 1987

The U.S. economy is changing in response to these powerful global forces. As manufacturing and agriculture are affected by international markets, they are declining vis-a-vis the increasing importance of service industries (Table 5). In addition, the types of products manufactured are changing from traditional products to more innovative technology-based goods (Table 6).

Table 5
U.S. Employment by Sector: 1960-86

Sector	1960	1970	1980	1984	1986
Manufacturing	25.54%	24.62%	20.43%	18.49%	19.13%
Service	11.22	14.68	19.13	19.77	31.33
Agriculture	8.30	4.40	3.39	3.16	2.89

Source: Statistical Abstract, U.S. Bureau of the Census, 1988.

Table 6
Manufacturing Employment by Products
(percent)

Product Manufactured	1959	1983
Basic Materials	25.6%	18.0%
Midrange Goods	40.8	36.6
Highly Innovative Products	33.6	45.4

Source: Birch. 1987. Inc.

The change to more innovative, technology-based goods means that U.S. industry must not only update products but must do it faster. For example, Japanese manufacturers can bring a new product to market faster than U.S. manufacturers, largely because of process efficiencies and technological advantage. Utilizing the latest technology not only creates better products but also creates marketing appeal that is generated by offering "state of the art" products (Bussey & Sease, 1988).

Creating state of the art products means that U.S. manufacturing today is changing dramatically from the "old style" traditional mass production to a "new style" of innovative, human capital intensive production:

> "We have, in essence, gone to our strength: innovation. We are making more and more of the kinds of things that require high levels of innovation - such as instrumentation and fabricated metal products - and have relinquished to others the production of items that have not changed a great deal in the past 20 years:

> automobiles, television sets, shoes, clothing, and paper... The whole point...to substitute brains for brawn... We will produce different products in different ways with an increasingly skilled labor force (Birch, 1987).

This trend toward new style production methods is one reason small companies are emerging as a source of growth and jobs and are responsible for fewer layoffs than larger firms (Table 7).

Table 7
Creation and Destruction of Jobs, 1981-1985

	Size of Company (employees)			
	0-19	20-99	100-499	500+
Jobs Created	33%	24%	16%	27%
Jobs Destroyed	14	22	22	42

Source: Birch. 1988. Inc.

While U.S. manufacturing in general has recently become more innovative, rural manufacturing is often characterized by traditional production methods that produce standardized products with jobs that tend to be low-wage, low-skill and repetitive. These traditional-style manufacturers are not competitive, so plants have closed and workers have lost their jobs as a result of rural manufacturing's inability to make the transition to new products and processes. For the nonmetropolitan U.S., the impact of the change from traditional to innovative manufacturing can be measured through the following:

> **Population:** Rural population growth is much lower than urban areas, with nearly half of the U.S. rural counties losing population between 1983 and 1985.
>
> **Income:** The ratio of nonmetropolitan to metropolitan county per capita income has fallen from 78% in 1973 to 75% in 1984.
>
> **Education:** The education gap between metropolitan and nonmetropolitan counties has also widened, particularly in relation to postsecondary schooling (Table 8). In 1980, for example, 10.3% more metropolitan county residents than nonmetropolitan county residents had completed 12 or more years of school.

Table 8
Educational Level of Population 25 years & Over
by Metro and Nonmetro Counties

Years of School Completed	METRO % Completing	NONMETRO % Completing	Metro-Nonmetro	Nonmetro/Metro
1980:				
12 years or more	68.9%	58.6%	10.3%	0.85%
16 years or more	17.9	10.9	7.0	0.61
1970:				
12 years or more	55.0	44.8	10.2	0.81
16 years or more	11.8	7.3	4.5	0.62
1960:				
12 years or more	43.5	34.4	9.1	0.79
16 years or more	8.6	5.3	3.3	0.62

Source: State & Metropolitan Area Data Book 1979, 1986. U.S. Department of Commerce, Bureau of the Census.

Employment: Employment is becoming a persistent problem for many rural regions. Urban employment has increased significantly since 1973, while rural employment has experienced a net decline (Table 9).

Table 9
Employment of the Metro/Nonmetro Labor Force
(numbers in thousands)

	1973	1980	1987
U.S.	84,406	97,270	112,440
Metro	58,369	67,120	89,138
Nonmetro	26,037	30,150	23,302

Source: Employment and Earnings, U.S. Department of Labor.

To summarize, U.S. manufacturing has become more innovation driven. That innovation depends upon technology and entrepreneurship. It thrives in the small business context. Rural manufacturing lags in the transition to more innovative approaches.

2. Measures of Technology Innovation

Slippage in international competition for markets is related in one way or another to technology. A recent study finds that:

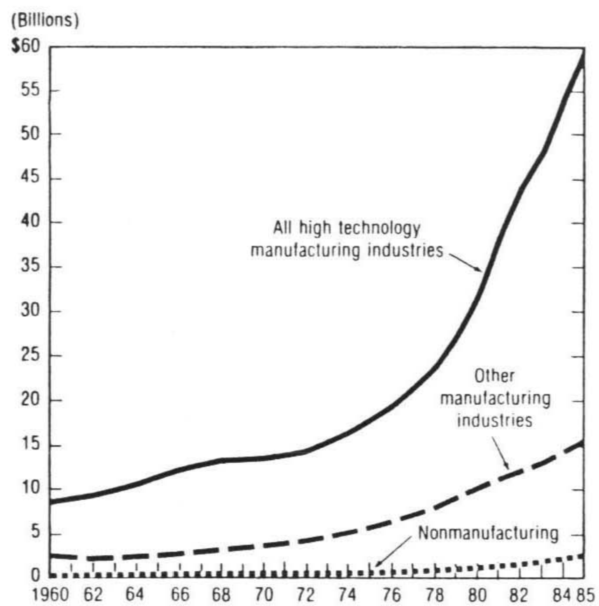
"in today's climate of rising trade competition, improved technology is increasingly important for the U.S. to compete with foreign countries. By adding new technology slowly, the nation's manufacturers will lose ground to foreign concerns and contribute to unemployment. The alternative to rapid rates of technological change is stagnation in U.S. wages and employment. Higher productivity growth, which is supported by technological change, is essential to the maintenance of higher real earnings and the preservation of U.S. jobs" (Karr, 1987).

Relating technology to international competition for markets leads to an examination of variables that are regarded as measures of technology innovation capacity. Knowledge and information are regarded as decisive factors in the growth of productivity, making R&D funding, number of scientists and engineers graduating and in the workforce, and patent applications are key measures of a nation's ability to innovate and compete (Johnson, 1984).

The status of research and development is one basis of economic growth, since the amount spent on R&D can be linked to worldwide competitive advantage. Comparison of R&D expenditures by industry groups (Figure 3) shows that high technology manufacturing industries increased R&D expenditures faster than other manufacturing industries. Since these R&D-intensive high technology manufactured product groups have had steady growth and positive trade balances and non-R&D-intensive manufactured product groups have had negative trade balances (see Figure 1 above), R&D efforts play a role in the competition for global markets.

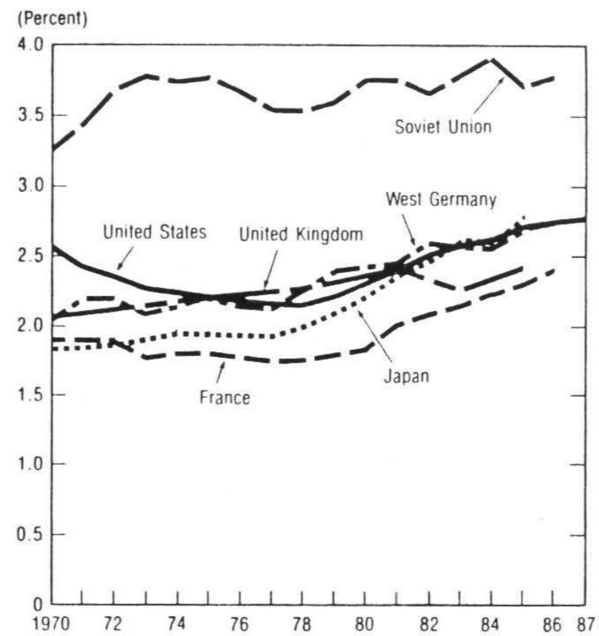
The level of R&D funding in the U.S. has grown steadily over the past few years and is remaining competitive with other countries (Figure 4). However, defense-related R&D has been responsible for that increase. A declining or stagnant trend is apparent when non-defense R&D expenditures are compared. U.S. non-defense R&D spending compares less favorably with

Figure 3
R&D expenditures, by industry group



Note: Data include Federally Funded Research and Development Centers administered by industry.

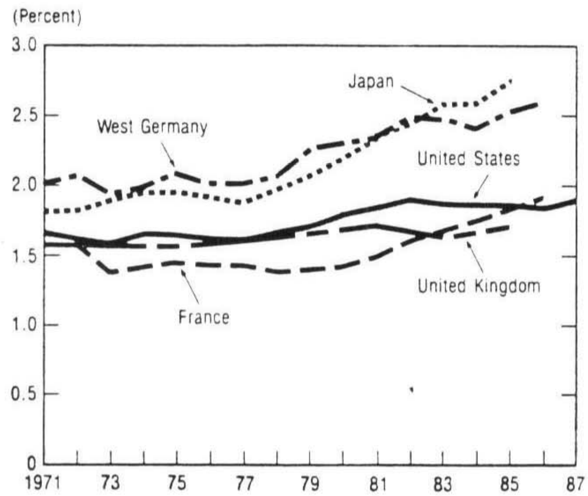
Figure 4
R&D expenditures as a percent of GNP, by country



Source: Science & Engineering Indicators - 1987

other countries (Figure 5), underscoring the pressure U.S. industry feels from foreign innovators.

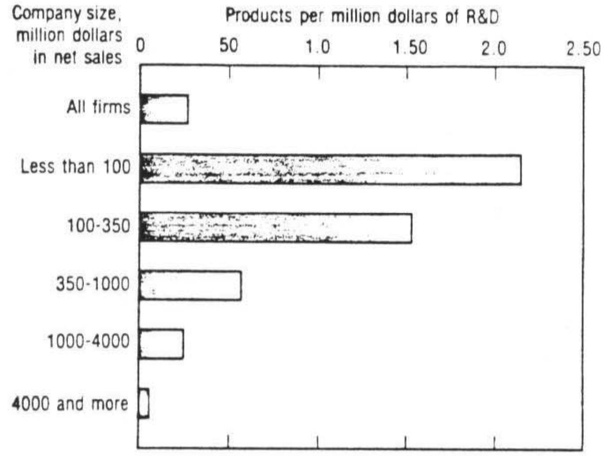
Figure 5
Non-defense R&D expenditures as a percent of GNP, by country



Source: Science & Engineering Indicators - 1987

In the U.S., large corporations perform the bulk of industrial R&D and produce most of the high technology products. However, small high-technology firms introduce an especially large proportion of new high-technology products in relation to their R&D expenditures (Figure 6). This underscores the increasing importance of small technology-driven businesses and entrepreneurs in the U.S. economy.

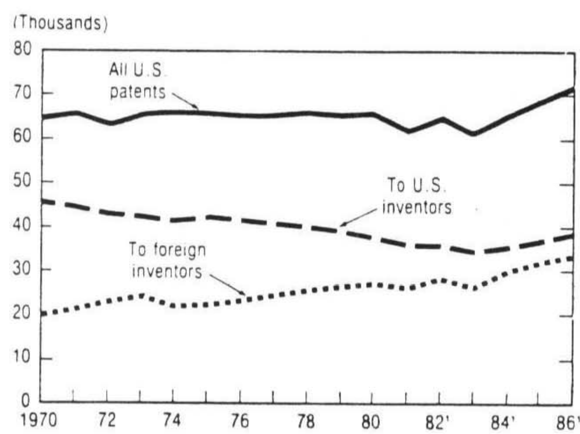
Figure 6
New products introduced in 1985, per million dollars of R&D



Source: Science & Engineering Indicators - 1987

The pressure U.S. industry experiences in the innovation race is also reflected in the number of U.S. patents granted. The number granted to foreign inventors is rising, while the number granted to U.S. inventors is falling (Figure 7).

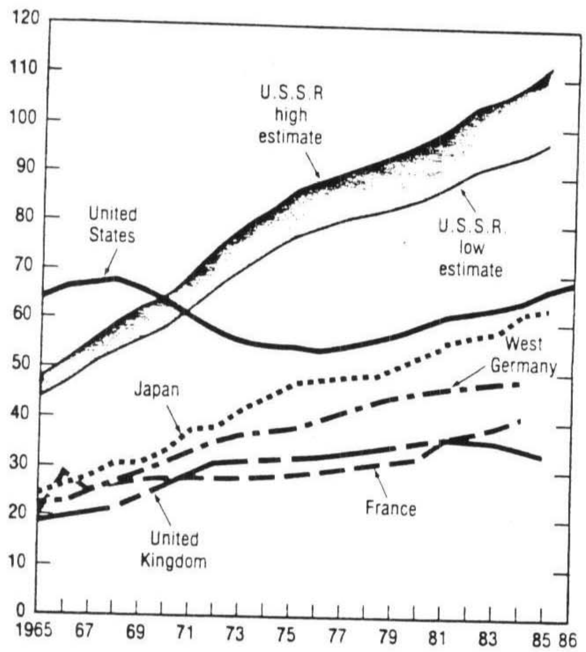
Figure 7
U.S. patents granted, by nationality of inventor and date of application



Source: Science & Engineering Indicators - 1987

Comparisons of scientists and engineers in the labor force shows the U.S. has an advantage over other countries (Figure 8). Compared with other countries, the number of scientists and engineers per 10,000 labor force population engaged in R&D in the U.S. has been growing in recent years but at a slower rate than Japan. In 1985, Japan's ratio of 63.2 was very close to that of the U.S. ratio of 67.4.

Figure 8
Scientists and engineers engaged in R&D per 10,000 labor force population



Source: Science & Engineering Indicators - 1987

As a result of challenges stemming from foreign competition in worldwide markets and from the accelerating pace of technological change, a new U.S. economy has emerged (Table 10). That economy is characterized by a shift from slow to rapid technological change, a shift from limited foreign competition to global competition, and increasing importance of small business and entrepreneurs as job sources. Using technological advances to introduce flexibility needed to "customize" products for global marketing will enable U.S. industry to improve its position in the international marketplace. These technological advances will come from scientists, engineers, and entrepreneurs who are engaged in research and development activities.

Table 10
Forces of Economic Change
Traditional vs. Emerging U.S. Economies

Prior Economy	New Economy
-Slow technological change	-Rapid technological change
-Limited foreign competition	-Internationalization of the economy
-Large corporations prevalent	-Increasing importance of small businesses and entrepreneurs as sources of jobs

Source: SRI Indicators of Economic Capacity. 1986.

3. Kansas Economic Performance and Productivity

Given the obvious major challenge that the U.S. economy faces, the question becomes how is the economy of Kansas, a rural state, performing. The Kansas economy is characterized by the following:

-small business dominance;

-reliance on manufacturing, particularly in non-metro areas;

-dual metro/nonmetro economies, with weak performance in nonmetro areas relative to metropolitan areas;

-underrepresentation of growth industries (Redwood & Krider, 1986; Redwood & Albrecht, 1986; McLean, 1984);

-chronic underperformance this decade when compared with the national average;

-weak export performance (Redwood & Harnish, 1988).

The structure of the Kansas economy has changed from a predominantly agricultural to a mixed economy. As was true at the national level, farm employment in Kansas has been decreasing steadily since 1950 (Table 11).

Table 11
Kansas Farm vs. Total Employment, 1950-85

	Farm Employment	Total Employment	Percentage Farm
1950	160,427	707,401	22.7
1960	101,462	783,877	12.9
1970	68,251	852,313	8.0
1980	69,290	1,078,741	5.8
1985	57,100	1,187,000	4.8

*Included are farm managers, laborers, foremen.
Source: Census of Population 1960, 1970, 1980.

The state employment trend has been one of transition out of farming to other forms of economic activity, so that farming currently produces about 8% of the state product and manufacturing about 20% (Redwood & Krider, 1986). Table 12 shows that there has been a decrease in farm employment, moderate increase in manufacturing employment, and a larger increase in the service sector since 1960.

Table 12
Composition of Kansas Employment by Sector, 1960-88

	1960	1970	1980	1985	1988
Farm	14.80%	9.39%	5.65%	n/a	n/a
Manufacturing	14.00	15.19	16.83	17.87	17.79
Service	8.45	11.64	14.73	19.16	20.24
Government	13.89	17.45	16.56	19.53	19.94
Trade	15.73	18.00	20.00	25.15	25.50
Construction	4.09	3.62	4.11	4.50	3.63
Mining	2.05	1.24	1.43	1.71	1.17
Other	26.98	23.46	20.69	12.08	n/a

Source: Employment and Earnings, U.S. Dept. of Labor, March and May, 1986; March, 1988.

The increases in employment in manufacturing and service sectors have not kept Kansas comparable to U.S. employment trends. Table 13 shows that from 1978 through 1986, employment gains in Kansas were less than that of the U.S. as a whole. Nonmetropolitan areas lost employment between 1978 and 1983 but showed gains below national averages from 1983 to 1986.

Metropolitan areas gained at a rate closer to the national average between 1978 and 1983 and gained well above national averages from 1983 to 1986.

Table 13
1978-86 Employment: U.S., Kansas, Metro/Nonmetro

	1978	1983	1986	% CHANGE 1978-1983	% CHANGE 1983-1986
U.S.	70,352,443	72,971,318	83,380,465	3.7%	14.26%
Kansas	705,128	713,931	802,794	1.2	12.45
Metro Areas	409,310	421,646	503,873	3.0	19.50
Nonmetro Areas	295,818	292,285	298,921	-1.2	2.27

Source: County Business Patterns, U.S. Dept. of Commerce, 1983 & 1988.

Looking at trends by industry between 1988 and 1985 (Table 14), non-metropolitan areas showed slight gains and metropolitan areas, such as Johnson County showed gains above the national average. The state as a whole averaged below national levels. Between 1980 and 1985, service industries in Kansas metropolitan areas exceeded national averages and showed the strongest gains. Business services also showed above average growth for the state and exceptional growth in Johnson County. All other sectors showed below average growth for the state and above average growth for Johnson County.

Table 14
Regional and National Employment Growth, 1980-85

Industry	Period	Johnson County	Kansas	United States
Manufacturing	1980-85	5.0%	-10.06%	- 8.18%
Wholesale Trade	1980-85	30.33	.04	7.93
Retail Trade	1980-85	21.45	6.59	11.99
Services	1980-85	69.20	17.04	25.35
Business Services	1980-85	113.76	56.98	42.83

Sources: U.S. Department of Commerce, Bureau of the Census, "County Business Patterns, Kansas." Washington, DC: U.S. Government Printing Office, 1970-1985.

The employment increases in manufacturing and service sectors have not been adequate to provide sufficient jobs for both natural labor force growth and for displaced farm labor. For example, Table 15 shows that employment in manufacturing and many other sectors has grown slower than would have occurred if Kansas employment growth had been the same as U.S. growth for these sectors. The negative employment trends shown in Table 15 illustrate the slow growth rate in Kansas relative to the U.S. and that this pattern is spread over many sectors.

Table 15
Estimate of Employment "Lost" in Kansas, 1981 - 1987

	Kansas Actual Employment (thousands) 1981	1987	Projected Employment (thousands) 1987	Actual minus Projected (thousands)
TOTAL EMPLOYMENT	1,293.1	1,405.8	1,476.9	-71.2
Mining	34.2	30.5	24.6	5.9
Construction	62.0	71.4	77.7	-6.3
Manufacturing	193.2	180.6	183.1	-2.5
Nondurable Goods	72.1	75.7	70.3	5.4
Food and Kindred Products	24.1	27.8	23.3	4.5
Apparel and other Textile Products	3.6	3.5	3.3	0.2
Paper and Allied Products	3.5	4.0	3.5	0.5
Printing and Publishing	18.9	20.2	22.4	-2.2
Chemicals and Allied Products	9.3	8.4	8.6	-0.2
Petroleum and Coal Products	5.2	2.9	4.0	-1.1
Rubber and Misc. Plastics Products	7.1	8.2	8.0	0.2
Other Nondurables Manufacturing	0.3	0.7	0.2	0.5
Durable Goods	121.1	104.8	112.5	-7.7
Lumber and Wood Products	4.0	4.3	4.5	-0.2
Furniture and Fixtures	1.8	1.4	2.0	-0.6
Primary Metal Industries	3.8	2.9	2.5	0.4
Fabricated Metal Products	12.9	11.1	11.4	-0.3
Machinery, Except Electrical	24.1	18.5	19.5	-1.0
Electric and Electronic Equipment	10.6	9.1	10.5	-1.4
Transportation Equip. Excl. Motor Vehicles	45.0	38.8	48.2	-9.4
Motor Vehicles and Equipment	5.7	6.5	6.1	0.4
Stone, Clay, and Glass Products	7.6	6.9	7.3	-0.3
Instruments and Related Products	3.6	3.1	3.4	-0.4
Miscellaneous Manufacturing Industries	2.1	2.1	2.0	0.1
Transportation and Public Utilities	72.6	73.4	78.0	-4.6
Wholesale Trade	69.4	70.7	74.8	-4.1
Retail Trade	199.6	216.8	235.1	-18.3
Finance, Insurance, and Real Estate	79.0	97.5	102.1	-4.6
Services	250.7	312.7	335.2	-22.5
Government and Government Enterprises	227.4	252.0	244.1	7.9
Federal, Civilian	25.3	28.7	26.8	1.9
State and Local	161.0	171.0	172.0	-1.0

Projected employment gives the amount of employment which would have occurred in Kansas if employment in each industry had grown at the corresponding U.S. growth rate for the industry.
Source: Calculated from data provided by the Bureau of Economic Analysis, U.S. Department of Commerce, Table SA-25, diskette, 1988.

The impact that negative economic trends has on state population is modest growth, decline in relative size, continuation of the "brain drain," and aging. In addition, the growth of the service sector, both for Kansas and for the U.S. is changing the way we work. According to the Hudson Institute study:

> "Service jobs tend to be located where and when the customer wants them, rather than centralized as in manufacturing. This will mean fewer people at each place of work. In addition, wages will become less equally distributed, since service jobs tend to have more high and low earners and fewer in the middle."

These factors contribute to further redistribution from rural to urban areas (Redwood & Krider, 1986).

Another indicator of relatively sluggish economic performance is that the rate of business formation in Kansas in recent years has been below the national rate (Table 16). Nationally, Kansas ranks thirty-sixth in new jobs created, thirty-second in new companies, and thirty-second in fast growth companies (Hyatt, 1988).

Table 16
Growth in Major Industrial Groupings for Kansas and the United States, 1983-86 by Number of Establishments

Industry	Percent Change by # of Establishments: Kansas	U.S.	Difference KS-US
Total	3.51%	9.42%	-5.91%
Ag Services, Forestry, Fish	4.89	15.25	-10.36
Mining	-6.33	-5.39	0.94
Contract Construction	-2.21	10.19	-12.40
Manufacturing	-0.22	1.81	-2.03
Transp & other Pub Utilities	-5.57	8.77	-14.34
Wholesale Trade	-3.85	1.82	-5.67
Retail Trade	-4.61	1.81	-6.42
Finance, Insurance, Real Est	0.73	7.33	-6.60
Services	10.87	13.64	-2.77
Nonclassifiable Establishmts	62.41	44.70	17.71

Source: Calculated from County Business Patterns, 1984 & 1986 for Kansas and the U.S., Table 1A.

The state has not been attractive to new, technologically based industry to the extent necessary to establish a strong economic base for the years ahead. Table 17 shows that between 1980 and 1986, rates of growth of advanced technology establishments in Kansas lagged significantly behind that of the U.S., even though the rate of growth experienced in metropolitan Johnson County exceeded the national average.

Table 17
Rates of Growth of Advanced Technology Establishments by Sector 1980-1986

	U.S.	Kansas	Johnson County
Mining	23.09%	13.97%	114.29%
Manufacturing	10.51	9.19	33.33
Transportation & Communications	16.03	13.36	24.14
Services	55.77	50.38	100.43
Tech-Driven Industries: TOTAL	34.29	24.10	75.06
All Industries: TOTAL	27.80	18.09	53.71

Source: County Business Patterns 1980 and 1986, Department of Commerce

In comparison with other states, Kansas ranks **twenty-third** in entrepreneurial energy, as measured by number of new companies per 10,000 companies, and **thirty-sixth** in percentage of companies classified as high growth (Corporation for Enterprise Development, 1988). In number of scientists and engineers per 1,000 workers, Kansas ranks **thirty-eighth**. It ranks **thirty-seventh** in university and federal R&D per capita. These measures are important because technology-based industry requires highly skilled workers, excellent R&D programs, and financial institutions willing to back high-risk ventures, in addition to basic infrastructure and amenity resources. Because Kansas ranks low in technological resources, financial resources, and infrastructure, its ability to attract advanced technology firms is restricted. (Table 18).

Table 18
C.E.D. - Business Capacity Report Card

SUBINDEX	KANSAS RANK	(GRADE)
Human Resources	12	(B)
Measures:		
High School Graduation		
Adult Illiteracy		
College Education Attainment		
Technological Resources	36	(D)
Measures:		
Scientists & Engineers in the workforce		
Science & Engineering Doctoral Students		
Patents Issued		
University Research & Development		
Federal Research & Development		
Financial Resources	33	(C)
Measures:		
Bank Deposits		
Loans to Equity		
Commercial & Industrial Loans		
Venture Capital Investments		
Dividends, Interest, & Rent Income		
Infrastructure & Amenity Resources	39	(D)
Measures:		
Highway/Bridge Condition		
Sewage Treatment Needs		
Housing Cost		
Doctor Availability		
Foundation Grant Funds Distribution		
Tourism Spending		
OVERALL	33	(C)

Source: Corporation for Enterprise Development, Making the Grade: The 1988 Development Report Card for the States, (April), 1988.

Because Kansas has not been attractive to new technology-based industry, the state's economy is still highly dependent on a small set of industries, particularly wheat, beef, food and meat processing, oil and gas, and aviation. Continued reliance on them alone will reinforce negative trends in the state's economic base. In fact, the survey conducted as part of this project found that Kansas manufacturers in nonmetropolitan areas were more likely to report a decrease in sales (Table 19), indicating that negative trends continue.

Table 19
Sales Trends Over Past Five Years

Trend	Percentage of Manufacturers: Metropolitan	Nonmetropolitan
Increase	30.7%	38.6%
Decrease	4.6%	15.0%
No Change	0	9.2%
Other	1.3%	.7%

Source: IPPBR Survey, 1988.

In addition to its difficulty in attracting or gestating new technology-based industry, several characteristics of Kansas and its economy contribute to a below-average ranking in exports: geographic isolation, comparative lack of international exposure in both education and daily life, an economy dominated by small, rural oriented businesses and industry (Redwood & Harnish, 1988). Between 1980 and 1984, the proportion of goods manufactured in Kansas that were exported abroad fell from 10.2% to 8.6%, lowering Kansas's export ranking in the U.S. from 41st to 45th. Table 20 shows Kansas manufacturers' exports were below the national average. However, half of the industries listed in Table 20 exported a larger proportion than the nation. The export issue is directly tied to losses in employment discussed above. Between 1980 to 1984, total employment in Kansas related to manufactured exports decreased by 8,100 and the percentage of jobs related to manufactured exports fell from 4.1% to 3.3% (Redwood & Harnish, 1988).

Preliminary 1987 statistics indicate that Kansas ranks 12th in total exports per capita among the states and 6th in total agriculture exports. The state ranks 27th however with respect to manufacturing exports per capita and 31st overall. This ranking, with respect to manufacturing exports, is likely to be understated because state export values are based on shippers export documents, so that for example commercial aircraft partly manufactured in Kansas would nevertheless be attributed wholey to the state of Washington in the published statistics. Clearly exports are important to Kansas, though there is a need for more manufacturing exports.

Table 20
Percent of Manufactured Goods Exported, 1984

SIC	Industry	Kansas	U.S.	Kansas Less U.S.
	Manufacturing	8.6%	11.9%	- 3.3%
20	Food & Kindred Products	6.9	4.8	2.1
23	Apparel & Other Textiles	0.9	3.0	- 2.1
24	Lumber & Wood Products	1.1	8.3	- 7.2
25	Furniture & Fixtures	8.1	2.7	5.4
26	Paper & Allied Products	11.1	10.6	0.5
27	Printing & Publishing	3.1	4.2	- 1.1
28	Chemicals & Allied Products	7.4	16.6	- 9.2
29	Petroleum & Coal Products	6.4	7.8	- 1.4
30	Rubber & Misc. Plastics	13.9	11.7	2.2
32	Stone, Clay & Glass	10.2	7.2	3.0
33	Primary Metal Industries	5.7	19.5	-13.8
34	Fabricated Metal Products	20.0	11.6	8.4
35	Non-electrical Machinery	8.2	21.5	-13.3
36	Electronic Equipment	25.2	18.2	7.0
37	Transportation Equipment	14.3	12.8	1.5
38	Instruments	7.3	15.4	- 8.1
39	Miscellaneous Manufacturing	11.0	7.4	3.6

*Positive numbers indicate that Kansas exported a higher percentage of shipments than the U.S. industry. Negative numbers indicate that Kansas exported a lower percentage of shipments than the U.S. industry.

Source: Bureau of the Census, 1984 Annual Survey of Manufactures: Origin of Exports of Manufactured Products, August 1987.

Table 21 shows that while manufacturing employment decreased from 1980 to 1984, nonmanufacturing employment related to manufactured exports grew substantially (Redwood & Harnish, 1988). These data show that exports create jobs.

Table 21
Kansas Employment Related to Manufactured Exports
(in thousands)

	1980	1984
Manufacturing	23.0	16.9
Nonmanufacturing	23.5	21.5
Trade	8.2	11.2
Business Services,	5.4	1.5
Transportation, Communication & Utilities	2.8	2.0
Other (including mining & agriculture)	7.1	6.8
Total	46.5	38.4

Source: Bureau of the Census. 1986. Annual Survey of Manufacturers: Origin of Exports of Manufactured Products.

To summarize, several key points can be made regarding Kansas economic performance. Kansas exports at rates below the national average. Since the U.S. as a whole is not performing well in the export area, performing below the national average means the state has an even bigger problem than the nation in competing for global markets. The export problem is tied to the state's difficulty in developing advanced technology businesses, who as a group compete better in global markets. While the state's performance in attracting advanced technology businesses is poor, metropolitan areas within the state are doing better than the state as a whole.

Increasing the number of advanced technology businesses in the state is only one part of the challenge. Kansas must also foster innovation and entrepreneurship in its existing industry by improving the transfer of technology from research labs to industry and increasing technical assistance for modernization of existing industry. Modernization and innovation within existing industry could improve their ability to compete in global markets and increase exports. Export increases are important because the state is losing jobs due to its poor export performance of industry and its low growth of advanced technology businesses.

4. Conclusions

An examination of the U.S. and Kansas economic performance indicates that while similar problems and challenges face the state and the nation, the state's problems are more severe and its ability to cope with those problems thus far have not been very successful. The key findings of the examination of the U.S economic performance are:

1. The U.S. economy is characterized by rapid technological change, international competition, and increasing importance of small businesses and entrepreneurs as sources of jobs.

2. The U.S. trade imbalance indicates industry is not meeting the challenges of foreign competition despite recent improvements in productivity. High-technology manufactured product groups have done better in global markets than other manufacturing industries.

3. The U.S. innovation indicators (non-defense R&D spending, patents, scientists and engineers in the workforce) show that the ability to lead in innovation and improve productivity is challenged by other countries' gains in innovation indicators.

The key findings of the examination of Kansas' economic performance are:

1. The Kansas economy has changed from predominantly agricultural to a mixed economy. Growth in nonagricultural sectors has not kept up with employment needs.

2. The growth of the Kansas economy lags behind that of the U.S. In 1988, the state ranked 36th in new jobs created, 32nd in new companies formed, and 32nd in number of fast growth companies.

3. The state, as a whole, has not done well in attracting new, technologically based industry, so the state is dependent on a small set of industries.

4. In 1988, the state ranked 38th in number of scientists and engineers in the workforce and does not have strong R&D traditions, so it does not have a natural comparative advantage in technology-based industry.

5. In 1987, Kansas manufacturers ranked 31st in exports, and 27th per capita.

These findings show that Kansas faces great challenges in revitalizing its economy. Kansas's industry has been facing these challenges and dealing with them despite geographic isolation, lack of international and even national exposure, and lack of access to technological innovations. The degree to which Kansas industries have identified and sought solutions to their problems was assessed.

B. Survey of Kansas Firms

Advanced technology or technology driven firms differ from other types of firms in that they typically rely upon people with technical skills (even for entry-level positions), conduct research, employ more engineers and scientists, incorporate newer technology, have faster growth, and are more competitive in the international marketplace (Pennsylvania Department of Commerce, 1985).

To gain a better understanding of the technology transfer problem in Kansas industry, two surveys of Kansas firms were undertaken in November-December, 1988 (the instruments are in Appendix A). One was sent to a sample of 640 of the state's 3,168 manufacturers listed in the Kansas Department of Commerce's Directory of Kansas Manufacturers and Products (Manufacturer Survey). An additional 642 firms were identified through lists of advanced technology or research and development firms. These firms received a second survey (Advanced Technology Survey). A total of 156 (24%) questionnaires were returned by manufacturers and 153 (24%) were returned by advanced technology firms.

The surveys sent to Kansas advanced technology firms and manufacturers were designed to assess business needs for technical and business/managerial assistance. The following questions were addressed:

1. What problems are Kansas firms facing in technical and managerial areas in the global and technological context of the 1980s?

2. Is the impact of changing technology and technical innovation affecting sales and forcing changes in types of technology used?

3. To what extent and in what ways are firms using academic institutions to identify and solve technical and managerial problems?

4. Do Kansas firms wish to use academic institutions to identify and solve technical and managerial problems?

A description of firms responding is presented in Table 22.

Table 22
Description of Firms

	Size: Employees		Location:		Years in operation:	Industrial Classification:		
	<25	25+	Metro	Nonmetro	Median	Mfg	BusServ.	Other
AdvTec*	64%	36%	93.5%	6.5%	9.0	40.5%	40%	20%
Mfg**	60%	40%	36%	64%	25.0	100%	NA	NA

* Size based upon full-time employees only
** Size based upon FTE employees

Table 23 presents the types of skills represented in the work force of advanced technology firms. The majority (63%) employ scientists and engineers and technicians (65%). Fewer report employing general laborers (39%). Twenty-three percent of those employed by advanced technology firms were scientists and engineers, representing the largest proportion of employees.

Table 23
Percentage of Advanced Technology Firms Employing Each Type of Worker and the Percentage of the Workforce Represented by Each Category *

Employee Category:	% Firms Having	% Employees: Mean
Clerical	81%	12%
Data processors	43%	8%
Technicians	65%	18%
Scientists & Engineers	63%	23%
Business/management personnel	78%	14%
General labor/operatives	39%	16.5%

*Based upon full-time employees only.

Table 24 presents the types of employees reported to be employed by Kansas manufacturers. Clerical, business/management personnel, and general labor were categories manufacturers most frequently reported as represented in their workforce. However, general laborers/operatives comprised the largest portion of the workforce (53.5%). Data processors, technicians, and scientists and engineers comprised the smallest segment of the workforce.

Table 24
Percentage of Manufacturing Firms Employing Each Type of Worker and the Percentage of the Workforce Represented by Each Category *

Employee Category:	% Firms Having	% Employees: Mean
Clerical	87%	11.5%
Data processors	39%	3%
Technicians	44%	9%
Scientists & Engineers	30%	2%
Business/management personnel	88%	14%
General labor/ operatives	88%	53.5%

*Based upon full-time-equivalent employees.

A summary of the survey results follows.

1. **Types of Problems Experienced by Kansas Firms**

Advanced Technology firms were asked to characterize problems that they experienced during early development (start-up) phases. These problems are ranked in Table 25. The types of problems that were identified as moderate to severe during the start-up phase were: product development (53% of firms), market strategy (52%), locating qualified technical and professional staff (52%), product commercialization (48.5%), obtaining financing (48.5%), and process development and control (41%).

Table 25
Start-up Problems for Advanced Technology Firms

Type of Start-up Problem:	% AdvTec Firms Scoring Moderate to Major Problem
Developing new product and/or service	53%
Planning market strategy	52%
Finding qualified technical and professional staff	52%
Commercialization of product	48.5%
Obtaining financing	48.5%
Analyzing markets	46%
Finding qualified managers and executives	45%
Finding other qualified employees (Not technical, professional, managerial)	43.5%
Process development and control	41%
Coping with government regulations	39%
Preparation/use of a business plan	35%
Developing/managing an accounting and control system	35%
Setting and implementing goals	31%
Establishing a banking relationship	31%
Personnel management	24.5%
Systems maintenance	15%

These problems are of course interrelated. For example, difficulty in finding qualified technical and professional staff would impact a firm's ability to develop new products, analyze markets and plan a market strategy. These problems can seriously affect a firm's ability to survive in competitive, technology-driven industries. For example, the founder of a northeast Kansas software company noted that the inability to find experienced technical staff would likely force relocation of the firm to California. Entrepreneurs also described selling their companies because they could not afford to do the marketing analysis necessary to position their product and could not afford to design and mount the advertising campaigns necessary to launch products.

Manufacturers also seemed to face significant problems. Kansas manufacturers report that in particular they have difficulty finding qualified employees (51%), planning marketing strategy (50%), analyzing markets (46%), developing new products (40%), developing new technology or improving existing technology (40%), adopting existing technology (25%), and process control (25%) (Table 26).

Table 26
Current Problems for Manufacturers

Current Problem:	% Firms Describing as Moderate to Major Problem
Coping with government regulations	62%
Finding qualified employees	51%
Planning marketing strategy	50%
Analyzing markets	46%
Developing new products	40%
Developing new or improving existing technology	40%
Upgrading current products/services	34%
Adopting existing technology	25%
Process control	25%
Preparation, use, update on a business plan	25%
Setting and implementing goals	25%
Managing personnel	21.5%
Systems maintenance	20%
Obtaining financing	19.5%
Obtaining, implementing, managing accounting and control systems	18%

One manufacturer described the spectrum of problems faced in finding qualified employees as ranging from difficulty in finding well trained, motivated apprentice craftsmen to an inability to afford quality design engineers. Another problem was the cost of machine tools. A small machine shop cannot afford to buy state-of-the-art machine tools, buys used equipment instead, and reports not being able to catch up with competitors with such an approach. Others described their struggle to maintain and improve their markets by diversifying and expanding sales/marketing efforts. However, their capacity to expand their markets was often limited due to lack of resources (e.g., knowledge, time, financing).

These results underscore the many difficulties Kansas's advanced technology and manufacturing firms have in areas that affect their competitiveness: coping with government regulations, finding qualified employees, planning marketing strategy, analyzing markets, developing new products, and developing new or improving existing technology. Given the high proportion of firms experiencing each of these problems, it is evident that these problems are pervasive throughout Kansas industry.

The variable that may link these problem areas is a firm's technology innovation ability. Technological innovators profit from innovations in manufacturing processes, but those who follow the lead of the innovators only reduce their losses (Dewar, 1988). In short, firms which do not keep up with technological change risk failure. Those who keep current with technological change will reduce their losses, and those who lead technological change will profit from their innovations. Thus, an important aspect of a firm's competitiveness may be its ability to lead or be among the leaders in technological innovation. This ability is affected by the firm's ability to predict change, the technical expertise of its staff, the type of technological change occurring in the firm's industry, and the firm's ability to access it. The survey of Kansas firms indicates that they face many challenges in keeping up with,let alone leading, technological change.

2. Dealing With Technological Change

The ability of Kansas firms to deal with technological change was assessed in the surveys. To determine their current level of sophistication, firms were asked to describe their level of technology (Table 27). Less than half of the advanced technology firms described themselves as leaders in innovation; only 42% considered themselves at the cutting edge of technology. Few manufacturers (18%) characterized themselves as at the cutting edge. Most are just keeping current (46%) or are potentially out of date (traditional: 37%). The combined group of manufacturers who are NOT at the cutting edge of technology in their industry is 83% of manufacturers who responded. Thus, a very large number of Kansas's manufacturers are potentially operating at a significant disadvantage with respect to technological competition, and could be described as "at risk." According to recent studies (e.g. Dewar, 1988), these are the manufacturers who may, at best, reduce their losses or, at worst, risk failure.

Table 27
Firm's Technological Level

	Percentage of Firms:	
Technology Level:	AdvTec	Mfg
Cutting edge	42%	18%
Current	52%	46%
Traditional	5%	37%

In addition to their precarious technological position, Kansas manufacturers reported they have difficulty predicting or anticipating technological change (Table 28). Over half of manufacturers responding reported they have very limited prediction capabilities (i.e., perceive they cannot predict or have only a fair ability to do so).

Table 28
Firms' Ability to Predict Technological Change

	Percentage of Firms:	
Ability to predict	AdvTec	Mfg
Excellent	29%	11%
Good	45%	33%
Fair	18%	34%
Can't predict	7%	19%
NA	<1%	4%

Most advanced technology firms reported good to excellent technological prediction capabilities (Table 28). This held true for large as well as small (<25 employees) firms (Table 29).

Table 29
Firms' Ability to Predict Technological Change: Analysis by Firm Size and Location

Ability to predict:	Percentage of AdvTec Firms by: Number of Employees	
	≤25	>25
Excellent	20.7%	8.7%
Good	26.7%	18.0%
Fair	10.0%	8.0%
Can't Predict	6.0%	1.3%
NA	0.7%	0%

Small and nonmetropolitan manufacturers have greater difficulty predicting change than large and metropolitan manufacturers (Table 30). Over 35% of small firms report that they cannot predict or have only a fair capability to predict. Thirty-five percent of nonmetropolitan manufacturers report that they cannot predict or have only fair prediction capability. Small firms may be less able to afford access to technical personnel (e.g., engineers, consultants) or information sources (e.g., technical meetings) where technological change and predictions are discussed. Nonmetropolitan firms may suffer from geographic isolation, making it less likely that they would have access to technical personnel or information sources.

Table 30
Firms' Ability to Predict Technological Change: Analysis by Firm Size and Location

Ability to predict:	Percentage of Mfg Firms by: No. Employees		Location	
	<25	≥25	Metro	Nonmetro
Excellent	3%	7%	6%	5%
Good	13%	20%	12%	21%
Fair	20%	13.5%	11.5%	22%
Can't Predict	15.5%	3%	5%	13%
NA	3%	1%	1%	3%

The greater percentage of scientists and engineers in advanced technology firms undoubtedly accounts for their pace of innovation. In the next two to three years, 67% of the firms plan to develop new products, and 50% plan to change the mix of their products and services. R&D budgets that average 18% of firms' gross income helps supply innovations in products (Table 31). Only 21% report no R&D budget at all.

Table 31
R&D Budgets Presented as a Percentage of Gross Income

Group:	Mean	% Reporting no R&D Budget (0% spent)
AdvTec	18%	21%
Mfg	3%	56%

A majority (56%) of manufacturing firms do not have an R&D budget (Table 31). The combination of low R&D activity and lower than average numbers of scientists and engineers in Kansas' manufacturing workforce may be important. The ability to innovate or implement existing technology is correlated with number of scientists and engineers in the working population (Williams, 1986). Scientists and engineers comprise 2% of Kansas's manufacturing workforce (reported in Table 24), while the national average is 3.6% (National Science Board, 1987). The below average number of scientists and engineers in the workforce may contribute to the lack of research and development.

Manufacturers were asked to estimate the impact of technology on their firm. Table 32 shows that many expect considerable impact in the areas of process, product, materials, information and employee skill level.

Table 32
Level of Technological Impact Expected in the Next Five Years

Area of impact:	% Mfg. Firms Great	Considerable	Some	Little	None	DK
Processes & process control	16%	29%	28%	15%	6%	7%
Products	11%	30%	34%	15%	4%	6%
Materials	10%	21%	37%	24%	7%	5%
Information needs	10%	36%	35%	9%	5%	6%
Employee skill level	8%	29%	42%	13%	3%	5%

Small (less than 25 employees) and nonmetropolitan manufacturers may be underestimating impact. These groups tend to predict less technological impact in the areas of process/process control than larger and metropolitan manufacturers (Table 33). Statistical analysis of these results indicated that the actual percentages in each category differed significantly ($p<.0453$ and $p<.005$) from chance occurrence.

Table 33
Level of Technological Impact on Process and Process Control Expected by Manufacturers: Analysis by Location and Firm Size

Level of Impact:	% Metro Firms	% Non-Metro Firms	% Firms <25 Emply	% Firms >25 Emply
Great	7%	9%	5%	11%
Considerable	13%	16%	13%	15.5%
Some	9%	19%	14%	13%
Little	1%	13%	11%	3.5%
None	1%	3.5%	5%	<1%
Don't Know	4%	3%	6%	1%

Chi-Square 11.325 DF 5 p<.0453 Chi-Square 16.734 DF 5 p<.005

Nonmetropolitan manufacturing firms were divided in their assessment of technological impact on employee skill level (Table 34). While 23% expect great or considerable impact, 36.5% expect some or little impact.

Table 34
Level of Technological Impact on Employee Skill Level Expected by Manufacturers: Analysis by Location

Level of Impact:	% Metro Firms	% Nonmetro Firms
Great	6%	2%
Considerable	8%	21%
Some	17%	25.5%
Little	2%	11%
None	<1%	3%
Don't Know	3%	1%

Most manufacturers report changes are currently occurring in their industry in technology (71%), technical systems (69%), and human systems (50.5%). The types of changes most frequently reported were computer aided design (CAD) and computer aided manufacturing (CAM), computerized accounting systems and higher levels of decision making at the shop floor level (Table 35). The differences between the percentage of firms reporting industry change and change in their own firm indicates that not all firms are implementing changes occurring in their industry. For example, 71% reported technological change is occurring in their industry (Table 35), but only 61.5% report making changes in technology in their firm. Approximately 10% are not implementing changes occurring in their industry.

Many firms have identified some form of technology or technical system that they would like to adopt but have not (Table 36). A relatively higher proportion of small and nonmetropolitan firms have delayed adopting potentially beneficial technology.

Table 35
Changes Currently Occurring in Manufacturing Industries

Type of Change:	% Firms Reporting Change in Their Industry:	Firm:
TECHNOLOGY	71%	61.5%
Computer aided design	49%	32%
Computer aided manufacturing	42%	25%
Automated material handling	35%	19%
Computer integrated manufacturing	22%	8%
Computer aided engineering	20%	10%
Robotics	13.5%	8%
TECHNICAL SYSTEMS	69%	62%
Computerized accounting systems	52%	36.5%
Total quality control	28%	20.5%
Statistical process control	25%	17%
Just in time production methods	20.5%	11.5%
Zero defect planning	13.5%	6%
HUMAN SYSTEMS	50.5%	47%
Higher levels of decision making at shop floor level	33%	28%
Self managing teams	21%	15%
Work cells	7%	7%

Table 36
Percentage of Firms Identifying But Not Adopting a Potentially Valuable Technology or Technical System

	All firms	Metro	Nonmetro	<25	>25
AdvTec	55%(61%*)	NA	NA	63%	37%
Mfg	42%	35%	65%	54%	46%

* AdvTec firms ≤15 yr in operation

Twenty-five percent of manufacturing firms and 27% of advanced technology firms report no barriers to introducing new technology. Those reporting barriers were more likely to cite lack of financial resources and lack of technical expertise as the main obstacles to technology implementation (Table 37).

Table 37
Barriers to Implementing New/Existing Technology

Barrier to New Technology/ Technical Systems:	Percentage of Firms: AdvTec	Mfg
Lack of financial resources	44 (52)*	28
Lack of technical expertise	25 (26)	19
Lack of skilled workers	18 (20)	15
Risk too high	17 (13)	11.5
Lack of engineers	14 (15)	11
Lack of technical information	12 (13)	9
Lack of managerial commitment	10.5 (8)	9
Other	10 (6)	11

*Percentage of "young" AdvTec firms (≤15 yrs)

These problems are acute for young advanced technology firms--those which have been in operation 15 years or less (Table 38). Small firms and those located in nonmetropolitan areas also overwhelmingly report that lack of financial resources, lack of technical expertise and skilled workers, and high risk factors are major barriers to implementing technology (Table 38).

Table 38
Analysis of Technology Implementation Barriers
by Firm Size and Age: Advanced Technology Firms

Barriers to Technology Implementation:	% of Firms: <25 Employees	≥25 Employees	≤15yr
Lack of financial resources	77%	23%	52%
Lack of technical expertise	58%	42%	26%
Risk too high	64%	36%	13%
Lack of skilled workers	78%	22%	20%

An analysis of barriers that prevent manufacturers from implementing technology shows that financial resources, technical expertise, risk factors, and lack of skilled workers concerned large percentages of manufacturers (Table 39). These are identified as barriers for large numbers of nonmetropolitan and small firms.

Table 39
Analysis of Technology Implementation Barriers by Location and Firm Size: Manufacturing Firms

Barriers to Technology Implementation:	% of Firms: Metro	Nonmetro	<25 Employees	≥25 Employees
Lack of financial resources	42%	58%	63%	37%
Lack of technical expertise	41%	59%	50%	50%
Risk too high	33%	67%	41%	59%
Lack of skilled workers	32%	68%	65%	35%

Despite the barriers faced in implementing technology change, most advanced technology firms report that they are very likely to make changes in technology used in the next five years (Table 40). In this, firm size is not a factor. Both small and large firms predict that they are very likely to make changes.

Table 40
Likelihood for Technology Change Within Five Years: Advanced Technology Firms

Likelihood for Change:	Percentage of Firms: All	<25 Employees	≥25 Employees
Very likely	78%	49%	29%
Somewhat likely	17%	11%	7%
Somewhat unlikely	0.7%	0.7%	0%
Very unlikely	0.7%	0.7%	0%
Not likely	3%	3%	0%

Most manufacturers also report that technology change in their firm is very, or somewhat likely, within the next five years (Table 41). Again, small and nonmetropolitan firms were more conservative in their estimation of the likelihood for change. The percentages occurring in each category of small and large firms were significantly different ($p<.0008$) than what would be expected by chance.

Table 41
Likelihood for Technology Change Within Five Years: Manufacturing Firms

Likelihood for Change:	All	Metro	Nonmetro	<25	≥25
		Percentage of Firms:		Employees	
Very likely	43%	17%	26%	17%	27%
Somewhat likely	39%	12%	27%	26%	13%
Somewhat unlikely	9%	4%	5%	7%	2%
Very unlikely	0%	0%	0%	0%	0%
Not likely	8%	2%	6%	7%	1%
		N.S.		ChiSq=16.803 DF=3 p<.0008	

3. <u>Interest in Academic Linkages</u>

As described above, Kansas businesses report industry-wide technological changes are occurring. Many report that they plan to implement or update the technology they use in the next five years, raising the question of what information sources will guide decisions regarding these changes. Although the majority report that their sources of science and technology information are adequate to be competitive and to innovate (AdvTec, 79%; Mfg, 81%), many report an interest in decreasing their dependence upon equipment manufacturers, magazines/journals, and sales representatives. They are interested in receiving more scientific and technical information from colleges and universities. This shift may reflect an interest in receiving less biased (i.e., less sales oriented), more cutting-edge information that would help create a competitive edge.

Firms are also interested in assistance from academic institutions, such as information, technical expertise, skills training, and research that will increase their technical advantage in key problem areas (Table 42).

Table 42
Level of Interest in Assistance Available at Academic Institutions

Type of Assistance	% Firms with Great/Moderate Interest: AdvTec	Mfg
Technical:		
Improve current products, processes	71%	No Data
Identify and assist with problems	69%	38%
Access to labs, equipment	45%	29%
Computer access to libraries	67%	33%
Technological Innovation:		
R&D for new technology, products, processes	67%	38%
Business/Managerial Assistance:		
Identify and assist with problems	57%	37%
Training:		
Technical training	69%	55%
Management development training	63%	50%

More than half of the advanced technology firms have great or moderate interest (Table 42) in technical assistance that would enable them to improve products and processes. Almost the same percentage are interested in assistance with problem identification, computer access to libraries, R&D, and training. More than half are interested in assistance with business/managerial problems.

More than half of the manufacturers have great or moderate interest in technical and management development training for their employees (Table 42). Thirty-eight percent showed interest in assistance with identification of technical problems and R&D for new technology, products, and processes. Business and managerial assistance was also important to 37% of the manufacturers.

To solve problems common in start-up phases, Advanced Technology firms indicated business/managerial and technical assistance would be extremely beneficial (Table 43). Various types of business assistance ranked above technical assistance during early development phases. Access to business professionals regarding market research and planning, financial planning and management, advertising and promotion, and preparation and use of a business plan was important.

Table 43
Assistance Regarded as Very/Extremely Beneficial During Early Development Phases by Advanced Technology Firms

Type of assistance:	% AdvTec Firms
Access to business professionals regarding market research & planning	43%
Access to business professionals regarding financial planning/management	40%
Access to business professionals regarding advertising & promotion	40%
Access to business professionals regarding preparation/ use of business plan	38%
Access to business professionals regarding starting a business	32%
Access to library or computer searches	32%
Access to technical consultants regarding preparation of grant proposals	32%
Access to technical consultants regarding new or existing technology transfer	30%
Access to technical consultants regarding new product development, including technical research	26%
Access to technical consultants regarding product analysis/ improvement	24%
Access to technical consultants regarding commercialization of products	22%
Access to scientific instruments and equipment	20.5%
Access to high powered computers	18%
Access to business professionals regarding personnel management	17.5%
Access to technical consultants regarding products and/or manufacturing processes	17%
Access to business professionals regarding inventory control	13%

4. Utilization of Academic Institutions

A majority of Advanced Technology firms (53%) report using academic institutions in the past five years. However, 74% of these firms report they would seek more assistance from this source if it were available. A large percentage report they would like assistance in making contacts with academic institutions (Table 44).

Table 44
Preference for Initial Contact with Academic Institutions

	% Firms:	
Preference:	**AdvTec**	**Mfg**
Make own contacts	33%	41%
Contacts made through liaison office	52%	42%
Other	6%	3%
Don't know	9%	14%

Less than half of the manufacturers surveyed (37%) report using academic institutions in the past five years. However, 64% report that they would seek more assistance if it were available. Preference for making the initial contact is divided between those preferring to make their own contacts and those preferring an intermediary (Table 44).

In general, manufacturers are not very familiar with most Kansas postsecondary academic institutions or the services they might offer. Table 45 shows that most are familiar with Kansas State University (72%) and the University of Kansas (70%), but most rank their level of familiarity as only "some" or "considerable."

Table 45
Manufacturers Level of Familiarity with Academic Institutions

		Percentage of Firms			
			Level of familiarity:		
Rank	Institution:	% Familiar	Very	Considerable	Some
1	Kansas State University	72%	12%	29%	31%
2	University of Kansas	70%	13%	25%	32%
3	Wichita State Univ.	48%	6%	11%	31%
4	Emporia State Univ.	44%	2%	4%	38%
5	Pittsburg State Univ.	42.5%	5%	8.5%	29%
6	Community College(s)	41%	14%	14%	13%
7	Fort Hays State Univ.	40.5%	2%	8%	30.5%
8	Technical/Vocational	40%	6%	18%	16%
9	Washburn Univ.	25.5%	4%	2%	19.5%
10	Kansas College of Tech	20%	2%	4%	14%
11	Private Institution(s)	18.5%	5.5%	9%	4%

Many manufacturers report no familiarity with types of services potentially available from academic institutions (Table 46). Of those who are familiar with potential services, most consider their familiarity to be limited.

Table 46
Manufacturers Familiarity with Services/Resources Available at Academic Institutions

		Percentage of Firms			
			Level of Familiarity:		
Rank	Resource:	% Familiar	Very	Considerable	Some
1	Libraries (general, science, engineering, etc.)	56%	7.5%	16%	33%
2	Management development training	55%	3%	20%	32%
3	Business/managerial assistance	52%	1.5%	20%	30%
4	Technical training of workers	46%	1.5%	11%	33%
5	Faculty technology/technical consultation	44%	1.5%	11%	31%
6	Science and technology research	43%	1.5%	9%	33%
7	Availability of labs/equipment	37%	0%	9%	28%
8	Computer searches/networking	36%	2%	9%	25%
9	Proposal preparation assistance	27%	1.5%	5%	20%

Both advanced technology firms and manufacturers were asked why academic institutions were not used more (Table 47). Advanced technology firms reported lack of knowledge about who to contact as the top ranked reason. However, perceived shortcomings of academics (e.g., out of touch with business problems, lack of experience/expertise, etc.) were also important reasons for over 20% of advanced technology firms.

Manufacturers cited lack of knowledge about who to contact or how to make contact as the primary reasons for lack of academic contact. Also important for over 15% of the manufacturers was the perception that faculty lacked experience/expertise in dealing with problems facing manufacturers and that academia is out of touch with business problems.

Table 47
Reasons Firms Do Not Contact Academic Institutions More Frequently

Rank: AdvTec	Mfg	Reason:	Percentage of Firms Citing This Reason AdvTec	Mfg
1	1	Don't know who to contact	28%	33%
2	4	Faculty/schools seen as too out of touch with business problems	26%	16%
3	3	Problems cannot be solved by faculty (lack of experience, expertise)	23.5%	20.5%
4	2	Don't know how to make contact	18%	24%
5	5	Don't have time to make contacts	16%	13.5%
6	6	Response time is too slow	15%	10%
7	7	Tried but got no response	6.5%	4.5%

Because not knowing who to contact was a major reason for not contacting academic institutions more frequently for both advanced technology firms and manufacturers, some intermediary mechanism is needed to help firms gain access to resources potentially available at academic universities.

Firms who had contacted academic institutions in the past five years were asked why they contacted a specific institution (Table 48). Location near the firm, knowledge of an expert on the faculty, and familiarity with the institution were the major reasons given.

The University of Kansas, Kansas State University, Wichita State University, and the community colleges were institutions most frequently utilized by advanced technology firms (Table 49).

Table 48
Variables Important to Firms When Choosing Academic Institution for Assistance

Reason for choice:	Percentage of Firms: AdvTec	Mfg
Located close to firm	41%	22%
Knew of an individual whose expertise could be used	25.5%	15%
Institution was familiar to the individual (alumnae, friends attended, etc.)	25%	11.5%
School/department has state/national reputation in area of interest	17%	9%
Institution/department/faculty agreed to help while others didn't	7%	1%
Institution/department/faculty was recommended by others	4%	8%
Other	8%	5%

Table 49
Percentage of Firms Reporting Interaction with Academic Institutions

Institution:	Percentage of Firms AdvTec	Mfg
University of Kansas	27%	8%
Kansas State University	12%	10%
Community College(s)	19%	6%
Wichita State University	14%	6%
Technical/vocational school(s)	6%	6%
Pittsburg State University	4%	4.5%
Kansas College of Technology	3%	1%
Fort Hays State University	1%	2%
Emporia State University	1%	1%
Washburn University	1%	0%
Private Institution(s)	1%	2%
Other	3%	5%

Few manufacturers have utilized state academic institutions (Table 49). Kansas State University and University of Kansas were ranked first and second in contacts, with community colleges, Wichita State University and Technical/vocational schools ranked third. The low percentage of manufacturing firms having contact with the technology oriented institutions, Pittsburg State University (4.5%) and Kansas College of Technology (1%), is disconcerting.

Firms reported the types of technical expertise and resources they utilized at academic institutions. Faculty consultation regarding products and processes and technical training were most frequently cited (Table 50). Since employee skill level, product development and improvement were major problems identified by manufacturers (see Table 25), utilization of these resources addresses key problem areas of firms.

Table 50
Technical Assistance Provided at Academic Institution

Technical Services:	**Percentage of Firms Using:** AdvTec	Mfg
Technical consultation with faculty regarding products and/or processes	31%	15%
Technical training of workers	22%	11.5%
Library or computer searches	19%	6%
Technical research for future products or processes	12%	4%
Use of computers	12%	8%
Use of scientific instruments and equipment	10%	2%
Explanation of existing technology	9%	6%
New product development	8.5%	6%
Product analysis/improvement	7%	9%
Explanation of new technology	7%	5%
Joint research	6.5%	Not Available
Plant layout & material handling	3%	3%
Assistance in proposal preparation	3%	1%
Commercialization	2%	1%
Manufacturing process analysis/improvement	1%	4%
Other	4%	4.5%

Firms also used business/managerial services available at academic institutions. Library utilization and management development training were most frequently cited by advanced technology firms (Table 51).

Table 51
Business/Managerial Assistance
Provided at Academic Institutions

Business/managerial Service:	Percentage of Firms Using: AdvTec	Mfg
Use of library	13%	4%
Management development training	6.5%	14%
Market research and planning	6%	8%
Personnel and organization	6%	9%
Use of computer(s)/computer applications	5%	8%
Preparation and use of a business plan	5%	8%
Advertising and promotion	4%	8%
Financial analysis and cost control	2%	8%
Development/management of accounting systems	2%	6%
Feasibility studies	2%	4.5%
Inventory control	0%	5%
Other	3%	3%

The match between what young firms need and what resources could potentially be utilized at academic institutions is actually quite good. However, when compared to the list of problems faced during start-up (Table 25), the amount of business/managerial assistance actually sought by advanced technology firms is low (Table 51). Most start-up firms fail because of management-related problems, yet access to this type of assistance is very low (0%-6% of advanced technology firms). For example, while advanced technology firms indicated that marketing issues (e.g. strategy, analysis) were major problems during early development phases, few (6%) turned to academic institutions for assistance. Other examples can be cited. While 35% stated that preparation and the use of a business plan was a problem, few (5%) sought assistance. Barriers to seeking assistance were discussed above (Table 47). Again, knowing who to contact, knowing how to make contact, having the time to do it, and getting a response in good time are critical issues to young firms struggling to survive.

Manufacturers use of academic institutions' business managerial resources tends more toward management development training (Table 51). As presented in Table 26, several business/management areas were identified as problematic (employee qualifications, marketing, process control, business plans/setting goals, personnel management, etc.). Few manufacturers are accessing resources in these problem areas (Table 51).

Since firms report that they would like to use academic institutions more, the types of services of greatest interest (Table 52) are those that impact problem areas and capitalize upon activities that are compatible with the academic mission. Access to state-of-the art technology, technical and business/managerial consultation, research and development, training, and information dissemination are services of interest. Academic institutions could provide these services if proper networks were developed for easy access.

Table 52
Academic Services of Greatest Interest

	% Firms With Great to Moderate Interest	
Type of Service:	AdvTec	Mfg
Access to state-of-art science & technology to improve current products & processes	71	NA
Access to training programs to improve employee technical skills	69	55
Access to technical expertise to facilitate technical problem identification & assistance	69	38
Research & development activities to develop new technology, products, processes	67	38
Computer access to university libraries for information retrieval &/or networking	67	33
Access to management development training	63	50
Access to business/managerial expertise to facilitate business/managerial problem identification & assistance	57	37
Access to labs & equipment	45	29

5. Conclusions

Kansas firms face considerable challenge in

* predicting technological changes
* identifying technology appropriate for their needs
* obtaining resources (technical, managerial, and financial) to implement technology
* developing new products
* planning marketing strategy
* finding qualified employees
* coping with government regulations

The combination or interaction of these challenges may create a climate of technological uncertainty that could seriously hamper Kansas firms' ability to be competitive. Technological uncertainty and financing difficulties appear to retard the rate at which new technology is implemented. Firms need resources designed to help them overcome these technological and business difficulties. Academic institutions are seen as possible sources of assistance, but barriers (e.g., lack of expertise, not in touch with business problems, difficulty in making contacts) exist that hamper utilization and further retard technology transfer. To determine if Kansas universities and colleges are or could be sources of technology transfer, technical assistance, and business/managerial assistance, the state's higher education system was analyzed.

C. Kansas Institutions of Higher Education

The higher education system in Kansas is the sole source of technology development and expertise within the state. Kansas is characterized by an absence of federal research laboratories and private research institutions.

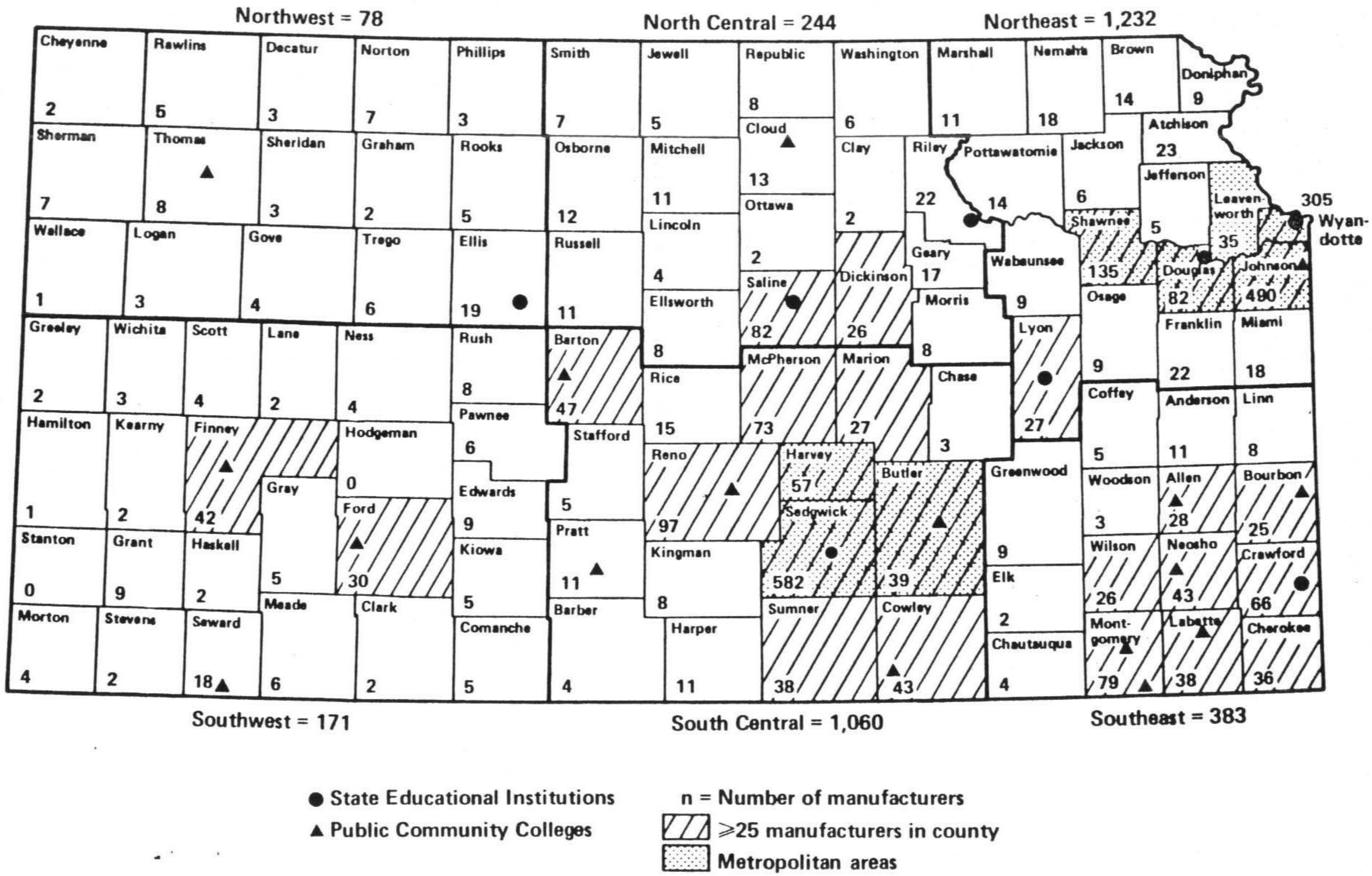
The lack of federal research laboratories and private research institutions puts Kansas at a disadvantage in the competition for technology to fuel industrial modernization and growth of technology-driven industry. Other states that have federal research laboratories and private research institutions have enjoyed the economic development benefits that these labs and research institutions provide in their ability to attract industry and spin-off new firms.

Kansas is also characterized by its lack of science advisors and state science advisory committees to provide independent information and advice to governors on technological issues. Other states created such advisory units in the 1960s and 1970s (Plosila, 1987). The absence of an advisory unit to focus upon or coordinate technological efforts at the state level resulted in lack of attention and action on technological issues and needs of the state's industry. It also led higher education institutions to compete with each other rather than coordinate efforts for limited state resources and corporate ties to support research activity. Thus, no large corporate/university collaborations exist at the present time.

Consequently, any system designed to develop and transfer technology, provide technical assistance, or provide business/managerial assistance to the state's private sector must be anchored in the universities and colleges of the state. One major problem with anchoring industrial liaison activities to the states academic institutions is that these institutions are not always located near manufacturing centers or centers of rapid growth (Figure 9). As the map shows, the northeast region for example, has 1,232 or 39% of the state's manufacturers but only 19% of the state's post-secondary academic institutions (two state educational institutions and

Figure 9

STATE OF KANSAS



three public community colleges (Table 53). Lack of geographical proximity hampers interaction.

Table 53
Proximity of Academic Institutions to Manufacturers

Region	No. Manufacturers	No. State Ed. Instit.	No. Public Comm. Coll.
NE	1,232	2	3
SE	383	1	6
NC	244	2	1
SC	1,060	1	5
NW	78	1	1
SW	171	0	3

Source: Directory of Manufacturers and Products, Kansas Dept. of Commerce
Kansas Educational Directory, 1987-88, Kansas Dept. of Education

An analysis of Kansas's universities and community colleges was conducted to determine what resources Kansas institutions of higher education have that are or could be utilized by Kansas business and industry to solve technical and business/managerial problems. On-site visits were made to six Regents institutions and to six of the 19 community colleges. Resources of the remaining 13 community colleges were assessed by telephone interviews. Presidents or chancellors of all institutions were contacted and asked to designate who within their institution should be interviewed to gain information regarding:

* Current activities in technology development (basic research to develop new technology);

* Current activities in technology transfer (transmission of new technologies from the lab to the private sector);

* Current activities in technical assistance (deal with technical problems by providing such things as product evaluation, process evaluation, use of state-of-the-art design and manufacturing tools, identifying expertise at universities that could provide assistance, etc.);

* Current activities in business/ managerial assistance (provide help with business plans, marketing strategies, personnel, accounting, legal matters, financial sources, etc.);

* Extent to which current activities in the above areas are targeted to small/medium size firms;

* How higher education-industry liaison might be enhanced.

Persons designated by the President or Chancellor were interviewed at each institution and additional literature pertaining to the academic degree programs in science and technology was collected. In total, 36 interviews were conducted with personnel in the Regents universities and 28 interviews were conducted with community college officials. The interviews did not constitute an in-depth review of the science and engineering capacities of the higher education institutions but rather served as a qualitative assessment of the current activities of higher education institutions in technology development, technology transfer and business/managerial assistance. The interviews and literature provided insight into strengths and weaknesses of the academic institutions' technical capacity (science and engineering programs) and related business/managerial capacity (business programs). The focus was deliberately limited to only those activities that involved linkage with the private sector to provide technical or business/ managerial assistance and technology development-transfer. (While all institutions provide training for businesses, a very important form of linkage, assessment of training was not included in this investigation because it is currently being examined extensively as part of another study.)

Examination of the current capacities of the academic institutions revealed that resources are available that could be used to assist industry, but every institution has different strengths and capacity to participate. The institutions can be divided into four groupings based upon the analysis of their capacity:

- research oriented universities;
- regional institutions with technological capacity;
- regional universities with management assistance capacity;
- community colleges.

1. <u>Research Oriented Universities</u>

<u>General findings.</u> Economic development has not been an active part of the universities research and teaching mission. In the past, the academic mission did not include a strong tradition of working with industry. Thus, it was not natural for Kansas higher education institutions to associate with the technological and managerial issues facing business communities. Recently, this has begun to change. State institutions are now aware of the need for a vigorous university-business interaction, enabling an entrepreneurial culture to develop which could foster an environment conducive to risk-taking. Over the past five years, higher education institutions in Kansas have taken significant measures to bring their assets to economic development. An effort has been made to take their research resources to the large as well as small- and medium-sized businesses, the more traditional businesses of the state. In the 1980s, the role of higher education is increasingly acknowledged as an essential prerequisite for promoting economic diversity and growth. The University of Kansas' Report of the Chancellor's Task Force on Economic Development (February 1987) led to the establishment of an Industry Liaison office. Wichita State University's involvement in the WI/SE program is yet another indication of a

higher education research agenda that is increasingly industry/market-driven. Kansas State University's Colleges of Agriculture andEngineering have been modifying their role and mission in response to the changing environment. These are clear indications of the growing support of the universities for technology transfer and application. Thus, in Kansas, the research strengths of the major universities and their preeminent academic reputation in certain fields is beginning to match the business history of the state.

An examination of the current science and technology capacities of the higher education institutions in Kansas reveals that the state has no major private science and engineering foundations to provide grants for basic university research, endowed chairs, and educational awareness programs, other than the Wesley Foundation. Until recently there has been little effort at R&D consortiums. The state ranks thirty-seventh in university R&D per capita, thirty-seventh in federal R&D per capita, and thirty-fifth in number of patents issued. Science and engineering training in Kansas is not extensive. In its technological and science resources, Kansas ranks relatively low (36th) nationally (Corporation for Enterprise Development, 1988).

An overview of the Schools of Business at the major institutions indicates that they largely provide management assistance through their SBDCs and SBIs and through faculty consulting arrangements. Business school faculty are research and publication oriented. They have not had a strong tradition of working with industry, particularly the small- and medium-sized businesses of the state. This is particularly so in technology related management, although the major schools are placing greater emphasis on production management and are attempting to develop productivity centers. For the most part, broader based relationships have not been developed with the state's business community. Interviews indicated that less than 20% of the business school faculty had frequent, regular consulting assignments with small- to medium-sized businesses in their regions. Few faculty exchange programs exist between Schools of Business and industry in the state.

Interviews also revealed that there were no examples of cooperative degree-granting programs between Schools of Business and Engineering, for example in manufacturing technology. Overall, in terms of potential and need, the response of Kansas's Schools of Business do not constitute a systematic and comprehensive response to Kansas industry.

Historically, the higher education institutions in the state have undertaken very few entrepreneurial development activities, have seldom pooled equipment and resources with neighboring institutions, nor have undertaken collaborative research with local industry. There have, of course, been exceptions, such as Kansas State University's long-standing extension services and Pittsburg State University's national and regional activities in the wood and plastics field.

Specific findings. The University of Kansas, Kansas State University, and Wichita State University have programs of research excellence devoted to improving basic and fundamental knowledge in engineering, the sciences, and technology development. The University of Kansas and Kansas State University, for example, rank 76th and 80th respectively among U.S. universities in total R&D funding.

According to an external review and evaluation report prepared for the

Kansas Technology Enterprise Corporation in November, 1988, all three research institutions had on-going projects in new technology and current technology application. Their Centers of Excellence vary considerably and benefit from strong support from their respective institutions. All the Centers have a multidisciplinary approach to research opportunities and energetic staffs. The University of Kansas' major strength lies in the intrinsic merit of its basic research. Yet CBAR, observed the external review, must work to broaden its research focus and develop a greater potential for commercialization. Kansas State University's Center of Excellence (CRCCA) demonstrates real strength in technology development and its application but suffers from understaffing both in its manufacturing laboratory and its technology transfer activities. Wichita State University's Center of Excellence similarly has strong elements of basic research and technology development and has considerable support from its community and local industry but has a limited technology transfer agenda.

Each Center of Excellence deliberately concentrates in a relatively specialized area, i.e., bioanalytical research, manufacturing technology, and aviation research, primarily because they are designed to enhance these research strengths at their respective institutions. They are not designed to focus on technology transfer and liaison in general, nor were they created to respond to the needs of regional industry. Despite the Center of Excellence's important initiatives in public/private interaction, their real focus remains on basic technology and technology development.

In addition to the Centers of Excellence, there are a number of academic research programs at the three research-oriented universities that have technology development and technology transfer elements. KU, KSU, and

WSU have sound programs with some pockets of national excellence. Most of the efforts of these departmentally based programs are research and training oriented, and not oriented toward technology transfer or technical assistance. The following selected indicators and observations underpin the conclusion that higher education in Kansas has the basic capacity to engage in technology transfer and liaison, but that it is also limited in this regard and needs support and assistance to do so productively.

University of Kansas. In "A Ranking by Engineering Education" (1987), in the Journal of the American Society of Engineering Education, KU was ranked 11th among state-supported universities in terms of the accomplishments of its engineering graduates. KU had more alumni employed by NASA than any other university in the country. Since 1980, KU students have won the individual and team competitions in the American Institute of Aeronautics and Astronautics Design competition. In 1982, KU students received first through fifth place awards in the individual competition. In five of the past six years, KU students placed first, second, or third in the National American Institute of Chemical Engineers Student Design Contest. The mechanical, electrical, and computer engineering departments in the School of Engineering are similarly noteworthy. General Motors, for example, recently designated these departments a part of the top engineering schools in the nation. In addition, KU's School of Engineering has a unique architectural engineering program which is ranked among the best in the country.

Research activities with opportunities for technology transfer occur in the basic sciences. For example, the Department of Chemistry at the University of Kansas ranks 84th nationally, the environmental sciences ranks

43rd, and the biological sciences rank 90th (NSF, 1986). Of particular significance are the pharmacy and the biochemical sciences. The medical and allied sciences rank 93rd in the nation (NSF, 1986). The University of Kansas Medical School receives $12-15 million in annual external support. Other prominent examples of technology transfer and outreach include KU's Tertiary Oil Recovery Program (TORP) and its continuing education programs of technology and technical transfer in abatement and asbestos removal, gas equipment calibration, and hazardous waste removal.

Kansas State University. KSU has a strong College of Engineering with a top undergraduate and a maturing graduate program. According to a recent New York Times survey, KSU ranked eighth in the nation for the number of faculty in relation to federal R&D dollars. KSU's strength in the life sciences (76th), the biological sciences (79th) and the mathematical sciences (82nd) makes it a powerful force in statewide science and engineering education and research (NSF, 1986). KSU's Engineering Extension and its Office of Hazardous Waste Research have given visibility to technology transfer activities in the areas of hazardous waste management, instrumentation, measurement and control technology and solidification/ stabilization technology. KSU's agricultural sciences (27th) and its great tradition of extension services have made it a pioneer in the interaction between university services and farming communities throughout the state. KSU has additional research excellence in agricultural commodity and food processing, biotechnology ranging from bio-mass utilization through genetic and monoclonal antibody production, artificial intelligence, and computer and radiation technology. The university's potential for technology development and technology transfer is augmented by the excellent cooperation between industrial and manufacturing engineering in the manufacturing area. Indeed, the manufacturing engineering program is the only accredited one in the Midwest.

Wichita State University. Wichita State University's research/ technology support strengths lie primarily in aeronautical engineering and the allied health professions which have received national recognition. From 1982 through 1987, for example, an unique consortium functioned which involved WSU, the FAA, NASA, and twelve national aerospace firms seeking to develop better research on the design of ice protection systems for aircraft. The Institute of Aviation at WSU has various affiliated units possessing technology transfer capacity:

-**The Center for Management Resource and Human Resource Development** provides research services for behavioral science issues and statistical studies identifying the nature and dynamics of organizational systems.

-**The Center for Entrepreneurship** provides seminars for special interest groups, entrepreneurs and business owners and managers, with an emphasis on defining the opportunities and problems entrepreneurs face in southeastern Kansas.

-**The Center for Economic Development and Business Research** provides economic data for south central Kansas.

-**The Center for Productivity Enhancement** supports the introduction of technologies that increase manufacturing productivity in southeast Kansas industries.

WSU has made a substantial effort in the last few years to aid in economic development, business planning, and assisting entrepreneurs and innovators by bringing the experience of practitioners to bear on the problems of companies in Sedgewick County and its environs. The WI/SE Partnership is an effort to develop a new track for the university, a track focusing on the direct support of local business. The WI/SE links are an important part of the services package described above.

2. Institutions with Technological Capacity

Pittsburg State University. The Center for Technology Transfer at Pittsburg State University and its bureaus have the capacity to transfer technology to the private sector and to provide technical assistance. PSU has built upon the technical activities of its Center of Excellence. To date, the Center's work has been mainly in the area of technical assistance with small firms, close coordination with the Institute for Economic Development at Pittsburg State University, and business and managerial assistance. Technology consultants generally are PSU faculty. The director of the Center for Technology Transfer (CTT) arranges for consultants and clients to meet, review, discuss, and analyze the situation. After the meeting, a report is prepared by the consultant and submitted to the client by the CTT.

The CTT interacts closely with the Institute for Economic Development and the O. Gene Bicknell Center for Entrepreneurship at Pittsburg State University, established in 1986, and offers one-stop managerial, financial, and technical assistance to both new and expanding businesses in southeast Kansas. Its market also extends from Joplin, Missouri, south into Bentonville, Fayetteville, and on to Fort Smith, Arkansas. PSU administrators believe this appears to be the fastest growing area technologically as well as economically in the four-state area. Thus, the Institute has oriented itself in this regional direction.

The Institute and its affiliated O. Gene Bicknell Center for Entrepreneurship, its Small Business Development Center, and its Bureau of Business and Economic Research provide direct management assistance to new and expanding ventures in southeastern Kansas. The primary activity of the

Institute is to assist business to improve their managerial capacity, their profitability, and their job creation potential. The Institute is co-located with PSU's Center for Technology Transfer. In addition to its operations on campus, the Institute has a field representative enabling it to deliver the services of the Bicknell Center and the SBDC to outlying counties.

Kansas College of Technology. The Kansas College of Technology (KCT) in Salina has a statewide mandate like KU, KSU, and WSU, and because of the importance of technical education and its application to business and industry, its mission includes economic development. The versatility of programs and special courses offered by KCT has allowed it to adapt and tailor its programs to the educational needs of the private sector.

Although its mission is not in research, KCT offers an associate bachelor of engineering technology degree and produces engineering technicians. Through some of its courses, such as its mechanical engineering technology program, students design, build, and test commercial products. The institution's programs include continuing education programs, such as training for the Kansas National Guard, a computer software program (ENABLE), which has expanded to McConnell Air Force Base and Fort Riley, and cooperative educational programs with local industries (e.g., Koch Industries in Wichita). KCT also provides technological assistance through its specialized short courses, various seminars, conferences, and workshops to businesses in Salina and Wichita.

KCT provides managerial assistance to businesses and receives referrals from SBDCs, the Regional Department of Commerce on campus, and the State Department in Topeka. During the past three years, they have established a proactive approach to the concerns of local industry through their continuing education/extension programs and faculty devotion to community involvement.

As our surveys indicate (see above), there exists a lack of awareness of the technical assistance and business/managerial programs offered by the Kansas College of Technology and Pittsburg State University.

3. Regional Universities with Management Assistance Capacity

Emporia State University, Fort Hays State University, and Washburn University have traditionally concentrated on their teaching mission. All three have little basic research in science and engineering. They do not have schools of engineering or colleges of technology, although a number of their faculty do have pre-engineering degrees but do not actively teach engineering courses. Technical assistance is limited and infrequent. All three institutions suffer from barriers such as faculty time demands, the lack of students to work on projects, funding, and a lack of faculty incentives for consulting activities.

The three institutions provide managerial assistance and are networked to their respective SBDCs which in the case of ESU and FHSU provide counseling and training and disseminate information to area businesses.
Within ESU's school of business, which is now five years old, several institutes and centers are active in managerial assistance and research. The Roe R. Cross Institute for Economic and Business Development (two years old) provides training programs, economic and market research, and various consulting services to private businesses and public agencies in Emporia and the Flint Hills area. Its management and development services assist

managers and other business executives to improve their effectiveness and productivity through both training and counseling. The Center for Insurance Education, the most recent unit in the school of business, is financed through private funding and provides business assistance for the insurance industry throughout the state.

All three institutions seek greater collaboration and networking with Wichita State University, Kansas State University, and the University of Kansas to meet the technical and managerial needs of their regions. All three report a great awareness of a lack of organized response to businesses who call with specific problems. Technical issues are often referred to specific faculty within the Schools of Engineering or, in many cases, are ignored totally. All three indicated a need to link with other educational institutions, businesses, and state agencies throughout the state to provide technical assistance.

4. <u>Community Colleges</u>

The main mission of the 19 state-supported community colleges in Kansas is to offer academic courses for the Associate Degree and to provide short term, job specific programs in the areas of continuing education and training and retraining. The colleges, with minor exceptions, have limited capacity in technological development and technical assistance outreach programs. This is due to the lack of research programs on the community college level, the size of the institutions, and the time limitations for faculty. Most faculty are teachers--not researchers--and full-time teaching loads (18 hours of weekly instruction and campus activity from 8-5 daily) mitigate against involvement in technical assistance programs.

In Kansas, few community college faculty do technical consulting, primarily due to a lack of expertise. Only three colleges reported consulting activities. When consulting activities occur, they are sporadic, informal and infrequent. Only two colleges noted regular consulting assignments. In addition, there are few incentives for providing technical assistance which is not connected with approved vocational programs. Since the only funds available come from student fees and county tax dollars, financing at the community colleges is credit driven. Any time spent in R&D and services are not typically covered.

Throughout the state, the general lack of equipment adds to the funding problems. None of the colleges reported adequate equipment at present. Further, there is an overall lack of information about how programs and other institutions work and a dire need for networks to make it easier for community colleges to find other technical resources. All 19 institutions expressed the need for better state-wide communications.

Community colleges in Kansas have important managerial assistance capacities, however. The colleges have a policy to assist their local business communities for education and training needs. This function and their capacity vary significantly throughout the state. It is premised on a regional, if not county, perspective and on the types and requirements of the small and medium sized businesses within their particular areas. With regard to management assistance training, the community colleges do this in several ways, utilizing several resources.

Colleges throughout the state react to the needs of their local business communities. These needs come to the attention of the colleges through several sources. In some cases, the business seeking training from the college contacts a staff person or faculty member directly. In other cases the involvement of college staff members in the local chambers of commerce, or other such organizations, is the principal mode of discovery. On occasion, staff members have been made aware of the needs of small business by informal conversations with business people. Yet another source of awareness is the various community college advisory committees throughout the state. Finally, community colleges have conducted various informal surveys to assess business needs in their local regions. These have served as sources of information for their specific training programs.

The delivery system for community college training is also varied, depending upon the needs of businesses and the time available for the training. Of consideration is also the financial and human resources required. Training is frequently done either at a workshop or a seminar. All 19 community colleges do both. Subjects covered range from customer relations, blueprint reading, and proper letter writing to data processing, business law, marketing, advertising, personnel, finance and economics courses. Office education and microcomputer courses have received particular attention in the short courses. To meet special training needs, one college, Independence Community College, has recruited laid-off Phillips Oil personnel to teach electronics and quality control. They have a reduced teaching load and are paid from adjunct funds, contracts, and/or local grants. Johnson County Community College has developed a model approach to firm-specific training in its relationship with Burlington Northern.

Workshops and seminars have also been conducted with the cooperation of the various small business development centers. These are located at all the Regents institutions, and for example, at Johnson County Community

College. SBDCs assist the community colleges with business counseling and training, business services, and provide various other business resources such as books, periodicals, films, videotapes, and computer software.

A third source of management assistance is the adult training programs which are partially financed by the State Department of Education. These programs are conducted by community college faculty, high school instructors or, perhaps local business people who are recruited specifically to conduct the workshop in their area of expertise. Topics range from store security to financial analysis. Such workshops are common throughout the mostly rural areas of the state. All 19 colleges report on their frequency and success.

The final source of training are the colleges' cooperation with the new and developing industry program of the State Department of Education. Colleges frequently act as the training agent for this program in their particular area. These short term training programs are tailored to very specific needs of both small and developing local industries. To date, 11 of the 19 community colleges have been involved.

To varying degrees, the community colleges also serve a brokering function for local businesses, referring the business to either a university or small business development center. Consultants are then sent to address the particular managerial problem. With regard to the brokering function, the community colleges pride themselves on their proactive approach within their particular regions. Almost all of them talk with local businesses and send letters and press releases out to highlight their training resources. Through these methods, plus faculty networking in the communities, businesses are contacting community colleges at a high rate. In part this would account for 30-50% growth in enrollments in many of Kansas' community colleges.

Still another activity of the community colleges is selected (and limited) faculty consulting. In a few cases, faculty are willing to do extra service out of loyalty to the community or their college. Fourteen community colleges have considered giving active faculty an underload teaching assignment to compensate them for their extra consulting work.

In addition to brokering, management consulting, and networking with SBDCs, several of the colleges have made major initiatives in incubator activity. For example, Labette Community College in southeastern Kansas made a substantial commitment to its incubator. Dodge City Community College is in the process of forming, within the next six months, an incubator in their community. Garden City Community College, through its chamber of commerce, has approached the telephone company to set up an incubator there. Allen County Community College is similarly considering an incubator, has already selected a site, and is searching for funding.

In sum, the engineering and technological capacity of the community colleges in Kansas is limited. They have strong management-related capabilities, but do not have the capability to be the sole basis for such activity. All the community college training programs are predominantly small- and medium-size business oriented. As a group, the colleges continue to search for ways to be further involved in their county and regional business activities. They possess real strengths in the areas of health care, computer application to farm/ranch management, oil and gas activity, law enforcement, beef-packing, and communication technology to produce software documentation. All 19 community colleges expressed the need for more information about how various statewide programs work. Eighteen of the nineteen mentioned the need for greater networking capabilities to know how to refer businesses to the technical resources and people that are available throughout the state. This would add an important dimension to their efforts to provide technical and business/managerial assistance to firms within their respective localities.

5. Conclusions

The following conclusions for technology transfer represent a synthesis of the above assessment of current activity and of the higher education environment in Kansas:

(1) The state does not have abundant science and technology resources. Nevertheless the research universities have sound academic programs in science and technology that could provide a foundation for productive technology transfer and liaison if appropriately linked and encouraged.

(2) Existing technology transfer programs are for the most part reactive, fragmented, and limited in impact. Furthermore, institutions are not distributed in the state in the areas where manufacturers are located, or where rapid growth and small business start-ups are occurring. On the other hand, there is an increasing willingness on the part of Kansas higher education to be involved, although there are significant barriers to involvement in applied research and technology transfer.

(3) As tends to be universal throughout the world, the research universities want funding largely for basic research. For example, it is far easier and more rewarding for faculty at the research institutions to obtain large federal government grants than to engage in technology transfer activities. Despite the movement towards working with industry, the research universities in Kansas to date have not developed significant partnerships with Kansas industry. At all three institutions, faculty involvement mainly occurs when there is an R&D element that is technology development.

(4) Little interaction exists between the schools of business of the research institutions and the colleges of engineering of these institutions, so that the capacity of the former to provide management assistance related to technological innovation and development is presently limited. There is however an increasing emphasis on production management, productivity and quality that can be built upon for industry liaison.

(5) Little scientific and technical information emanates from the higher education institutions in the state to Kansas industry. Insufficient links exist between university research and Kansas business, although the Applied Research Matching Program of KTEC has been valuable in encouraging such interaction.

(6) Our present Centers of Excellence are mostly university/faculty driven, making them less aware and responsive to business needs than they need to be to serve economic development objectives. Broader-based relationships with the business community are still in their infancy.

(7) Schools of business at the research institutions throughout the state have not been very encouraging of entrepreneurism on the part of their faculty, particularly in technology-driven matters. Individual faculty members at these schools of business are only infrequently involved in outreach activities. This void is particularly noticeable in meeting the needs of small- and medium-sized firms and in technology related management. On the other hand the non-research institutions have expanded their involvement in general management assistance substantially and productively.

(8) The strength of schools of business has primarily been in their relationship with SBDCs focused on business plans and other basics involving managerial assistance. Hence, a small- or medium-sized company that moves out of its start-up phase into a more mature phase often finds that SBDCs are not able, or do not have the capability to handle the level of work, especially when such work transcends the managerial assistance domain.

(9) The science and engineering capacity of the 19 public community colleges in Kansas is restricted by resource and mission limitations. All the community colleges in the state have considerable business/management assistance capacities which are mainly small- and medium-sized business oriented. All the colleges are presently searching for ways to increase their involvement in business activities in their regions.

D. Key Implications

The analysis of problems facing U.S. and Kansas industry indicates that the rapid changes in the structure of the global, national, and state economies are fueled by rapid technological change and intense global competition for markets. The U.S. is struggling to stay competitive by modernizing existing industries and by moving toward service industry and advanced technology manufacturing products.

Kansas has been slow to adapt to these basic economic realities. Kansas lags in R&D efforts, number of scientists and engineers in the workforce, number of new and rapidly growing firms, and number of advanced technology firms. These weaknesses interact with the fact that there are no federal research laboratories or private research institutions to spur technological advances within the state. The state's universities and colleges, as a whole, are not strong technological centers, although pockets of excellence exist. What technological expertise is available to lead or at least participate in modernization and innovation efforts are not organized or oriented toward dealing with technological and business problems that Kansas's businesses face. Even if academic institutions were oriented toward assisting businesses with their technical and business problems, barriers exist that discourage businesses from interacting with academics. Clearly, organized mechanisms are needed to facilitate business-academic interaction; and vigorous marketing of any programs formed will be necessary to inform and encourage businesses to take advantage of the programs.

III. TECHNOLOGY TRANSFER PROGRAMS IN OTHER STATES

The extent of the economic problems facing the state of Kansas must be considered when formulating a model for industry-academic linkages. Like other nations and states, Kansas needs coordinated, organized plans and programs for technology development, technology transfer, technical assistance, and business/managerial assistance. Because of its timing in entering the arena of industry-academic linkages, Kansas is in an excellent position to study programs implemented in other states, learn from their mistakes, and adapt what works well in other states. Thus, an in-depth analysis of programs in other states was done to determine what characterizes programs that have the greatest impact on industry.

A. Overview of Literature

In response to the need to keep up with technological change to improve productivity, pressure mounted in the U.S. for more innovation in the private sector and for more cooperation among organizations to participate in the revitalization of the American economy. Because of the "new federalism" pervading the early 1980s, fewer federal funds were available to launch a centralized effort in this area. The "new federalism," characterized by a severe budgetary environment, left state governments little choice but to take the lead in revitalizing state economies. Many states began technology development programs that were designed to organize and coordinate public (government), private (business), and academic resources (Plosila, 1987). State funds were used to encourage corporate and academic cooperation to promote technology development and research, transfer of technology to the private sector, and technical assistance.

While corporate support for and interaction with higher education dates back to the 19th century, the decade of the 1980s has seen a rapid evolution of this support. This change was driven by

- Government promotion of industry-academic linkages to enhance economic competitiveness in world markets;

- Industry's desire to improve competitive position through access to graduates, faculty expertise, innovation and product development;

- Academic institutions' need for financial support (Fairweather, 1989).

As the evolution in government, business, and academic cooperation continues, programs are developed, modified, and reorganized to emphasize technology transfer (capitalizing on university research or integrating technological results of research into existing industry or into new products), business/managerial assistance, and technical assistance. The overriding concern is economic development.

> "Economic development analysts generally agree that while advances in scientific and technological knowledge are indispensable for spurring innovation, this activity is part of a larger process by which new ideas are reduced to practice and introduced into the market. The desire to ensure that the fruits of research are used for technological development thus leads to an interest in ways in which the academic/industrial connection might foster the transfer of technology" (Johnson, 1984).

Industry must continuously innovate to cope with rapid product and process changes of a continuously changing technological and market environment. Three types of innovation are needed to anticipate and meet market changes:

1. Incremental improvements to existing products, production methods, and processes;

2. Diversification, using existing expertise and capabilities in different product markets; and

3. Radical departures from previous activities, based on the introduction of products or processes embodying novel applications of technology (Johnson, 1984).

Not surprisingly, the evolution of industry-academic liaison activities has resulted in programs that address these three types of innovation. Technical assistance and business assistance programs provide expertise businesses need to modernize, to make the incremental improvements in existing products, production methods, and processes. Applied research and technology development programs assist businesses in using existing technology to make more significant changes, such as product diversification. Basic research programs create new technology that can lead a business to depart radically from previous activities (new products, processes, etc.).

While programs have evolved to meet the need for different types of business innovation, the progress has not always been orderly. An extensive review of the industrial-academic liaison literature (Fairweather, 1989) offers several key points regarding the evolution of these programs and the philosophy or rationale guiding that evolution:

1. The literature is dominated by ideological-driven debate. Advocates of industrial-academic relationships believe universities should play a role in economic development. Opponents believe universities should be independent of the marketplace or believe they are not effective vehicles for promoting economic development.

2. Little evaluative data are available, especially of a comparative nature (comparing one type of program with another). Little evidence can be found to answer ideological arguments of whether industry-university alliances produce cost-effective economic benefits.

3. The most widely recognized form of industry-academic relationship is research agreements. These account for the largest portion of funds given, but account for only a small portion of the relationships between industry and academia. Other relationships include such things as faculty consulting, training, and information dissemination (conferences, etc.), business/managerial assistance, and technical assistance.

4. Industry and academia have fundamentally different cultures. They differ in motivation, goals, organizational structures, and employee attitudes, behavior, and reward systems. These differences affect the degree of compatibility that exists between various types of industrial-academic liaisons.

The literature also provides additional insight into the academic disciplines and industries that most frequently engage in collaborative research agreements. The industries frequently participating in these research relationships include chemicals, electronics, food, manufacturing, petroleum, pharmaceuticals, and biotechnology (National Science Foundation, 1982b; Kenney, 1986). These industries are characterized by a greater emphasis on research, innovation, and manufacturing than companies driven mainly by marketing and sales (Lawrence & Lorsch, 1967). It is evident that firms with strong, sophisticated research and development departments are usually more aware of faculty research and can utilize those research results more effectively. Since the ability of the industrial sponsor to take the invention to market is crucial to achieving economic benefit, more direct attention on industry's ability to do that is critical for economic development.

Because certain types of industry fund academic research, funding is concentrated in a few academic fields. Technical areas of particular importance to the corporate sponsor are funded. Disciplines frequently funded include engineering (especially electrical, mechanical, manufacturing, materials, and robotics), computer science, medicine, agriculture, chemistry, and biotechnology (Blumenthal et al., 1986; Holmstrom & Petrovich, 1985; Kenney, 1986; National Science Board, 1987; Nelson, 1986; Peters & Fusfeld, 1983; Wofsy, 1986).

Several factors seem to be important in corporate choice of academic institution for research agreements. Important factors include the caliber of the research program (Geiger, in press, Praeger & Omenn, 1980), geographic proximity (Broce, 1986; National Science Foundation, 1982b), fiscal strength, quality of leadership, and history of relationships with an academic institution (National Science Board, 1987; Praeger & Omenn, 1980).

The importance of this funding to universities cannot be underestimated. Universities could not have started research programs in some areas, such as biotechnology, without industry support (Brooks, 1984; Kenney, 1986). In addition, certain disciplines have used industrial revenue to make up for funding lost due to decreases in federal funds (Fowler, 1982-1983).

B. State Initiatives

Nature and Investment

Most states are actively providing funding for programs to promote technological innovation. Because of the variability in the problems faced and the resources available within each state, state programs range from limited managerial and technical assistance to comprehensive, multi-million dollar programs. The types of programs are defined as:

Technology Offices. Thirty-six states have boards, commissions, authorities, or offices that oversee or coordinate state technology initiatives. The most common type of structure is a public/private partnership comprised of representatives from private firms, academia, and state government. Technology offices may operate as independent public agencies or private nonprofit corporations. States without a technology office may have a science and technology policy advisor. The duties and responsibilities of technology offices range from the administration of multi-million dollar technology centers to providing information dissemination and advisory services.

Research Grants. Research grants are a common component of many state technology development strategies. Grants are usually made to universities based on joint proposals from the university and a private sector sponsor. Most often, these grants require a certain level of matching funds from the private sector. Grant approval usually depends on its potential for economic development and future job creation.

Research Parks. Research parks are planned groupings of technology companies, often near universities, that encourage university/private partnerships. They draw industry to a particular location and provide incubator facilities and services which encourage the development of new businesses. Generally, states provide initial capital with the requirement that future funds come from private sources.

Incubators. Incubator facilities provide below-market rates for office and lab space for start-up companies. In addition, these facilities offer shared support for clerical, reception, and computer services. Generally, a company's stay in an incubator facility is limited. Once a company has progressed to a specified development level, it is expected to leave the incubator in order to allow the facility to accommodate new start-up companies. Incubator facilities are usually located in or near advanced technology centers and commercial research parks.

Technology Transfer. Technology transfer programs facilitate the transmission of new technologies from the laboratory to the private sector. These technologies can become the impetus for the creation of new businesses, the introduction of new product lines for established firms, or the revitalization of mature industries. Technology transfer is achieved through information exchange and active outreach programs which seek users for existing and newly-developed technologies.

Technical/Managerial Assistance. Twenty-nine states have programs which provide technical or managerial assistance to technology companies. Programs assist in the development of business plans and marketing strategies, advise firms on personnel, accounting, and legal matters, and identify sources of financing. Professionals also evaluate product lines and manufacturing processes, assist in the use of state-of-the-art design and manufacturing tools, and identify special expertise at universities and other research centers.

Seed/Venture Capital. Seed and venture capital programs provide risk financing to early-stage companies that are unable to secure funds from traditional sources. Funding is provided to start-up companies whose projects have commercial and/or job creation potential. Seed capital is provided to companies that have yet to develop a marketable product. Venture capital financing is available to developing companies with established business plans and commercially feasible projects.

Technical Training. Some states have realized the significance of a skilled workforce for attracting high technology businesses. As a result, various training programs have been developed to meet this need. States either sponsor programs through an institute for higher learning or provide financial assistance to private companies to implement their own training programs.

Information/Networking. Information/Networking programs act as clearinghouses to provide a variety of business and technical information to state firms. These programs provide access to national and local database services, disseminate information on state and federal financing programs, and identify technological expertise at universities and other research centers. These programs may also attempt to develop cooperative programs among private companies, universities, and government agencies to work together in solving common business or technology problems.

Equity/Royalty Investment. States with equity or royalty investment programs provide risk capital to new start-up businesses and developing firms. Funding is generally available to companies with commercially feasible products and processes. Typically, funds are used as working capital for land and equipment purchases, organizational expenses, and research and development efforts. Equity investments provide a stake in the financial success of the firm. Royalty investments require a repayment to the state based either on a dollar amount per unit sold or a percentage of gross or net revenues.

Source: Office of Science and Technology, Minnesota Department of Trade and Economic Development, 1988. State Technology Programs in the United States.

Some states have only one type of technology program, while others approach technological development by investing simultaneously in a number of programs. The following summary of state initiatives is drawn from the recent study of the Minnesota Office of Science and Technology (1988).

Table 54 presents the type of science and technology program found in each state. In 1988, 36 states had technology offices, 30 had some form of technical/managerial assistance programs, 29 had established technology/research programs, 25 were involved in technology transfer, and 15 were involved in information/networking programs.

As Figure 10 indicates, the primary focus in the last few years has been on the expansion of technical/managerial assistance (from 23 states in 1986 to 30 in 1988), technology transfer programs (from 20 to 26 states) and technology/research programs (from 27 to 29 states). This new focus on technology development, transfer and liaison undoubtedly reflects state's perceptions of what programs are cost effective in achieving the overall goal of enhancing innovation and competitive ability. Despite the new focus, the national distribution of state expenditures on science and technology initiatives still centers upon technology/research centers and research grants. As noted in Figure 11, over 41% of state expenditures went to technology/research centers, around 18% was invested in technology transfer, liaison and assistance programs.

Table 54

SCIENCE AND TECHNOLOGY PROGRAMS BY STATE

State	Technology Offices	Technical & Managerial Assistance	Incubators	Seed Capital Programs	Venture Capital	Tax Incentives	Equity Programs
Alabama	*	*	*				
Alaska	*	*					
Arizona		*					
Arkansas	*	*	*	*		*	
California							
Colorado	*						
Connecticut	*		*	*			
Delaware	*	*				*	
Florida	*			*			
Georgia	*	*	*		*		
Hawaii	*	*	*		*		
Idaho		*					
Illinois	*		*		*		*
Indiana	*	*		*		*	
Iowa	*	*	*			*	
Kansas	*	*		*			
Kentucky	*	*	*				
Louisiana							
Maine	*						
Maryland	*	*	*				
Massachusetts	*						*
Michigan	*	*		*		*	
Minnesota	*	*			*	*	
Mississippi		*					
Missouri	*		*			*	
Montana	*	*		*			
Nebraska	*	*			*		
Nevada							
New Hampshire		*	*				
New Jersey	*	*	*				
New Mexico	*			*	*		
New York	*	*			*		
North Carolina	*	*	*				
North Dakota		*					
Ohio	*		*				
Oklahoma	*					*	
Oregon	*	*		*		*	
Pennsylvania	*	*	*	*	*		
Rhode Island	*						
S. Carolina	*	*					
South Dakota							
Tennessee	*	*			*		
Texas		*					
Utah					*		
Vermont			*				
Virginia	*	*	*			*	
Washington	*	*	*			*	
West Virginia							
Wisconsin							
Wyoming	*						

Table 54 continued

SCIENCE AND TECHNOLOGY PROGRAMS BY STATE

State	Royalty Programs	Technology & Research Centers	Research Grants	Technology Transfer	Technical Training	Research & Technology Parks	Information/Networking
Alabama			*		*		
Alaska							
Arizona		*				*	
Arkansas				*			
California			*				
Colorado		*		*			*
Connecticut	*		*			*	*
Delaware		*			*	*	
Florida			*	*	*		
Georgia		*		*			*
Hawaii		*			*	*	
Idaho		*					
Illinois	*			*		*	
Indiana			*	*			
Iowa	*	*	*			*	
Kansas		*	*	*			*
Kentucky		*	*	*		*	
Louisiana							
Maine			*	*			*
Maryland		*					*
Massachusetts		*			*		
Michigan	*	*	*		*		*
Minnesota		*	*	*	*	*	
Mississippi				*	*		
Missouri		*		*		*	*
Montana			*	*			
Nebraska		*					
Nevada							
New Hampshire							
New Jersey		*	*	*			
New Mexico		*		*			
New York		*	*				*
North Carolina	*	*	*				*
North Dakota		*		*			
Ohio		*	*	*			*
Oklahoma		*	*	*			*
Oregon			*	*			*
Pennsylvania		*	*				
Rhode Island			*	*			
S. Carolina						*	
South Dakota			*				
Tennessee		*		*		*	
Texas			*	*			*
Utah		*					*
Vermont			*	*			
Virginia		*	*	*			
Washington		*		*			
West Virginia		*			*		
Wisconsin		*	*	*	*		
Wyoming							

Figure 10

Science and Technology Initiatives
Distribution of Programs in the U.S.
FY 1986 and FY 1988

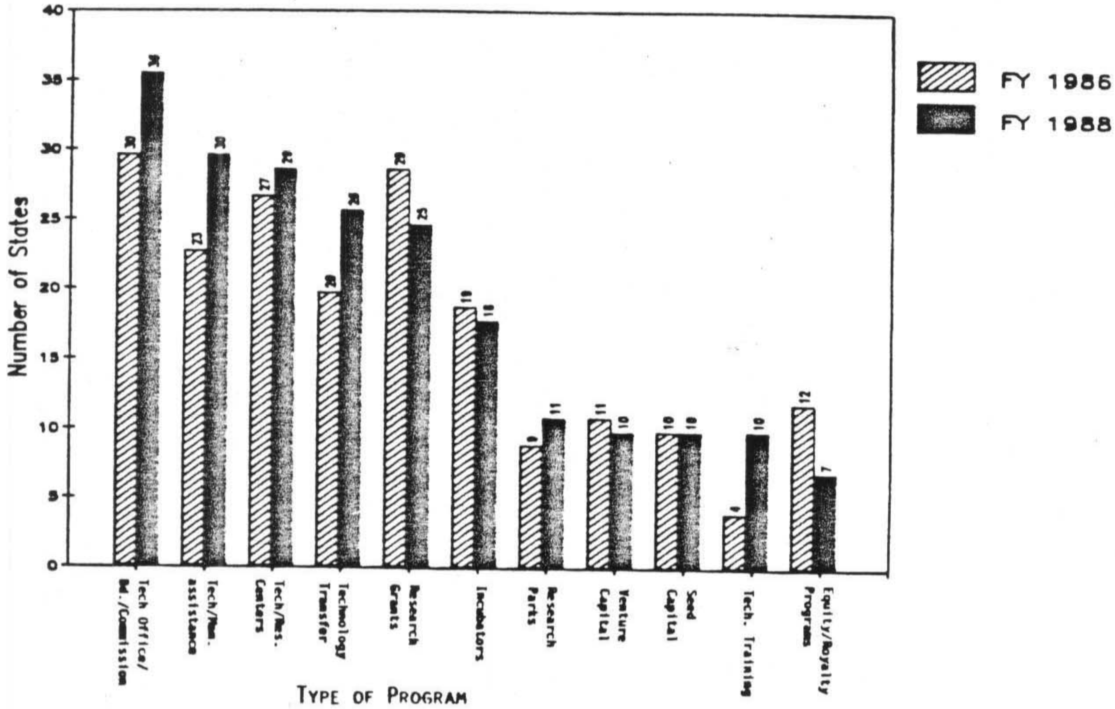
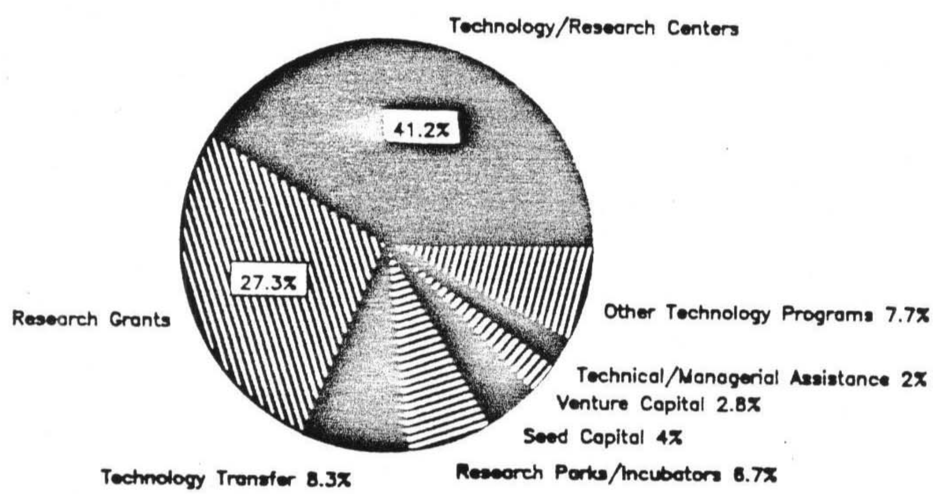


Figure 11

Science and Technology Initiatives
Distribution of State Expenditures in the U.S.
Fiscal Year 1988



Source: State Technology Programs in the United States, 1988: Office of Science and Technology, Minnesota Department of Trade and Economic Development

State general funds provide most of the financial resources for these programs (Table 55). Ten states draw funds from other sources including bond issues, state lottery funds, pari-mutual gambling receipts, and state employee pension funds. The levels of support from sources other than general funds range from 100% program support through lottery receipts in Oregon and North Dakota to less than 10% lottery support in Iowa. Individual state expenditures for science and technology programs in FY 1988 varied from no allocation in Nevada, Idaho, South Carolina, Vermont and Wyoming to over $76 million in New Jersey. Traditional manufacturing states of the Northeast and Midwest have tended to invest most intensely in technology programs, while rural western states tend to have the fewest programs and provide the least money. Table 56 also indicates the highest per capita spending occurred in New Jersey, Minnesota, Missouri, and New Mexico. Kansas ranks 29th. Four states allocated more than $30 million (New Jersey, Texas, Pennsylvania, Minnesota) while 56% of the states committed between $1 and $20 million to the effort (Figure 12 and 13).

As programs broaden their approach through the addition of technology transfer and assistance programs, states are placing more emphasis on understanding the needs of the private sector and the market they operate in. Many state programs have created non-profit corporations to run their initiatives to remain closer to the needs of business and for cultural reasons explained below. Business needs are emphasized by encouraging corporate board members to assist in setting research goals to ensure that results have market potential. Industry participation is encouraged and market relevance is stressed. Consequently, programs are more proactive.

Table 55

1988 FISCAL FUNDING FOR TECHNOLOGY INITIATIVES

STATE	TOTAL STATE FUNDING	STATE GENERAL FUNDS	INITIAL STATE FUNDING	BOND ISSUE	MISC. * FUNDING SOURCE
Alabama	$ 2,855,205	1,055,205			1,800,000 (a)
Alaska	30,000	30,000			
Arizona	7,000,000	7,000,000			
Arkansas	3,150,000	3,150,000			
California	5,900,000	5,900,000			
Colorado	3,700,000	3,700,000			
Connecticut	12,550,000	9,450,000		3,100,000	
Delaware	1,650,000	1,550,000		100,000	
Florida	27,958,000	27,958,000			
Georgia	11,094,430	11,094,430			
Hawaii	2,851,000	2,851,000			
Idaho	0				
Illinois	13,540,000	12,540,000		1,000,000	
Indiana	10,637,500	10,637,500			
Iowa	4,895,000	1,395,000			3,500,000 (b)
Kansas	3,550,000	3,425,000			125,000 (c)
Kentucky (FY89)	560,000	560,000			
Louisiana	0				
Maine	184,280	184,280			
Maryland	7,365,750	7,365,750			
Massachusetts	14,665,000	14,665,000			
Michigan	13,063,500	13,063,500			
Minnesota	39,439,200	39,439,200			
Mississippi	9,300,000	9,300,000			
Missouri	28,566,000	28,466,000	100,000		
Montana	3,550,000	3,550,000			
Nebraska	858,500	858,500			
Nevada	0				
New Hampshire	200,000	200,000			
New Jersey	76,345,000	19,345,000		57,000,000	
New Mexico	7,654,000	7,654,000			
New York	22,129,300	22,129,300			
North Carolina	23,357,000	23,357,000			
North Dakota	207,000	207,000			
Ohio	18,000,000	18,000,000			
Oklahoma	12,046,375	12,046,375			
Oregon	2,215,000				2,215,000 (d)
Pennsylvania	49,050,000	49,050,000			
Rhode Island	2,000,000	2,000,000			
South Carolina	0				
South Dakota	3,050,000				3,050,000 (e)
Tennessee	13,109,400	13,109,400			
Texas	60,690,000	60,690,000			
Utah	5,187,000	5,187,000			
Vermont	0				
Virginia	9,400,000	9,400,000			
Washington	11,000,000	11,000,000			
West Virginia	150,000	150,000			
Wisconsin	18,978,000	18,978,000			
Wyoming	0				

* MISCELLANEOUS FUNDS:

(a) State Trust Funds
(b) State Lottery
(c) State Gaming Funds
(d) State Lottery
(e) Future Fund

Source: State Technology Programs in the United States, 1988: Office of Science and Technology, Minnesota Department of Trade and Economic Development.

Table 56

1988 STATE TECHNOLOGY PER CAPITA EXPENDITURES

STATE	FUNDING	POPULATION	PER CAPITA
ALABAMA	$ 2,855,205	4,083,000	0.70
ALASKA	30,000	525,000	0.06
ARIZONA	7,000,000	3,386,000	2.07
ARKANSAS	3,150,000	2,388,000	1.32
CALIFORNIA	5,900,000	27,663,000	0.21
COLORADO	3,700,000	3,296,000	1.12
CONNECTICUT	12,550,000	3,211,000	3.91
DELAWARE	1,650,000	644,000	2.56
FLORIDA	27,958,000	12,023,000	2.32
GEORGIA	11,094,430	6,222,000	1.78
HAWAII	2,851,000	1,083,000	2.63
IDAHO	0	998,000	0
ILLINOIS	13,540,000	11,582,000	1.17
INDIANA	10,637,500	5,531,000	1.92
IOWA	4,895,000	2,834,000	1.73
KANSAS	3,550,000	2,476,000	1.43
KENTUCKY (FY89)	560,000	3,727,000	.15
LOUISIANA	0	4,461,000	0
MAINE	184,280	1,187,000	0.16
MARYLAND	7,365,750	4,535,000	1.62
MASSACHUSETTS	14,665,000	5,855,000	2.50
MICHIGAN	13,063,500	9,200,000	1.42
MINNESOTA	39,439,200	4,246,000	9.29
MISSISSIPPI	9,300,000	2,625,000	3.54
MISSOURI	28,566,000	5,103,000	5.60
MONTANA	3,550,000	809,000	4.39
NEBRASKA	858,500	1,594,000	0.54
NEVADA	0	1,007,000	0
NEW HAMPSHIRE	200,000	1,057,000	0.19
NEW JERSEY	76,345,000	7,672,000	9.95
NEW MEXICO	7,654,000	1,500,000	5.10
NEW YORK	22,129,300	17,825,000	1.24
NORTH CAROLINA	23,357,000	6,413,000	3.64
NORTH DAKOTA	207,000	672,000	0.31
OHIO	18,000,000	10,784,000	1.67
OKLAHOMA	12,046,375	3,272,000	3.68
OREGON	2,215,000	2,724,000	0.81
PENNSYLVANIA	49,050,000	11,936,000	4.11
RHODE ISLAND	2,000,000	986,000	2.03
SOUTH CAROLINA	0	3,425,000	0
SOUTH DAKOTA	3,050,000	709,000	4.30
TENNESSEE	13,109,400	4,855,000	2.70
TEXAS	60,690,000	16,789,000	3.61
UTAH	5,187,000	1,680,000	3.09
VERMONT	0	548,000	0
VIRGINIA	9,400,000	5,904,000	1.59
WASHINGTON	11,000,000	4,538,000	2.42
WEST VIRGINIA	150,000	1,897,000	0.08
WISCONSIN	18,978,000	4,807,000	3.95
WYOMING	0	490,000	0

Source: State Technology Programs in the United States, 1988: Office of Science and Technology, Minnesota Department of Trade and Economic Development

Figure 12

Science and Technology Initiatives

State Funding Levels
FY 1986 and FY 1988

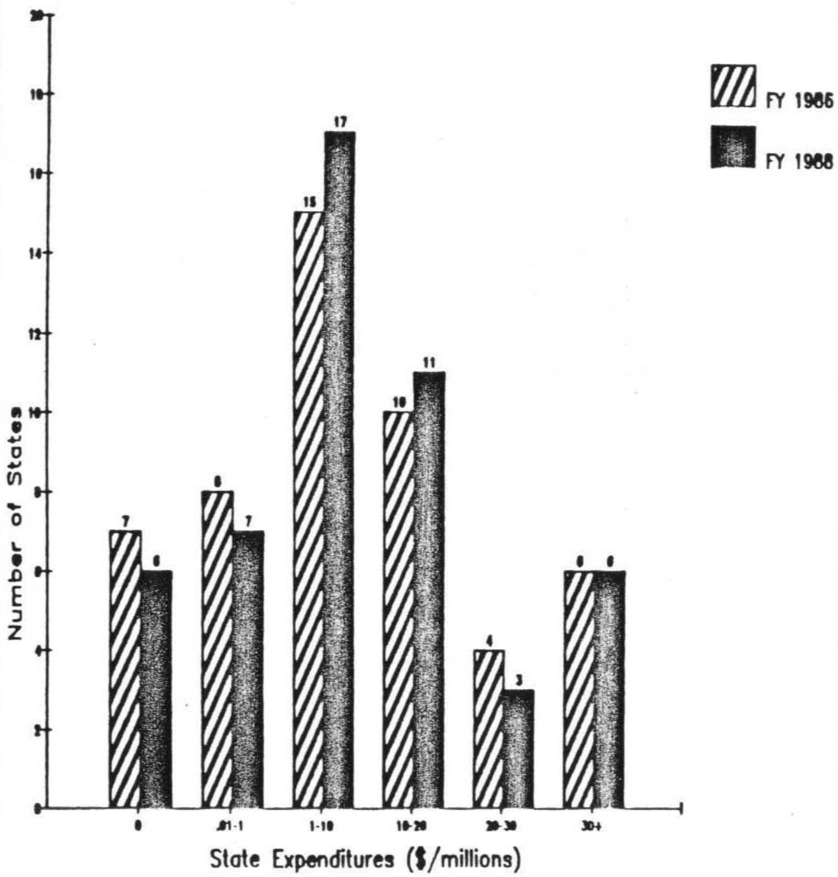
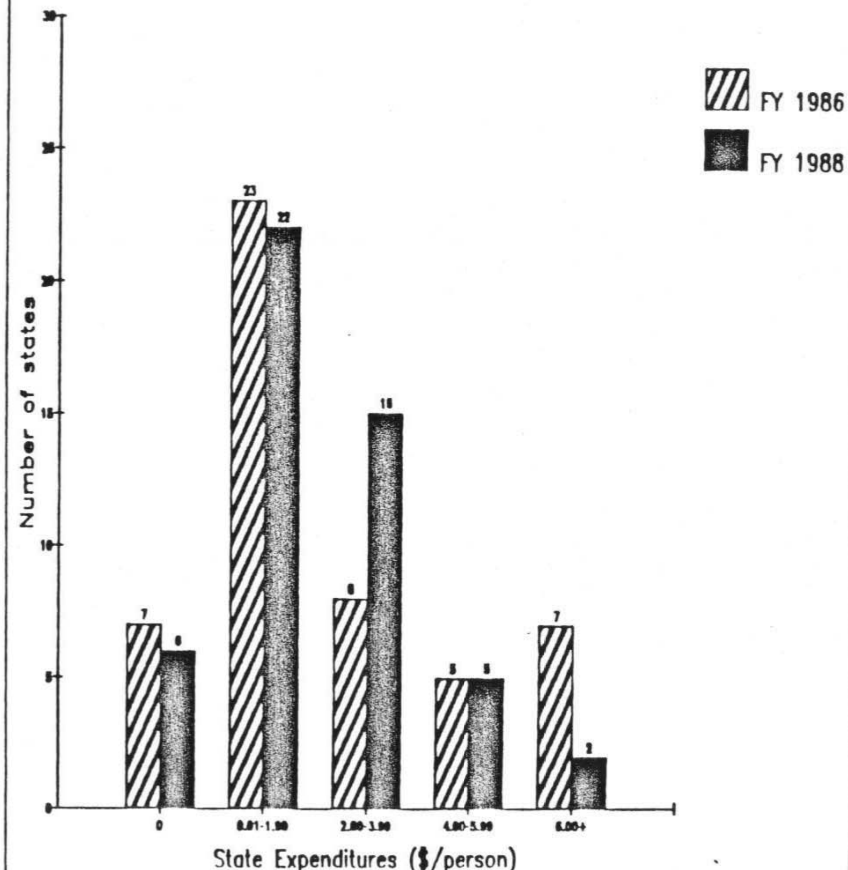


Figure 13

Science and Technology Initiatives

Expenditures per Capita
FY 1986 and FY 1988



Source: State Technology Programs in the United States, 1988; Office of Science and Technology, Minnesota Department of Trade and Economic Development.

Programs take responsibility for making businesses aware of the technical/ managerial assistance that these initiatives can provide them.

The creation of a comprehensive system of technological advancement necessitates addressing a number of critical issues. Although each state is unique in its relative strengths, and many programs are built around those strengths, there are some common issues (barriers/problems) that nearly every state must address in order to have an effective operation.

Barriers/Problems

Many, if not all programs, integrate the resources of three different sectors of society. Table 57 summarizes the attributes common to the three cultures that converge in state-sponsored technology programs: academic, public, and private. The public and private cultures are similar on many dimensions (e.g. time horizon, mode of thought, mode of work, and expression, etc.) and the academic culture is dissimilar in most dimensions.

Cultural differences exist primarily because of dissimilarities in purpose or mission of the three groups. For example, the mission of academic institutions is to extend and disseminate knowledge while the goal of private industry is financial viability and profit. This results in different values (e.g. freedom of inquiry and open exchange of ideas vs. commercialization and proprietary knowledge) and different measures for success (e.g. research productivity and quality education vs. meeting business objectives and profitability). Thus, it is not surprising that when academic institutions and private industry try to work together, difficulties arise. For example, collaborative research programs often flounder over conflicts university researchers have with industrial sponsors regarding proprietary data, ownership of intellectual property, and narrowness of work statements. Industry sponsors, in turn, often complain about lack of progress during the first year of funding, straying from project goals, and faculty insistence on the right to present and publish research results.

Table 57
Three Cultures: University, Government, and Industry

Attribute	Culture		
	Academic	Public	Private
Driving interest	Respect of peers	Approval of voters	Profit
Time horizon	Long	Short	Short/Medium
Mode of thought	Generic	Particular	Particular
Mode of work	Solo	Collaborative	Collaborative
Mode of expression	Abstruse, qualified	Simple, absolute	Simple, absolute
Desired outcome	Original insight	Reliable solution	Commercial application
Preferred form of conclusion	Multiple solutions, uncertainties emphasized	One best solution, uncertainties submerged	Profitable, uncertainties resolved
Concern about feasibility	Small	Great	Great
Stability of interest in topic	Low	High	High
Confidentiality interests	Freedom to publish	Public access to information	Proprietary interest

Source: L. Johnson. 1986. "The Requirements for Effective College and University Involvement."

To achieve successful collaboration across cultures, programs must be carefully constructed so that these tensions are minimized. Response to these issues varies. Table 58 addresses some of the barriers to industry-academic linkages. Academic institutions have faced these barriers and dealt with them in various ways when engaging in economic development programs. Many of the solutions demonstrate a willingness to remove or correct policies that impede academic-industrial collaboration (e.g. lack of faculty incentives and rewards, more flexible policies, and new organizational vehicles) while protecting the fundamental academic mission of the dissemination and extension of knowledge.

Table 58
Overcoming Barriers to College and University Involvement in Economic Development

Barrier	Solution
Unclear mission	Strong leadership. Restatement of mission. Development of new mission.
Faculty resistance	Incentives and rewards. Recruiting new faculty. Recognition.
Arts/Sciences conflicts	Involvement of arts and humanities with industry and community.
Possible conflicts of interest	Development of policies to protect university interests.
Lack of understanding of community and industry needs	Ongoing dialogue. Periodic surveys, assessments.
Lack of public awareness of university resources	Communication activities.
Lack of resources for economic development	New industry support. New state programs.
Administrative constraints	More flexible policies. New organizational vehicles.
Poor internal communications	Interdisciplinary activities.
Lack of linkages to industry and community	New organizational arrangements.

Source: L. Johnson, 1986. The Higher Education-Economic Development Connection.

As a result of experience in dealing with these cultural differences, states have designed different programs that exploit the natural strengths of the public, private, and academic sectors to meet different economic objectives. Many states have created separate, not-for-profit, corporations to act independently of these cultures, to better react to the needs of the private sector, and to fully utilize the potential of each of these resources.

Another factor that becomes apparent when studying these programs is that no single program addresses all economic objectives. A variety of programs are required, varying from basic research at the university level, to proactive, independent assistance to industry to facilitate the implementation of current technology. Thus, designing a state initiative to meet the technological needs of industry is a challenging task.

Specific Responses by Selected States

To better understand how to design and implement a comprehensive state technological initiative, the programs of several states were examined in detail. This included extensive on-site visits and interviews. The states and programs that were examined for this project represent a broad cross-section of the technology development initiatives currently in operation. The states analyzed were Indiana, Iowa, Virginia, Pennsylvania, and Ohio. These states represent diverse approaches, they have been relatively successful, and they have had a record that is long enough to justify review and evaluation.

IOWA

Technology transfer and assistance efforts in Iowa are initiated through a variety of state sponsored programs and the universities within the Regents system. Funding for all of these programs is provided through a combination of state general funds and state lottery proceeds. Total amounts for 1988 include $1.4 million in general funds and $7 million in lottery funds.

The state sponsored programs are: 1) the **Iowa High Technology Council**--an advisory group formed to assist the Iowa Department of Economic Development in making policy and funding decisions regarding technology development; 2) the **Iowa Product Development Corporation**--a group that provides funding and marketing support for targeted new products or processes in the state; and 3) various capital access and incentive programs including the **Iowa Venture Capital Fund, Research and Development Tax Credit Program,** and the **Iowa Innovation Program** (Table 59).

Specific university programs include the **Center for Industrial Research and Service (CIRAS)**, which is a managerial and technical assistance outreach program founded in 1963 at Iowa State University, and the **Technology Innovation Center (TIC)**, an incubator facility established at the University of Iowa to offer both technical and managerial support to new or developing businesses. These programs are administered and staffed through their host institution but they receive funding and operational support from the state. The two are described in detail below.

The **Center for Industrial Research and Service** (Table 59) was established in affiliation with the School of Engineering at Iowa State University to provide a wide variety of assistance to the state's small- to medium-size businesses. CIRAS' primary activities include helping existing companies to become more productive through the integration of advanced management and technical processes. The thrust is not towards 'high-technology' per se, but rather towards assisting businesses to identify and address problems inherent in their current operations. In the technical area, such categories as improved plant design and layout, equipment procurement, materials refinement, and research methodology are included. Management assistance covers topics such as inventory control systems, assistance in the preparation of financing and bidding proposals, market research, and computer accounting systems.

CIRAS also provides educational services in the form of seminars and information searches, and will assist businesses in establishing contacts with university faculty who may possess expertise in a particular area of technical need beyond the CIRAS staff's capabilities. The CIRAS field agents have recently been equipped with portable computers with modems so that they can conduct nation-wide data-base searches to anywhere in the country from their "client's" location. Various groups, including the Iowa legislature, have also requested that CIRAS serve as the administrator for special research projects and funds. CIRAS also assists in technology transfer throughout the state by coordinating the interaction of technology-related businesses with faculty researchers.

CIRAS operates through a combination of six agents in the field and a 13 member in-house professional/engineering staff. The field agents are proactive. They contact the businesses in their respective regions and then work closely with the central staff in solving the particular problems. CIRAS handles approximately 1200 requests for assistance per year. There is no charge for its services. If a company requests an ongoing relationship, CIRAS will provide references to faculty or professional consultants, and then assist in the contract negotiations. CIRAS conducts a biannual survey of the small-to-medium size businesses in Iowa in order to fine-tune its agents activities to the market needs of the state. Every company that receives assistance from CIRAS is required to fill out an evaluation form describing the nature and effects of the service.

CIRAS has established an excellent reputation throughout Iowa for the quality of services it provides. Many of the requests come from businesses who have used the service. Both the state government and the university are strong supporters of this program and assure its ongoing operation.

CIRAS' successful efforts have created additional program needs. One of the most critical is the integration of other universities in the effort. ISU realizes it has some specialized strengths, such as its engineering school, but would also like to draw on the expertise of the other regents institutions to provide more comprehensive services to businesses.

The Technology Innovation Center (Table 59) at the University of Iowa is attempting to build on the university's world-class research agenda. The Center seeks to facilitate the interaction between academic researchers and technology related companies. It serves as an information clearinghouse for high-technology research projects occurring at the university and acts as an administrator and support organization for technology related companies locating in the university incubator facility.

In its capacity as an information clearinghouse, TIC distributes directories which lists all faculty researchers and their projects, and all available on-campus research equipment. This service is directed at state, national, and international companies who may have an interest in a particular area of research conducted by university faculty. As the administrator and support facility for the companies in the incubator and research park, TIC provides management assistance, clerical support, portable and mainframe computer access. It also assists in obtaining grants or other funding for its clients.

TIC has a director and a small support staff. A Small Business Development Center is located in the same administrative building and provides much of the business/managerial help required by the new high-technology companies. TIC charges a minimal fee for the services and space provided to the companies involved with the center.

The operations at the University of Iowa main campus and satellite location at Oakdale are limited to the needs of its geographic area. Integration with CIRAS and their services are limited due to the separation of the two efforts by both location and school.

The Iowa Product Development Corporation (Table 59) provides a comprehensive network of assistance services to introduce new products or processes in the state. It interacts with universities and experts to help bring the new product to the marketplace. Networks and processes for assistance are still being secured, as it is a relatively new program.

IPDC does provide up to $150,000 for products developed to the design and/or prototype stage and assists in identifying other sources of financing. IPDC takes a royalty position in successful investments until some multiple of the original investment has been repaid to the state.

The IPDC also attracts new operations to Iowa. This effort has had recent success in attracting biotechnology processing plants. For example, Kodak recently announced the construction of a $400 million plant in Cedar Rapids.

Iowa has two additional university affiliated incubator facilities as well as a high-technology research park located at the University of Iowa's Oakdale Campus.

In summary, Iowa has created a comparatively unique program to serve the needs of its business environment. State efforts have been successful to the point that they are now seeking to expand beyond their created areas of location and activity. Additional key points about this program are:

1. There is a recognition that the programs need to be market, and not university, driven. CIRAS attempts to do this through its recurrent business surveys.

2. Mechanisms are built into its programs to keep the agents (or operators) current on the latest technological developments in their field.

3. Iowa sees the optimum technical assistance program as one having contact with all of the state's major educational institutions. It realizes that if a program is centered around one institution, the complete resources of the state will be underutilized. Furthermore, an ideal technology transfer program maintains contacts with many institutions outside of the state which expands the resources available for the needs of the state's businesses.

TABLE 59

IOWA

Iowa Department of Economic Development ==> Total State Funding $8.4 Million

	University Programs			
Iowa High Technology Council	CIRAS	University of Iowa Technical Innovation Center	Iowa Product Development Corporation	Various Capital Access Programs
-Advisory group to aid Iowa Department of Economic Development make policy decisions	-Established in 1963	-Advisory business incubator and provides technical information transfer	-Funding and marketing support for targeted new products or processes in the state	i.e.
	-An arm of the Iowa State University Extension Service	-Package of programs designed to cover "economic outreach"	-Funding available up to $150,000 for products developed to design and/ or prototype stage	-Iowa Venture Capital Fund
	-Assists owners and managers of manufacturing and processing firms through in-house technical assistance, networks of faculty or extensive on line database services	-Thrust is to advertise and promote the resources of the university--not to serve as a problem solving operation	-Assists in identifying other sources of financing	-R & D Tax Credit Program
	-13 person professional staff at the home office, at Iowa State University, and 6 field reps	-Promotes lab usage, research and some faculty assistance	-IPDC takes a royalty position until some multiple of the original investment has been repaid--3 time is typical	-Iowa Innovation Program
	-Field representatives actively visit firms and respond to call-in requests			
	-Most advisory assistance is free and CIRAS subsidizes up to 3 or 4 visits by a faculty member to a firm			
	-Organizes several seminars yearly and maintains contact with firms through a quarterly newsletter			

VIRGINIA

Virginia's activities are coordinated by the **Center for Innovative Technology (CIT)**. The center was created by legislation in 1984, and its board members are appointed by the governor. CIT has a staff of over 30 persons and has a total state budget allocation of $14.5 million. CIT consists of three interrelated programs: 1) Technology Development (Research and Development); 2) Technology Commercialization; and 3) Technology Transfer. (Table 60)

The thrust of technology development is very similar to the Centers of Excellence in Kansas. Funding is provided to the universities for research to create and improve new technologies. Four "research institutes" exist on state university campuses.

The original structure of this program was loosely defined and targeted to economic development. Thus, university faculty sent in various project proposals which used state funds to leverage their existing grants with little check as to their market potential. As CIT matured, it realized that there needed to be a better targeting of state resources to both university strengths and market needs. CIT created a more comprehensive evaluation mechanism to gauge the marketability and contribution to state economic development goals of these proposals.

Presently, the four research institutes concentrate on one of four (broadly targeted) technology areas: Biotechnology, Computer Aided Engineering, Information Technology, and Materials Science and Engineering. The Universities serve as administrators, orchestrating and funding projects throughout the state (Table 60).

The Institutes research projects are chosen competitively. Review and selection involves industry representatives, the Institutes, CIT staff, and technical peer groups from both in and out of the state. Not only does the group work to ensure intellectual and technical content of the proposals, but it also evaluates the potential benefits to Virginia's economy.

As indicated above, Virginia's R&D programs are evolving away from a university/research agenda. While utilizing the strengths of their research universities, they are also encouraging more interaction with the private sector in directing the efforts of R&D on university campuses. This evolution has sought to ensure that the economic development impact of the R&D activities is permanent.

Technology commercialization (Table 60) assists in the further development of technology to introduce products, processes and services into the marketplace. There are seven university-based centers to provide management and technical assistance for technology driven enterprises. These enterprises can either be developed by the university or emanate from the private sector.

Several of these centers also provide entrepreneurs with "incubator" space and services for offices and laboratories. The objective is to provide a supportive physical environment conducive to networking and successful business development.

Additional activities of this program include venture capital conferences, contacts for additional (small company) research co-sponsorship with universities, and a role in organizing companies sharing common strategic needs.

Virginia works hard to attract business to its university environment. There are, however, barriers to the movement towards cooperation due to lack of understanding and reluctance to contact these university resources. As Barry Holt, director of both the technical commercialization and technology transfer programs in the state, noted: "These traditional manufacturers think that we are only helping high-tech; service companies think that we really cannot do much for them because we are there for the basic manufacturing. It is an ongoing communication issue, having to articulate to companies what we do" (Interview, 1988).

The final program, Technology Transfer, was developed in late 1987 (Table 60). It was developed in response to the needs of existing business. The CIT promotional brochure describes this program as "... a bridge that helps research results cross into business applications." This program, modeled after the agriculture extension services, is based at the community colleges. Each office accommodates a regional director who is available to respond to business requests. It is targeted toward small- to medium-sized businesses. The director, in responding to a request, can access the resources of the higher education institutions and federal data bases as well as any other resource that may be available for the client's benefit. The agent then provides the company with options and potential solutions which may include referral to the technical development and/or commercialization divisions of the program. The service is free. If the agent refers the business to services or equipment that requires compensation, the business takes responsibility for the cost.

The Virginia Technology Transfer program developed evaluation techniques before the first regional center was created. Quantitative and qualitative benchmarks were included to evaluate the effectiveness of the program using measures such as job creation, business contact and level of assistance and referral capacity.

From its inception, the CIT program has made a significant transformation to move closer to the existing needs of business. In particular control of the programs has changed from being strictly university driven to a more "private sector" approach. The Technology Transfer program was created also for this purpose. Although the transitions have not been easy, Virginia considers it a positive and necessary move for economic development throughout the state.

Additional features of the Virginia program are:

1) Virginia has learned that evaluation techniques must be built into the design of the programs. Goals and expectations must be set at the beginning to avoid a "random walk" of state funds around and away from economic development.

2) Creating awareness of programs is imperative to the success of the program. Virginia is moving toward reaching those existing businesses and industries that will have a positive impact on the economy with assistance as well as building upon their high technology (and start-up high-tech) initiatives. The state has also realized these programs must take a proactive approach at all levels to encourage the future success of the initiatives.

3) Virginia realized that assisting their present industries to remain competitive is as important as creating new business. Through the creation of the Technology Transfer program, Virginia has diversified its efforts and has created separate and distinct expertise in each of the three CIT programs.

4) The CIT umbrella allows coordinated efforts and communication. Being within the same organization allows for more effective networking of research findings, services and capabilities.

TABLE 60

VIRGINIA

The Center for Innovative Technology (CIT) ==> Total State Support $14.5 Million

(funding access for all programs)

Technology Development	Technology Commercialization	Technology Transfer
-"Pure technology" research and development at 4 university based "research institutions"	-7 university-based "Innovation centers"	-"...a bridge that helps research results cross into business applications."
-The Institute of Biotechnology, Virginia Commonwealth University	-Assists in the introduction of products, processes and services into the marketplace	-Located at 10 community colleges and modeled after the agriculture extension service
-The Institute of Computer Aided Engineering, UVA	-Provides technical/managerial assistance	-Targeted toward small and medium-sized manufacturers, distributors, and service firms
-The Institute of Information Technology, VPI and SU	-Some incubator space	-Local agents only react when called by a local business
-Projects are co-sponsored by companies	-Works to facilitate joint ventures and industrial alliances	-Provides solutions through access to extensive data bases, consultation with faculty and/or professional businessmen and consultants
-Companies assist in directing the research material to ensure commercial application potential	-Assists in marketing and licensing intellectual property	

PENNSYLVANIA

Pennsylvania's efforts are administered by the Department of Commerce which coordinates three general programs, 1) the **Ben Franklin Partnership (BFP)** and its companion program, the **Industrial Resource Centers (IRC's)**; 2) state economic development capital support; and 3) the **Pennsylvania Technical Assistance Program (PENNTAP)** (Table 61). BFP was created in 1982 and houses two basic operations: 1) Advanced Technology Programs (ATC's), and 2) the Small Business Research Seed Grant Program. The economic development capital leverages incubator development, provides "venture" capital and economic revitalization tax credit. PENNTAP, created in 1965, is a technical transfer program based at Pennsylvania State University.

The Ben Franklin Partnership (BFP) program is directed by a board of directors chaired by the Secretary of Commerce. Currently, there is an increasing emphasis on attracting more board members with technical expertise from private industry so that the program can be private sector driven.

BFP's Advanced Technology Center's are located at Lehigh University, University City Science Center, Carnegie-Mellon University/University of Pittsburgh, and Pennsylvania State University. Each ATC is sponsored by a consortium of universities in a region (Table 61). They receive a majority of their funding through the Challenge Grant Program, a program similar in nature to the Kansas Applied Research Matching Program. To qualify for a grant, individuals and/or businesses submit a proposal to one of the four area ATC's, outlining the specific research project, budget, and state matching funding configuration. The proposals are reviewed at the ATC level on a competitive basis and recommended for state approval. Small business access to the program is facilitated through innovative forms of matching. A large majority of the proposals come with University sponsorship as a result of ATC brokering. Total state funding for the immediate past fiscal year was $28.5 million. This outlay was matched by more than $108.3 million from consortia members, including more than $69.2 million in private sector support.

The four regional ATC's provide three general types of services:

1) Joint applied R&D efforts (the Challenge Grant program mentioned above), a sort of "high-tech transfer program." Each ATC was created to complement the sponsoring university's field of excellence. The intention is to use these institutions not only on the basis of their strengths, but also to respond broadly to regional needs in science and technology.

2) Education and training, assisting all higher education institutions to provide training and retraining in skill areas essential in firm expansions and start-ups.

3) Entrepreneurial assistance services. This includes a full range of activities including product evaluation, technical assistance to select and use new technologies such as CAD/CAM, assistance in finding venture capital, incubator space for newly established firms, exchange of information among companies, Federal Small Business Innovation Research (SBIR) and Seed Grant proposal assistance, seminars and workshops on advanced technology topics, and assistance in finding funding sources for projects that do not fall under BFP auspices's.

The ATCs were originally developed as an organization within each university's system. After careful evaluation, ATC's were found to be overly influenced by their university location; they had become integrated within other university programs. The evaluation, presented to a Senate Committee on July 12, 1988 by the Secretary of Commerce, further noted that there was an imbalance of research initiatives with more developing from the universities than from the private sector. The evaluation revealed a need to make the program more responsive to market needs, to establish a closer partnership between universities and private industry, and to create a mechanism whereby it could be more responsive to the dynamics of the marketplace.

To respond to these concerns, the ATC's were incorporated into private, non-profit, independent corporations governed by a Board of Directors, consisting of membership from higher education institutions and at least 50% private sector participation. The BFP feels that this change more effectively takes advantage of the experience, foresight, and dynamism of the private sector while continuing to have a close university association.

The Industrial Resource Centers (Table 61) were created in late 1987, with the mandate to help small- and medium-sized traditional manufacturing firms use existing technologies and techniques (such as total quality control) to remain competitive in today's international marketplace. This program was created in response to the needs of existing business to better manage their existing resources and to assist in identifying new processes and technologies that would benefit the firm. Total state allocation for this program is $10 million with a $2 million limit for each individual program. IRC's have been established at Homestead, York, Delaware Valley, Bethlehem, Erie, Pittsburg, Williamsport, Philadelphia, and University Park Pennsylvania, and were originally sponsored by widely varying consortia.

The program is loosely defined so that each IRC can be constructed to best address the needs of the region it is serving. The staff, once called in, assists in problem identification and either uses in-house expertise and resources to address the issue, or conducts a search to find the appropriate party that would best address the firm's needs. Although the method of compensation for services at each IRC varies, a majority of the IRCs provide initial free consulting to resolve or determine the nature of the problem. Once this stage is reached or a paid service is brought in, the firm is billed in relation to its size. The services are provided by the IRC itself or that is arranged by it.

The funding of the IRC's comes from state support, and from matching contributions from the communities expressing interest in having one of these centers in their region. Match requirements were required to be a one to one match in the first year with expectations of an increase to up to two to one non-state to state match in following years. Further matches are conditional upon each IRC's performance and subsequent year's competition.

The IRC's are also set up as private, nonprofit corporations governed by their own board of directors, at least 50% of whose members represent private industry. The remainder of the board is expected to represent university/college and economic development interests. IRC's must have acquired an association with a university or community college with manufacturing/technology expertise (while explicitly remaining an independent entity) and should be able to attract the human and capital resources necessary to complete their designated work program.

During the 1988 evaluation, it was questioned as to whether the ATC's and IRC's were providing redundant or duplicative services. It was challenged that these two services should be integrated into one operating unit. The Secretary of Commerce made the following comments in response:

> ...We believe that these programs complement each other, while their focus and directions are clear and simple.
>
> The BFP (ATC's) focuses on technology innovation--its development and application. This is a program which invests in small firms and provides grants to a constituency that primarily includes young entrepreneurial "high-tech" companies and their academic partners.

The IRC initiative, on the other hand, is a <u>manufacturing</u> program...This program (does not) offer grants, but rather, services provided by professionals with backgrounds in private industry--reminiscent of the "agents" provided through the Agricultural Extension Service.

While the (BFP) continues to develop new technologies for future uses, the Industrial Resource Centers will service needs of existing production processes. These two initiatives send a clear signal to the business community that Pennsylvania is delivering on its promise to be more competitive in the world marketplace.

The final program of BFP (Table 61) is the research "seed" grant program for businesses seeking to develop or introduce advanced technology into the marketplace. These grants are provided to businesses of 250 or fewer employees, with preference given to firms with 50 or fewer employees. The maximum amount of grant is $35,000. Total state support in 1987-88 was $1 million.

Pennsylvania's state sponsored capital support includes three programs (Table 61):

1) The small business incubator loan program ($4 million '86-87) to fund the development of small business incubator facilities in local communities.

2) The seed "Venture" Capital fund. The program has helped to establish 5 privately managed Seed Capital funds. The state's $4.5 million appropriation has been matched by more than $27 million in private funds, resulting in $32 million in total funds available state wide. The funds provide equity financing to new businesses during their earliest stages of growth, including eligible firms located in small business incubators.

3) Economic Revitalization Tax Credit. This $25 million ('87-88) program permits corporations involved in any manufacturing, processing, and R&D activities to convert net operating losses that expired in 1981-82 into 20% tax credits of Pennsylvania plant and equipment investments.

The final program is the Pennsylvania Technical Assistance Program, PENNTAP (Table 61). PENNTAP, according to its promotional brochure:

> ...takes the form of technology transfer locating and translating into understandable terms the latest or most appropriate technical, scientific, and engineering information. While new advances are continually being made in ...(many) laboratories, news of these discoveries is often hard to come by, especially for individuals and small operating units. PENNTAP, with access to leading U.S. data banks, and government, university and private laboratories, bridges the research-applications gap.

PENNTAP's '87-88 state fiscal allocation was $250,000 additional funding is leveraged by the university and private grants for a total budget of $1.4 million. PENNTAP's services are free to clients and are marketed through active contact and through Penn State's 23 Continuing Education locations.

PENNTAP has ten "technical specialists," one and one-half librarians, two information specialists, five secretaries and one director. Initially, faculty were retained on a part-time basis. PENNTAP found a conflict with faculty "wearing two hats" as well as a traditional university reward system that seldom encouraged service of this type. Thus, technical specialists who have academic ties with the university but concentrate 100% of their time to PENNTAP were employed.

The impressive Pennsylvania program can be described as "... a private sector driven program based on University resources" (Interview, Jacques Koppel, Director, Ben Franklin Partnership, 1988). The key to success of the programs is cultivating awareness that such programs exist and always reminding the constituencies that help is available if it is needed. The following attributes of the Pennsylvania program are important to this study:

1) Pennsylvania has evolved to a market driven attitude. The programs have been clearly oriented to the needs of business. This has been accomplished by encouraging business participation through membership on various boards and having a flexible structure that can respond quickly to changes in technology and the market place.

2) This is a proactive program. Pennsylvania makes constant efforts to inform the public of their activities and to encourage business participation.

3) A broker/facilitator function is the foundation of the ATC and IRC programs. They are intermediary mechanisms to link business and education to mutual advantage and to the benefit of the state overall. Each mechanism deals with a different level of technology need.

4) Instead of legislative or BFP specification of location, and consortium, Pennsylvania invites all institutions and communities, to compete for state allocation for these programs on the basis of their strengths, regional needs, and desired organizational arrangement. Diversity of approach is expected and encouraged, within the broad framework of the state purposes of these programs.

5) The Technology Centers that BFP funds have broker functions, not research functions in contrast to Kansas' Centers of Excellence and Ohio's Technology Centers. They create the mechanism for research but do not do it themselves.

6) Basically, Pennsylvania sets the direction and purpose, imposes few restrictions, and monitors the individual centers to ensure that its program objectives are achieved. Funding is employed as the control mechanism to ensure compliance.

7) Pennsylvania has a comprehensive program. It is clearly focused.

TABLE 61

PENNSYLVANIA
The Department of Commerce ==> Total State Support $49.05 Million

	Ben Franklin Partnership			
Industrial Resource Centers (IRC's)	Advanced Technology Centers (ATC's)	State Sponsored Small Business Research Seed Grant Program	Economic Development Capital Support	PENNTAP
-9 private based assistance centers targeted at small to medium sized businesses	-4 independent, non-profit centers based at universities, utilizing their respective strengths	-Provided to companies with less than 250 employees seeking to introduce or develop advanced technology into the market place	-1) Small business incubator loan program. To subsidize up to half of total eligible costs for a small business incubator	-Assists in the transfer of technologies to new and existing industries, municipalities, educational institutions, and government agencies
-Assists existing industry develop methods and technologies to increase production, quality, and cooperation	-Research funded through "Challenge" grants. State monies matched with "funds" from the private sector	-Maximum grant is $35,000	-2) "Venture" capital fund. $4.5 million matched by $27 million in private funds. Five privately managed funds provide equity financing to new businesses	-Directed through Penn State University, their 23 campus offices and 3 regional centers
-Oversees any consulting relationship developed	-Each Center provides: --joint applied research and development efforts, in concert with the private sector --education and training. Assisting all higher educational institutions to provide training and re-training in technical and other skill areas essential in assisting firm expansions and start-ups --entrepreneurial assistance services, which include linking R&D, entrepreneurs, venture capitalists, and other financial resources	-Total state support is $1 million	-3) Economic revitalization tax credit	-Agents evaluate the problem, provide a search through data bases, faculty and professional consultants for potential solutions
-State support "matched" by support from private business, corporations, federal sources, and in some cases, higher education institutions at each location	-$28.5 million state support			
-$10 million state support				

OHIO

The **Thomas Edison Program** in Ohio was created by the legislature in 1983. It is administered by the Department of Development and directed by the Industrial Technology and Enterprise Advisory Board. The Board consists of two state legislators and seven private citizens. Total state funding is $36 million.

The Edison Program sponsors three university-based initiatives and one complementary program. The initiatives are: **The Edison Incubators; The Edison Technology Centers;** and **The Edison Seed Development Fund.** The initiatives are state-sponsored and further leveraged by funding from the private sector. Its complimentary program is the **Ohio Technology Transfer Organization (OTTO)** (Table 62).

The Edison Incubators are geographically located near or at universities and are co-sponsored by local government, higher education institutions, civic organizations and individual support. There are currently six incubators that support fledgling companies with a variety of services from secretarial support to technical assistance through the university system. The amount and diversity of support varies with location.

Edison Technology Centers perform three basic activities: research (group or individual), technology transfer (high-tech), and education/ training (Table 62). These centers are currently focused on five general areas of research: welding, advanced manufacturing, polymers, animal genetics, and data base management. The centers, their location and academic partners are listed below:

Applied Information Technologies Research Center, Columbus, Ohio

Academic Partner: The Ohio State University

Cleveland Advanced Manufacturing Program, Cleveland, Ohio

Academic Partners: Case Western Reserve University
Cleveland State University
Cuyahoga Community College

Edison Animal Biotechnology Center, Athens, Ohio

Academic Partners: Ohio University
Case Western Reserve University
The Ohio State University

Edison Polymer Innovation Corporation, Akron/Cleveland, Ohio

Academic Partners: Case Western Reserve University
University of Akron

Edison Welding Institute, Columbus, Ohio

Academic Partners: Columbus Technical Institute
The Ohio State University

Institute of Advanced Manufacturing Sciences, Inc., Cincinnati, Ohio

Academic Partner: University of Cincinnati

Research agendas are designated by industrial boards to ensure that results can be commercialized. There is a membership fee and a fee for the usage of the equipment and facilities. The fee varies with both the size of the member company and the particular technology center.

Two contrasting examples of Edison Technology Centers are the Edison Welding Institute (EWI), which is focused on welding and joining, and the Edison Animal Biotechnology Center (EABC). Basic research is performed at EABC in the area of animal biotechnology in close relationship with Ohio University; while EWI does or sponsors both basic and applied research and is loosely connected with Ohio State University.

EWI boasts a membership of 200 companies, 25% of which are Ohio companies. The objective is to build a program that is national in scope and orientation and to use the program as a magnet to bring in additional companies to the state and to provide existing companies with technological assistance. EWI is located near Ohio State University, operates independently, but utilizes the University services and personnel.

One weakness of the EWI program is that the membership fee mechanism constitutes a major barrier to small and medium sized business involvement. The membership fee ranges from $10,000 to $50,000, according to the size of the business.

EABC located at Ohio University parallels the efforts of the Center for Bioanalytical Research Center of Excellence at Kansas University in that basic research is performed at the university level and then passed on to a specifically created company to commercialize it. The EABC designated company, Embryogen, is owned by venture capitalists, the scientists developing the technology, and the universities involved. Drawbacks to this particular program include: a perceived lack of permanence of state funding because of the two-year funding cycle, and a narrow scientific focus with high risk/high return characteristics.

The Edison Seed Development Fund assists university researchers and business people develop individual technology-based ideas for commercialization (Table 62). There are two categories of funding a company can apply for. Class 1 funds of $10,000 to $50,000 are provided for early stage research projects so that they might demonstrate the feasibility of the project for commercialization. The time limit is usually one year. Class 2 can follow successful Class 1 funding or can be applied for separately.

This phase provides funding up to $250,000 to help develop a product through the prototype stage. The project is usually given two years for successful development. Successful Class 2 projects are required to provide a return on the state's investment. The state hopes to create a "rotating" capital base from these investments. Predominantly 80 percent of state funds involve small companies lacking the capacity to undertake their own R&D. In essence, the state provides seed funding of up to $300,000 per project. The company generates the rest of the finance. The actual research is undertaken through the University involved.

The complementary operation to the Edison programs, OTTO, is a network of 32 field agents located at four universities and 24 technical and community colleges (Table 62). OTTO actively provides technical assistance to business through personal visits or call in requests. The 1986 annual report describes its approach in three basic steps: "...first, in a confidential one-on-one relationship, the agent works with the client to define the specific need; second, the agent gathers the resources necessary to meet the need; and third, delivers the resources to the client." The primary responsibility of an agent is to identify the problem and create linkages to whomever can deal with it. These linkages can come through the university system, the resources of their extensive data base access, or any other resource within the network.

OTTO was started at Ohio State University in 1979 with initial annual funding of $300,000, and in 1983 became part of the Department of Economic Development, as an associated program of the Thomas Edison Program. Major operational activities are still based at Ohio State. Funding was boosted to $3.7 million (for the biennium) and continues at that level. The integration of OTTO assisted in creating a comprehensive, coordinated state effort of technology transfer and assistance. OTTO estimates of the return for the state dollar invested has been around 20-to-1.

OTTO is also attempting to put greater emphasis on private sector involvement in determining the activities of the program and to increase the association with the university system, federal laboratories and the Edison Technology Centers. These efforts are expected to provide more comprehensive access to research on critical information and research needed to prosper in the dynamic global marketplace.

Ohio has one of the most renowned and effective programs of university-industry liaison and technical assistance in the nation and has created a well diversified and integrated set of activities to contribute to the state's economic development. Characteristics of the Ohio program that have particular relevance for Kansas include:

1) Ohio has paid particular attention to networking and integrating its activities. This is particularly important with OTTO which is at the "front line" of interaction with existing business and its needs. The state has focused on both new start-ups and the problems of existing industry and has created mechanisms that involve state-industry-academic partnerships.

2) The guiding principle is that the research agenda and associated technology transfer is market driven. Ohio has been successful in soliciting corporate sponsorship and corporate involvement for the specific purpose of ensuring that the research is focused on the industry needs of business rather than research for its own sake.

3) The Thomas Edison Programs are in close proximity and liaison with the universities but are run independently. This ensures that the overall program is market driven while utilizing the academic sources available.

4) State funds are leveraged through corporate participation, seed capital assistance, and networking for maximum effectiveness.

5) Ohio has a proactive approach that "gets the word out" that programs are available to provide needed assistance to industry throughout the state at all levels of technology need. It is a comprehensive program.

Table 62

OHIO

The Department of Economic Development ==>Total State Support $36 Million

	The Thomas Edison Program		Complimentary Program
The Edison Incubators	The Edison Technology Centers	The Edison Seed Seed Development Fund	Ohio Technology Transfer Organization (OTTO)
-Six incubators based at universities, geographically dispersed. -Financial, and other assistance provided through local government, nearby higher education institutions, civic organizations and individual support	-3 Functions: 1. Research 2. Technology transfer 3. Education/training -5 Areas of research 1. Welding and joining 2. Integrated manufacturing 3. Polymers 4. Animal genetics 5. Data base management -9 Centers in the state located in university communities for convenient academic association -Participation involves a membership fee and a fee for utilization of the research facility -Centers welcome out of state membership -Receive state funding so performance criteria is met	-Serving primarily new and/ or start-up projects -Provided by the state; are matched by business -2 "classes" of funds available -Class 1 for early stage projects -Funding provided up to $50,000 -Funding is in the form of a grant -Class 2 for prototype and production development -Successful Class 2 funding demands repayment to the state	-Service to provide technology: technical assistance & managerial support to existing business -32 field agents located at universities & community colleges -Majority at community colleges -Agents actively solicit business participation through personal visitation and prompt response to requests -The primary focus of an agent is to identify the problem and then create linkages through networking to resources that may have the answer

INDIANA:

The **Indiana Economic Development Council** oversees that state's economic development strategy and programs. State initiatives can be categorized into four areas: 1) **The Corporation for Science and Technology (CST)**; 2) **The Indianapolis Center for Advanced Research (ICFAR)**; 3) **The Indiana Institute for New Business Ventures Inc.**; and 4) State University programs (Table 63).

The Indiana Corporation for Science and Technology (CST) is a private, non-profit organization created by the Indiana General Assembly. Its objective is to support research and to develop and infuse advanced technologies into the operations of a broad range of Indiana businesses, agriculture, industry and education to enhance the future economic base of the state. CST's annual state allocation is $10 million. Its mission is implemented in three general ways: 1) technological counseling and assistance, 2) business/financial counseling, and 3) R&D related funding support (Table 63). This activity is undertaken through its own staff, a contingent of over 500 volunteer members of the 13 Targeted Technologies Committees, and the state's universities.

Initially, most CST activity was designed to operate through the universities. Today, 75% of CST funding goes to private companies and only one sixth goes to university centers. This significant change occurred because of problems associated with ensuring the university-based program was effectively meeting the economic development mandate of CST.

In the draft update of Indiana's Strategic Economic Development Plan (June 1988), the concern is clear that many of the programs that were developing out of the state-created organizations for economic development were neglecting various critical areas of industry. In particular, Indiana found that their small- and medium-sized manufacturing companies employ a rapidly growing percentage of manufacturing workers, and that in order to remain globally competitive, these firms must rapidly modernize their production processes.

> Indiana's 8000 small manufacturers are not yet getting much help from their state or local governments. By contrast, the agriculture extension service employs over 200 technology change agents located in every county in this state. Our universities have a variety of "centers" ... on campus to serve the large company which can dedicate people and time to participation in demonstration centers. The Purdue-based Technical Assistance Program and the small assistance centers at our other universities do make faculty and graduate students available to work with small- and medium-sized manufacturers. However, these programs can serve but a part of the needs of a fraction of the companies.

In recognition of the potential of these businesses and their specific needs, the Manufacturing Services Centers were created in late 1988. The original state allocation for three initial centers was $200,000. These regional centers are independent of but remain in close network with the higher education system and are structured to accommodate local needs and resources. The regional offices were created to specialize in each region's needs. They also serve as intermediary mechanisms to bridge the general reluctance of small- to medium-sized businesses to contact university and college resources for assistance.

The Manufacturing Services Centers closely cooperate with local and regional economic development organizations to stay in touch with regional business and industry needs and to coordinate overall Center activities. Regional economic development organizations provide supplemental financial support for these efforts.

Each Center takes a proactive approach. They seek out small- and medium-sized companies within the region, determine if, what, and how assistance may be provided, locate and facilitate appropriate sources of assistance, record case histories, and develop measures of performance on all contacts and activities in order to assess the effectiveness of the program. The program is intended to "broker" resources to these small companies. Although each center contains technical specialists who can and do assist, they also define problems and work as a networking resource for these companies. The program works to make firms aware of existing and new technology and processes that would allow them to have a comparative advantage in the global marketplace.

The Indianapolis Center for Advanced Research (ICFAR) provides technology transfer, scientific research and engineering development in cooperation with CST and NASA (Table 63). ICFAR performs three basic services for business and industry: 1) Technology Transfer Program; 2) Environmental Program; and 3) Medical Instrumentation Program. ICFAR also manages ARAC, a NASA Industrial Applications Center, from which a majority of the funding for the center is derived. State support for ICFAR in FY 1988 was $37,500.

ICFAR's technology transfer program concentrates on the acquisition, analysis, and dissemination of technical information for its private sector clients. ICFAR offers the first consultation free with an ARAC information specialist who will define the technical challenge at hand, delineate the scope of inquiry, and list associated fees. If the arrangement is consummated, ARAC engineers prepare a Client-Tailored Study. Once the study is complete, ICFAR maintains contact to determine the applicability of their findings, makes suggestions for further action or research, and lists references of knowledgeable contacts.

Small business clients can also contact ICFAR for assistance through their Client-Tailored Studies. Fees are commensurate with the depth and scope of research provided. For those clients requiring only referral services, the Indiana Technology Referral Network (ITRN, and ICFAR based program) provides access to technological expertise with no cost or obligation to its clients. The network links Indiana's universities, colleges, private laboratories, and consultants into a single statewide source of technical information.

This program may appear on the surface to conflict with the intentions of the Manufacturing Services Centers. In contrast, it is a resource for the MSC's and provides a contact for more advanced technology questions. Additionally, this resource is targeted to the needs of big (rather than small) business. The MSC's function is to create additional awareness of these programs and assist in the utilization of such programs.

The Indiana Institute for New Business Ventures was created in 1983 by the Indiana General Assembly to encourage and support the development of growth-oriented enterprises throughout the state (Table 63). It is located in Indianapolis. The Institute considers itself a catalyst/broker, linking entrepreneurs with management, technical and financial resources necessary to start and successfully operate a new enterprise. The Institute also conducts conferences and workshops (48 in 1987-88) addressing the challenges of managing and financing growing business enterprises. The state allocated $600,000 for this program in 1987-88, which was further leveraged by conference and seminar fees (nearly 20% of revenue) and nearly 1,500 hours of volunteer involvement.

This program coordinates with the state's Small Business Development Centers. While offering similar services to the SBDC's, such as venture capital conferences and advisory services, this state-sponsored program takes an active role in marketing its services and is not constrained by the SBDC's guidelines.

The state's university programs were created as a direct response to Indiana's strategic plan for economic development (Table 63). The colleges and universities created individual programs that take advantage of each institution's particular strengths and capacity to serve economic development needs. Each university program is nominally supported by state funds with the main support coming from the university itself. The main programs are: **The Purdue Technical Assistance Program (TAP); Purdue Technical Information Service (TIS)**; the **Technology Services Center** and **Center for Research and Management** at Indiana State University; and the **Industrial Research Liaison Program** at Indiana University.

Purdue's Technical Assistance Program (TAP) is a high-technology referral service provided by the university. Businesses must contact the program. It does not actively solicit clients. TAP is a selective program, only accepting a project after a faculty member(s) has agreed to commit to it. Five days of consulting are provided free. If extended time is needed or requested, an arrangement is made for payment to the faculty member.

The Purdue Technical Information Service (TIS) is an independent but complementary operation with TAP. Initiated to "...raise the overall technology level of Indiana Business," TIS allows a business to access a number of resources at the library. They can consult with technical librarians, receive books on loan, and access data bases. In October alone

TIS sent out 600 pieces to business and industry, from its library resources.

The Technology Services Center at the Indiana State School of Technology is a technical assistance program targeted to area manufacturers. This program markets itself through brochures, presentations and personal contact. TSC considers itself a facilitator. Through its extensive network contacts, it matches specific business needs with an appropriate faculty member. This program concentrates on finding and applying existing technology to business. This is a fee-based service. TSC does, however, assist in acquiring funds from various capital resources such as seed capital, SBA, and Federal grants.

The Center for Research and Management, at Indiana State works closely with TSC. Operated through the School of Business, it is a referral service to businesses. The service matches businesses with a faculty member in the area of assistance needed. This program primarily addresses specific business-related situations and tries to target itself in areas where private-sector consultants are not available. Businesses are charged an hourly fee for the Center's services.

The Industrial Research Liaison Program at Indiana University has four basic activities: 1) The Small Business Assistance Program; 2) Partners in Applied Research; 3) various "awareness activities" consisting of newsletters, videotapes, workshops, and expos; and 4) DataBase services, which provide businesses access to various technical information and assistance programs. The two particular strengths of this university's programs are its Small Business Assistance Program and its Partners in Applied Research Program (PAR). The Small Business Assistance Program helps small businesses obtain funding for product or service development from various governmental and private foundations. It consults with businesses, assisting them in writing and reviewing the proposals. This program boasts a 40% success rate with applications compared to 4% nationally. This service is free to users.

The PAR program is designed to help Indiana businesses solve their applied research problems as rapidly and inexpensively as possible through the resources available at IU. PAR projects are intended to be short and low cost, carrying no overhead for Indiana companies. Usually, companies are only billed for materials and graduate research assistants' time.

As indicated, Indiana's impressive programs are both wide and deep in scope. A number of organizations have been developed to focus on an array of aspects of the economic development strategy for enhanced competitiveness and new business formation, providing for a comprehensive program. This has led to some problems of coordination and integration of effort that is of concern to the Economic Development Council. As well the Council is seeking a broader impact of its overall program that has been occurring from segmented efforts and is placing a much greater emphasis on networking and synthesis or programmatic activity.

Some particular aspects of Indiana's programs that are relevant to this study include:

1) Indiana places emphasis on creating an awareness of services available to business and industry. The view is that not only is it important to inform existing business of available services, but also that it is important to create this awareness in out-of-state businesses considering moving to Indiana.

2) While there is an appreciation of the importance of high quality basic research at the universities, the real objective is to develop comparative advantage in transferring existing knowledge to existing industry. While the universities are important in this

regard, they are not pivotal in the Indiana scheme. Many of the needed programs are provided by organizations separate from higher education, though linked.

3) Indiana is targeted in the use of its universities. The state sponsored programs know the resources and the services in the sense that the state has leveraged university involvement at the level and of the nature that the respective institutions were prepared to provide and not pressed for involvement otherwise. It is a different approach to that described for other states in this report, in that it involves a meaningful, but not central, participation on the part of higher education.

4) Indiana has recognized that both high-technology enterprises and traditional, existing business need services. The state has recognized that future jobs will not only come from these new businesses but also from existing business expansion. Indiana is working to keep their existing businesses and industries globally competitive, thus increasing their job base and encouraging new business creation from within. The key to success is perceived to be effective technology transfer.

5) Indiana is seeking to transition its programs from a reactive to a proactive mode. The focus is on needs and how to respond to them, rather than strengths and what can be done with them.

Table 63

INDIANA
--> Total State Support $11 Million overseen
(but not necessarily evaluated by) the Indiana Economic Council Inc.

State University Programs	Indianapolis Center for Advanced Research (ICFAR)	Corporation for Science and Technology	Indiana Institute for New Business Ventures
-6 university-based programs created to utilize each institution's own strength and initiative. -Services range from pure research (similar to Kansas Centers of Excellence) to a proactive technical and managerial assistance at Indiana State.	-Private research facility supported through NASA's ARAC program, technology transfer user fees and nominal support from the state. -"...conducts scientific research, technology transfer and engineering development to enhance the economy of its city, state, and nation." -3 areas of program: 1. Technology transfer 2. Environmental program 3. Medical instrumentation program	1. Technological counseling and assistance. --support for entrepreneurs, businesses and industries in providing answers to technical questions. 2. Business/financial counseling. --specializes in counseling for which traditional economic and business analysis methods are inadequate due to the implications & risk levels associated with the project. 3. Funding Support --start-up "seed" --venture capital --basic research 4. Manufacturing Service Centers --regional "technical assistance" programs --"brokers" resources to existing firms in Indiana --seek out small and medium-sized companies within the region; determining if, what and how assistance may be provided; and locating and facilitating appropriate sources of assistance.-	Considers itself a catalyst/broker, helping entrepreneurs with management, technical and financial resources necessary to start and successfully operate a new enterprise. -Conducts conferences and workshops targeted to start-up and growth companies in Indiana. -Based in Indianapolis.

C. Key Implications

Noteworthy trends are evident from our research and state program visitations:

1) Programs are shifting from university control to private, non-profit organizations in order to more effectively attain economic development objectives.

2) There is an emerging trend of technology transfer and technology assistance to be focused as much, or more, on existing industry as on new business formation. Without discounting the importance of basic research, states such as Indiana and Pennsylvania have their predominant focus on providing assistance in implementing and/or using existing technology. Be it either assistance in quality control for an existing manufacturer, or application of existing research in developing new products, states are recognizing the key importance of programs of this nature in making their states globally competitive.

3) States are diversifying their efforts at various levels. Many state economic development efforts have moved away from investing all of their resources in one type of program. Three common initiatives in state programs are: 1) basic research; 2) technology transfer and development, a "higher" technology initiative, targeted mainly to newer and start-up firms; and 3) technology and business assistance, a "lower" technology initiative, targeted to existing manufacturers and service industries.

4) Successful programs are proactive. Successful state programs actively create awareness of their services and search out businesses for assistance. They also encourage participation from communities, higher education, and the private sector. This assistance--both financial and non-financial--leverages the state investment in these initiatives and creates active interest in their success.

5) Guidance from the private sector is imperative. Nearly every state evaluated is making an effort to get closer to the true needs of the private sector. An effective way to do this, they found, has been to encourage participation and guidance from business. There is an increasing number of board members and amount of corporate participation at all levels of these initiatives. By encouraging investment of their time, materials or money, corporations take an active interest in the return on their investment.

6) There is a clear separation of control in initiatives that are technically and fundamentally different. For instance, Pennsylvania distinctly separates the ATC's (a technology transfer program) and IRC's (a technology and business assistance program). This allows each program to target particular markets and provide specific services and expertise for that market.

7) Communication networks are both wide and deep. Each initiative makes an effort to be constantly aware of all available services and capabilities to provide comprehensive services to their constituents and remain current with technological trends.

8) States are now creating programs with limited state restrictions. Basically, the states provide the direction and monitor the results; funding is used as the control mechanism. Minimum formal structures encourage flexible market-driven organizations that can change rapidly to provide dynamic services to the needs of business.

9) Nearly all programs require matching funds. The states have not attempted to fund programs fully, but rather see their contribution as providing (i) core support and (ii) the basis for extensive leveraging.

IV. PROPOSED KANSAS TECHNOLOGY TRANSFER MODEL

The following model of technology transfer for Kansas has been developed on the basis of the nature of the need, the relevant characteristics of the state, and the key lessons that emerge from the experience of other states. The key considerations are summarized below. The proposed model is then developed and its appropriateness to Kansas explained.

A. Key Characteristics of Kansas

There are important characteristics of the private sector and the higher education institutions in the state that must be recognized in formulating a workable and effective model for Kansas.

1. Because of the dearth of federal and private research institutions and laboratories in Kansas, the higher education system is essentially the only accessible in-state source of technology development and knowledge in the state. Consequently, the state has no choice but to develop a system that is anchored in the universities and colleges.

2. The immediate dilemma, however, is that Kansas universities and colleges are not, as a group, strong in science and technology by any comparative yardstick. The three research-oriented universities, namely KU, KSU, and WSU, have sound science and technology academic programs. However, only some of these enjoy national preeminence, and few are in fields that can give rise to commercialization potential. Further, existence of three research universities barely constitutes a critical mass of scientific endeavor conducive to a R&D climate. The development of a science and technology foundation has not been a state priority, nor seemingly a dominant priority at the individual institutions. Thus, the overall capacity to pursue newly evolving scientific directions is also limited.

3. As a historical generalization, Kansas universities have not had a tradition of R&D and technology transfer interaction with the private sector. (An exception to this has been KSU's cooperative extension and tradition of public service outreach in some of its component units. Another has been the PSU-private sector interaction in plastics and wood technology). This situation has changed significantly for the better in the last few years,

however, as evidenced by WSU's lead participation in the WI/SE program. There now exists a pronounced willingness at the institutions to explore and adopt mechanisms and avenues for constructive interrelations with industry. In essence, an impressive increase in interaction and linkage has occurred. However, it is fragmented, uncoordinated and spotty, relative to need; and it is not linked to other related state initiatives, such as the entrepreneurship of new business ventures. However, the basis for acceptance and commitment to new thrusts on the part of higher education does exist, and is growing.

4. The overriding concern of higher education in Kansas is the chronic underfunding of its primary education mission. This has important economic development implications in that special programs for industry liaison will not be productive if the basic quality of the institutions is itself inadequate and if the institutions are overwhelmed or preoccupied with this larger problem.

5. Pittsburg State University and the Kansas College of Technology have the mission and capacity to serve as focal points in a technology transfer/technical assistance program. They constitute important strengths in this regard, although their capacities are not well known around the state. The community colleges on the other hand have higher regional recognition among firms, but have very limited capacity in science and technology. Enough exceptions to this generalization may exist to support a regional approach to a technical assistance program.

6. Kansas postsecondary institutions function with a high degree of individual autonomy and have shown only a limited propensity for inter-institution cooperation. Furthermore, the location of these institutions does not match the evolving population and economic activity patterns in the state. These characteristics constitute a significant challenge to the formation of effective consortiums and networking.

7. Kansas industry largely comprises small- to medium-size firms. Firms of this size generally do not have the capacity or resources to undertake R&D or to even participate jointly in technology development. Furthermore, there seems to be significant cultural barriers to interaction with academia, particularly by small firms. Business schools, for example, tend to orient towards larger companies in their curricula and outreach structures.

8. The Institute's survey of Kansas manufacturers and advanced technology firms reveals barriers to competitiveness that are common to many firms. Firms are experiencing technological uncertainty, generally have no R&D capacity, have difficulty in predicting technological change, and lack technical expertise. They also have difficulty identifying and entering markets (market research and planning), and have difficulty in financial

planning and access to capital. Kansas firms would like academic institutions to:

- provide access to state-of-the-art science and technology for research and development, identification and assistance with technical problems, and assistance with product and process development;

- provide access to business and managerial expertise to identify and assist with business/managerial problems, especially marketing, production and financial problems;

- provide computer access to university libraries for information retrieval and/or networking; and

- provide technical and managerial training.

Relatively few firms report using academic institutions in the past five years. Fewer are familiar with the institutions and their capabilities and resources. And few firms know how to make meaningful contact with our universities and colleges. Better linkages and networks are imperative.

9. The economic performance of Kansas industry has not been strong in this decade of global competitiveness and rapid technological change. Employment growth for example has persisted at a rate that is chronically below U.S. average. The problem is particularly acute for scattered rural industry. Furthermore, the gestation of new firms, including technology driven enterprises, has lagged behind national averages, especially in rural areas. The need for support and assistance could be described as acute.

10. Kansas business, particularly the small to medium core, has not developed systematic linkages with the universities and colleges. The research matching program has encouraged some productive interrelations for the firms and institutions involved, but this is not as yet broadbased. This situation is not uncommon, but it is exacerbated in economic contexts dominated by a small firm structure.

11. State resources for economic development are limited. By any yardstick, they are modest in magnitude and are generally soft (being lottery based). For specific programs, such as the Center of Excellence program, the funding has been below a threshold level necessary to achieve a significant impact. One implication of this would seem to be that in designing a model for Kansas, only limited funding will be available to implement it.

12. Elements of an overall technology model currently exist in varying stages of development. These include the Centers of Excellence program, the research matching program, and seed capital program. All elements need to be meshed into a comprehensive set of mutually supporting and effective programs.

B. Key Lessons from Other States

The following major implications for a Kansas model are derived from the extensive study of the approaches taken by other states to foster technology development and liaison.

1. It is imperative to recognize that there are distinct, albeit overlapping, dimensions or levels of technology. For our purpose, three fundamental levels can be identified:

   Basic Research
   Applied Research and Technology Development
   Technical Assistance

   *Basic research is concerned with the generation of new knowledge.

   *Applied research and technology development relates to the commercial application and extension of state-of-the-art knowledge.

   *Technical assistance refers to the transfer of existing "off-the-shelf" technical knowledge.

   Technology transfer and industry liaison occur at all three levels.

2. A comprehensive model to achieve economic development objectives of encouraging successful new start-ups, of fostering new product development and new process implementation, and of enhancing the competitiveness of existing industry necessitates a focus on <u>all</u> three dimensions of research, development and assistance.

3. Cost effectiveness considerations in a context of limited funding dictate the following guiding principles in devising a comprehensive model:

   a. Basic research ultimately underpins all generic technology transfer activity. It is mostly funded by the federal government and by traditional state appropriations to institutions. Hence, limited state economic development funds for this purpose should be targeted only to selected pockets of strength that can lead to commercial potential.

b. The state role with respect to applied research and technology development should be largely a broker/catalyst function and should leverage private sector participation.

c. Investment in technical and associated management assistance can have a high return, if it is localized and networked.

4. A technology transfer and liaison program for economic development will only be successful if it is market driven. Programs must either be based upon meaningful institution-private sector partnerships or be private-sector controlled. Mechanisms that are institution-controlled tend to prioritize non-economic development objectives over time.

5. The most effective programs seem to be based on the following principles:

   1) The different technology dimensions are best served by having separate mechanisms that focus on each level but that are coordinated and networked into a cohesive system. There are numerous examples in other states of combinations such as basic research and technology development, or technology development and technical assistance within a single mechanism. When such combinations occur, however, one observes the tendency for one dimension to swamp the other. Usually the higher technology level overshadows the lower level, according to the propensities of those controlling the organizational arrangement.

   2) The program will not be effective unless all its elements are networked

      -horizontally, at the same technology level

      -vertically, to the other technology levels, and

      -laterally, to other related economic development organizations (e.g. seed and venture capital funds, SBDCs, and so forth)

   Research, development, and assistance are not independent levels, but are interdependent. Furthermore, expertise and capacity varies within levels. Because the totality of technological capacity is limited, all elements must be accessible through networks in order to respond to diverse needs.

3) A grass roots, decentralized, partnership/consortium, bottom-up formulation of specific organizational arrangements, that respond to state determined program objectives and principles, seems to lead to more responsive, flexible and creative mechanisms than a top-down approach. Heterogeneity based on context and need seems to be more productive.

6. State funds should be used

   a. to leverage private sector involvement and commitment;

   b. to ensure economic development objectives are paramount;

   c. to require that certain needs be met (e.g., small businesses are not squeezed out by better resourced firms);

   d. to encourage, and not stifle, creative responses to need; and

   e. to ensure all regions of the state are served.

7. Institutional capacity and expertise should be tapped only in those dimensions where their strengths lie, and not in others. For example, the involvement of faculty at research institutions is suited to basic research and to technology development, but in general not to technical assistance. Technical assistance can be provided best by faculty at other institutions or by practitioner experts. In essence, the institutions must be involved in a manner where they can contribute and not in ways that distort or conflict with their basic mission.

8. Management-related expertise and assistance is extremely important. Conceptually, it parallels the technology dimensions. It is important that this dimension be interwoven into the overall model.

9. A multilevel approach that is market driven and has a strong regional dimension is not only imperative from an effectiveness perspective, but also is conducive to political acceptance and support. The short-term impact of accessible regionally based technical assistance programs complements the medium-term impact of technology development and the long-term dimension of basic research.

10. Technology oriented incubator development has been expanding in many states because of apparent successes in gestating new advanced technology firms.

C. The Kansas Model

It is recommended that the state support the establishment of (1) three Advanced Technology Centers, anchored at the research universities, to enhance applied research and technology development, and (2) six Regional Technical Services Centers, sponsored by regional public-private consortiums, to provide technical and management assistance. The former would focus primarily on the economic development objective of new product and new process development, and the latter primarily on the competitiveness of existing industry.

The comprehensive model of technology transfer would therefore comprise:

Technology Level	Mechanism	Number
Basic research (With commercialization potential)	Centers of Excellence	3
Applied research and technology development	Advanced Technology Centers	3
Technical assistance	Regional Technical Service Centers	6

Centers of Excellence

Centers of Excellence were not specifically addressed in this study. However, given the conceptualization proposed, the following observations are pertinent to this program component:

1. The primary objective of the Centers of Excellence should be the enhancement of basic research in specific fields that have potential for future commercialization. This can be, indeed should be, accompanied by a complementary element of technology development and transfer.

2. These Centers need to be properly funded before they can be reasonably expected to have an economic impact.

3. While university based, the Centers must be driven by a university-private sector partnership to ensure a market impact on the research agenda.

Advanced Technology Centers

It is recommended that the state support the establishment of three Advanced Technology Centers that would be composed of a partnership of industry and higher education and anchored at the state's research universities (KU, KSU, WSU).

The primary economic development goal of these Centers would be to enhance new product and new process development in new and existing Kansas firms through technology development, applied research and 'state-of-the-art' technology transfer. More specifically, the objective would be to sustain the competitiveness of Kansas industry through technological innovation and to support the gestation of new technology driven enterprises. A particular mandate of the Advanced Technology Centers would be to ensure that small- and medium-size Kansas firms can gain access to research and development and advanced technology assistance. A second objective would be the enhancement of university research capability in the state that would underpin the long-term science and technology needs of Kansas industry.

The Advanced Technology Centers would be sponsored by private sector-university consortia and would adopt the non-profit corporation form of organization. The Board of Directors (Figure 14) would have a private sector majority, including a requirement for meaningful small business representation. Other than these specific aspects that are designed to ensure the program is market driven, the particular arrangement for each

Center should largely be determined by the parties to that particular partnership in accordance with their circumstances and context, and the paramount importance of economic development objectives. For example, if an individual firm membership approach were to be adopted for purposes of generating matching funds, then it is essential that small business membership be assured through a graduated or subsidized fee structure.

Figure 14
EXAMPLE OF AN ADVANCED TECHNOLOGY CENTER STRUCTURE

Eleven-Member Board of Directors*

|

Executive Director

|

3 Staff whose primary functional duties would embrace:

Research and Development:	Entrepreneurial Assistance:	Education/Training:
- Foster and broker R&D linkages - Facilitate access to science/technology knowledge	- Provide and broker entrepreneurial assistance and access to finance - Possible incubator administration and assistance	-Provide and foster appropriate training programs

* Eleven-member board comprised of:

6 private sector members, including 2 small business representatives

3 academic members:

2 from sponsoring research universities

1 from other participating universities or colleges

2 representatives of economic development and other co-sponsoring entities.

Total: 11

For the sake of visibility and targeted development, each Center would designate and focus upon certain types or specific fields of advanced science and technology. However, its activities would not be restricted to those designated fields. The Center would be responsive on a broader basis where appropriate capability existed in the respective institutions, to ensure that all potential opportunities and needs are addressed. Furthermore, each Center would have a statewide mandate, based upon its capability and targeted fields; however, there would be an expectation of regional outreach with respect to small business.

The generic task of the Centers would be to facilitate, link, leverage, and broker joint private sector-university advanced technology interrelations. The specific activities would embrace the following and be undertaken in a proactive manner:

1. arrange research and development on behalf of private firms;

2. facilitate access of private firms to science and technology information and expertise, and develop university researchers' awareness of private sector research and development needs;

3. provide or facilitate problem identification and high level technical assistance to bring technological innovation to the marketplace;

4. support technology-driven incubator development;

5. facilitate assistance in support of technology-oriented entrepreneurship; and

6. foster associated education and training programs.

The state would, through KTEC, provide core or base funding to provide for organization infrastructure. However, funding should also be provided through a "matching" requirement from private and other sources, with a clear expectation that Centers would leverage extensive funding support from diverse sources. Non-Kansas firms could participate, but this would need to be monitored to ensure overall benefit to the state.

The Centers would be the focal point for linking potential start-up opportunities with specialist finance sources, such as seed and venture capital funds, and for the development and initial review of applied research matching program funds. Scope should be provided for the state to gain some return on the applied research matching funds on successful projects in the form of royalties, licensing, etc. This should encourage ATCs to develop projects with strong commercialization possibilities.

Initial full year state funding for each Center would need to be at least $300,000. This is a minimum threshold level. This core funding level might need to be larger for any given Center if special needs existed (e.g., an outreach office in Johnson County for the KU-based Advanced Technology Center). This funding level would support a professional staff of four to five persons, with matching funds being used primarily for sponsored research projects, operations, and programmatic activities.

Regional Technical Service Centers

It is recommended that the state provide support for the establishment of six Regional Technical Service Centers, geographically dispersed throughout the state. These would be sponsored by a non-profit consortia of regional interests, including business, colleges, universities, and economic development organizations.

The overall economic development goal of the Regional Centers would be to assist small- and medium-size Kansas firms, particularly manufacturers and technology-oriented service firms, in their efforts to become more competitive producers in today's rapidly changing marketplace. The Regional Centers should be designed to help Kansas firms identify and solve production or other technical problems, to improve production processes and quality, and to take advantage of advanced production techniques and technologies. The goal is the retention and expansion of Kansas industry in a context of rapid technological change and markets.

In principle, it is not imperative that these Centers be anchored at a college or university. Although the technical capacity is weak or nonexistent at many, the participation and sponsorship of most Kansas institutions is likely because most are actively involved in providing management-related assistance in some form or other. It could be expected however, that Pittsburg State University and the Kansas College of Technology would take lead roles in the development of the Regional Centers in their region and the networking of technical and management services.

A comprehensive Regional Technical Service Center program would embrace the following elements:

1. technical consulting services;
2. assistance in evaluating competitive ability and need;
3. assistance in identifying and applying appropriate new technologies;
4. development of particular assistance capabilities for selected technologies and regional industries;
5. provision of information and data services through networking and links with research institutions;
6. assistance in business, finance and management through network access and consulting services; and
7. provision of education and information regarding modern manufacturing techniques and concepts such as total quality control, inventory control, and CAD-CAM.

These services would be provided by experienced in-house professional staff on a fee basis where appropriate (possibly graduated by firm size) and by networking a pool of specialized business and manufacturing consultants, both academic and non-academic.

The state would, through KTEC, provide sufficient core funding to underpin the basic organization infrastructure. Each Regional Center would be expected to generate matching funds through a combination of regional industry sponsorship (as distinct from individual firm memberships), fees for services, and other sources (e.g. federal, foundation, in-kind space). Initial full year state funding for each Regional Center would need to be a minimum of $250,000 to support three or more professional staff.

Each Regional Technical Service Center would operate on a regional basis, on a partnership and networked basis, and focus on its regional specific needs. Inter-region networking and cooperation to achieve economies of scale for certain activities (e.g. workshops) and complementary services (e.g., types of expertise) would be imperative. Indeed all RTS Centers will need to be networked among themselves, to the other technology levels, as well as to the labyrinth of economic development organizations in their region and the state (e.g., KDOC regional offices, CDCs, SBDCs, seed capital funds, etc.). In the ultimate, the number of RTSCs to be formed will depend upon the willingness of the parties to support their establishment. The number could be more or less than 6, depending upon regional support.

D. Advantages of the Proposed Model

The proposed model of technology transfer would seem to be the most appropriate one for Kansas, and has the potential to be the most effective in achieving economic development goals of business development, retention and expansion. The model has been developed with full recognition of (1) the nature, character, and needs of the state's economy, its private sector, and its institutions of higher education, and (2) of the lessons from other state's recent and extensive experience in technology transfer.

The following factors have been particularly important in formulating this model:

1. The approach is consistent and compatible with the basic thrust of the state's economic development strategy. It constitutes a specific investment in innovation and entrepreneurship, a key foundation underlying economic growth. It is specifically focused upon enhancing the retention of our existing industry and start-up firms within the state. The locus of activity and creativity will be at the grassroots level--at the firm, community and institution level.

2. The model is responsive to the nature and needs of the private sector in Kansas. The primary interface will be with small- to medium-size firms. The predominant orientation will be towards the manufacturing sector which has experienced severe competitive problems and is in serious need of assistance and support. The regional structure will serve the scattered and often rural location of Kansas industry by helping nonmetropolitan manufacturers to overcome barriers to technology change and by facilitating entrepreneurship in rural locations. Overall, the effect will be to make the state more attractive to technology-based industry and to broaden the state's economic base.

3. The approach is comprehensive in that it responds to all levels of need by creating mechanisms at three distinct levels of technology transfer, namely basic research leading to 'cutting edge' commercialization, 'state-of-the-art' applied research and technology development, and 'off-the-shelf' technical assistance. The multi-level mechanisms recognize the long-term, medium-term and short-term or immediate-time dimensions of research, development, and technical assistance respectively, as well as the independent importance of each technology level.

4. The separate mechanisms of Centers of Excellence for basic research, Advanced Technology Centers to broker joint R&D, and Regional Technical Service Centers to provide immediate technical assistance also ensures that each dimension of technology transfer and liaison and its component Centers have the opportunity to develop creatively to the fullest potential. Where technology dimensions have been combined in other states, the propensity is, because of different cultural values, for the higher level (e.g. R&D) to dominate the lower level (e.g., technical assistance) and

for the latter to receive a lower priority (or to even be disdained). At the same time, the proposed mechanisms would not operate independently of each other. On the contrary, it is essential that they function as interwoven parts of the whole in an interdependent manner.

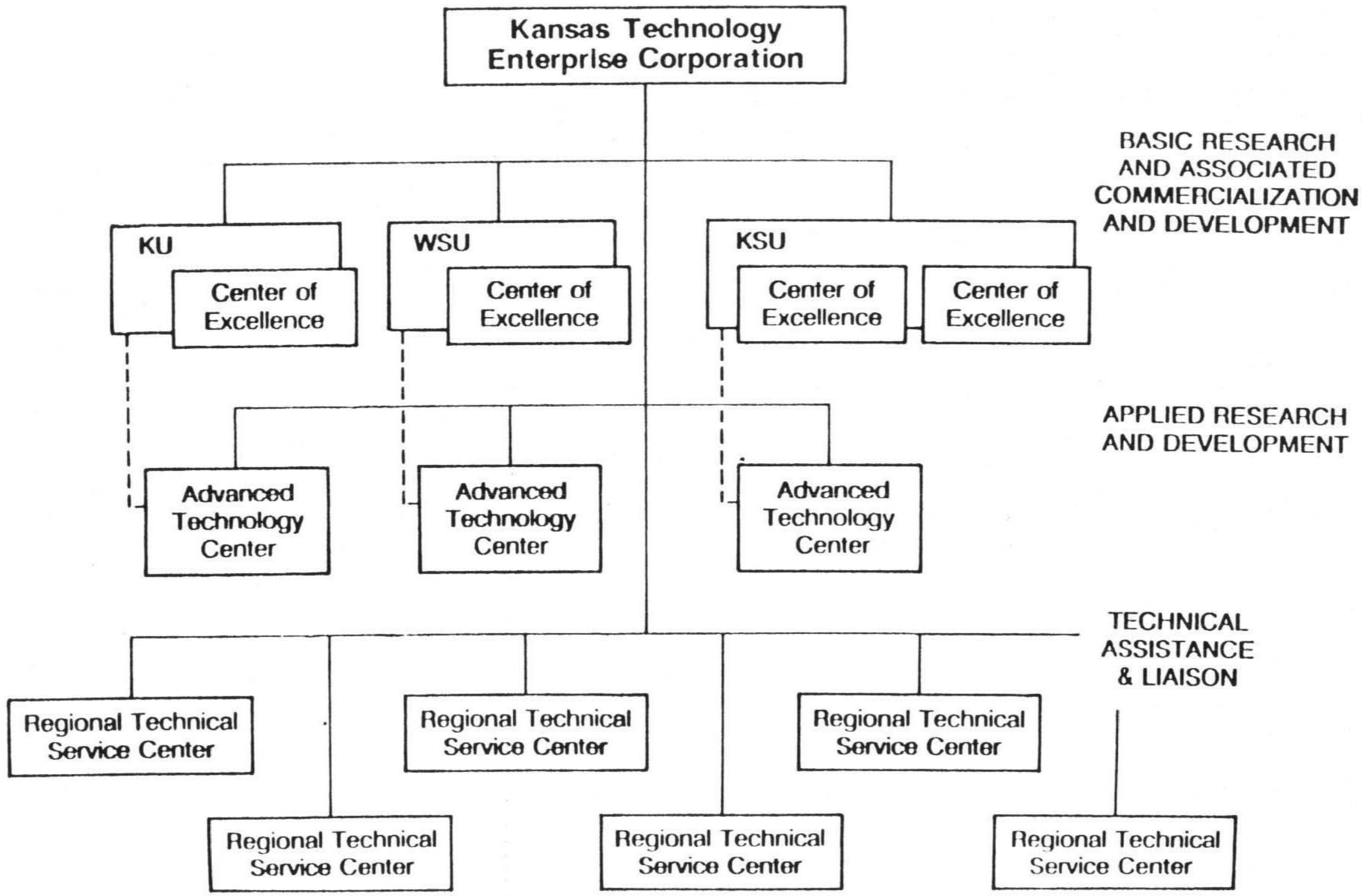
5. A further advantage of having multi-level Centers is that the higher education institutions and their faculty are involved only at levels appropriate to their mission, interests and capabilities. For example, faculty at the research universities have the capacity to participate in basic research and problem solving at the 'state of the art' level, while faculty at other institutions and professional practitioners are better suited in general to hands-on, day-to-day forms of interaction and assistance. This model minimizes the dilemma and distorting consequences of expecting institutions and their faculty to engage in economic development activities for which they are neither suited nor interested. On the other hand, the distinction between technology levels is not without overlap. Hence one could envision considerable cross-sponsorship and networking among the mechanisms. For example, PSU, with pockets of technology development capability could choose to link to an ATC through co-sponsorship. Similarly the research institutions could link to the Regional Technical Service Centers in their region on a similar basis. Again, WSU, on the basis of its existing Center, may seek a primary involvement at all three levels, and propose particular linkage arrangements suitable to this involvement. It is recommended that KTEC encourage creative proposals that will recognize the diversity of circumstances associated with the implementation of the proposed model, but do so in adherence to the important principles outlined in this proposal.

6. Given a dearth of alternative sources to draw upon, this model does engage the higher education resource to the extent of its capability. There is no alternative resource in the state to underpin technology development. With this model, all institutions can participate in a manner consistent with their respective missions and capabilities. Overall coordination under the KTEC umbrella (Figure 15) and the implementation of a networking system will improve cooperation among institutions and provide state-wide capacity to respond to any need, whatever its nature and the location of the firm.

7. The consortium approach to Center sponsorship, the matching requirement for state funds, and the non-profit corporation form of organization are all designed to ensure the broadest participation of the private sector and to ensure that the technology transfer program is, first and foremost, market-driven to serve economic development objectives. It is perceived that higher education institutions have more to gain in the long run from this form of market-driven, joint partnership than they would from an education-driven program.

Figure 15

Kansas Model for Technology Transfer



8. Relative to the alternatives, this is a low cost model. Full year funding by the state for a minimum threshold program would be about $M2.9, and apportioned as follows:

Advanced Technology Centers	3 @ $300,000	$M0.9
Regional Technical Service Centers	6 @ $250,000	$M1.5
Educational Support Programs (see below)		$M0.5
		$M2.9

For purposes of contrast, Pennsylvania allocated $M10 for its nine new industrial resource centers (analogous to the proposed Regional Technical Service Centers) in FY90. The average annual allocation of Ohio to its advanced technology centers (these combine our concepts of Centers of Excellence and proposed Advanced Technology Centers) is around $M2 each.

9. While modest in size, this program should be cost effective and have a broader ranging impact than would occur otherwise. The approach is analogous to a balanced portfolio of investments and risk minimization for a sound return as opposed to a higher risk (albeit potentially higher return) strategy of concentrating all funding on one dimension or another, such as gambling on commercialization by funding only basic research in the Centers of Excellence, or only serving lower technical needs by funding multiple Regional Technical Service Centers.

10. This model can be implemented relatively quickly. It has the capacity to produce immediate, visible results through RTSCs, while the less politically sustainable medium- and longer-term activities of the ATCs and Centers of Excellence attain productive levels of achievement. Through networking, it is a statewide program in structure and operation.

In summary, the proposed Kansas program will have these virtues. It is consistent with the state's development strategy of supporting internal business retention and formation, and focuses where the need is greatest, namely existing small- to medium-size firms and start-up firms. It is comprehensive since it is designed to respond to needs at all technology levels. Yet, through its multi-level approach, research, development, and assistance programs will have full opportunity for success. The program involves the higher education institutions, a key resource for the state, and does so at levels appropriate to their mission and capacities. The broadest possible private sector participation is encouraged through consortia sponsorship, matching, and private-public control to ensure a market-driven program. It is a relatively cheap, cost-effective, and action oriented program; the resources are committed to "hands-on" activity, not "bricks and mortar," and it can be implemented quickly. It is a statewide program; any firm with a problem should be able to secure appropriate assistance from the networked system.

E. Educational and Other Support Programs of University-Industry Liaison

It has been stressed above that the basic technology transfer model must be linked, if not integrated into, the broader array of economic development initiatives, such as seed and venture capital funds, incubator development, loan programs, and the SBDCs. In the same vein, there are a set of activities of a complementary nature that, if nourished at moderate cost, could be very productive in enhancing the basic program proposed above.

Putting it succinctly, many firms have management or technical problems, and are neither aware that they have the problems, nor that potential solutions exist. Many firms have simple information needs that could be met from existing resources if creative access mechanisms were developed. At the same time, our institutions have generic capabilities (such as libraries, instrumentation, and continuing education) and generic needs (such as opportunities for hands-on experience for faculty and graduate students) that could be tapped to respond to business needs, to mutual benefit.

Given the considerable diversity of approach in other states and abroad, the following activities would seem to have the greatest potential for Kansas:

1. <u>**Technical and Resource Information Services**</u>

In the broadest sense, the library system of Kansas constitutes an important information resource for economic development. The libraries at Regents institutions have the capacity to serve the scientific, technical, and management information needs of Kansas industry.

Technical information service programs have been developed at numerous academic institutions in other states. The successful programs at Purdue University and Pennsylvania State University involve dial-up access search of on-line library catalogs and information databases. They also provide assistance from information specialists when firms need to identify the information for a particular technical or management-related problem. The response is often immediate through electronic link or prompt through printed material. A service of this nature based initially at the research libraries could be developed over time with a relatively modest annual investment by the state and the institutions.

KTEC has provided funding for the first two years development of the Kansas Technology Resource (KTR) DataBase System by Kansas State University. This project involves the development of a computerized inventory of faculty expertise and other resources at Kansas universities and related private sector capacity, that can support economic development in Kansas. This database will constitute an important and integral component of the networking that needs to be developed to underpin an effective technology transfer program.

2. <u>Industrial Associates Programs</u>

This mechanism for transferring knowledge and fostering academic communication in areas of science, technology, and management has been quite common at American and foreign universities. The objective is to nurture contact between industry and academic researchers. Activities range from periodic joint meetings for the exchange of ideas, personnel exchange, short-term visits to laboratories, equipment sharing and access, joint symposia and seminars, and faculty supervised graduate student research projects. Indiana University's Partners in Applied Research Program, which matches business' need for information with faculty expertise on a low cost, no overhead basis, is an example of a recent innovative response in this sphere. Kansas institutions have little tradition in this area, although growing instances of interaction of this nature are now occurring. This needs to be encouraged and facilitated by KTEC, although the primary impetus must necessarily come from the institutions themselves.

3. <u>Management Development Infrastructure</u>

Many technically competent firms falter, or barely survive, because of an inability to recognize and deal with management-related problems. This is particularly true with respect to many small- to medium-sized firms, the backbone of Kansas industry as indicated in the surveys of Kansas industry conducted for this study. The proposed technology transfer centers (ATC and RTSC) would have a mandate and organizational component to respond to management as well as technical problems. However they will not address the crucial questions of how the intrinsic management competence of Kansas industry, its responsiveness to change, and its awareness of improved techniques are enhanced over time.

The long-term need for competent management is served by the primary mission of our business schools to educate and train professional managers at the entry level, although it is an open question as to how well this is done for smaller enterprises. For the medium term however, the availability of programs in the state appears to be limited, relative to the need in general and to that of small- to medium-size firm managers in particular.

This inadequacy is largely due to lack of funding, and not commitment. For example, both KU and KSU business schools have been endeavoring to establish formal centers that would focus on production quality, productivity, and competitiveness issues, through research and management education in this critical sphere of business operation. The competitive environment makes it imperative, and not just desirable, that modern management techniques such as statistical quality control be pervasive in Kansas industry. The same argument holds in such diverse areas as marketing, human resource management, strategic planning, and financial management. It is recommended that state funds be used specifically to underpin as well as to leverage a threshold level of involvement of institutions in management development.

4. <u>Institutional Support</u>

This study does not purport to identify all the innovative initiatives that have occurred in higher education throughout the U.S. in recent years. However, the array is impressive. At a minimum, institutional response would seem to be highly desirable in two further areas:

a) creating the mechanisms and associated procedures so industry could readily access, on a fee basis where appropriate, university resources such as computer capacity, libraries, databases, and testing instrumentation; and

b) creating the mechanisms that encourage, rather than discourage, the commercialization process of faculty basic research, through for example support for incubator development and the provision of patent assistance.

The lack of patent assistance is a major barrier to the commercialization of faculty basic research. It is recommended that the state implement a model along the following lines to alleviate this problem.

A full-time Patent Agent could be employed by KTEC and housed at KTEC or at one of the Advanced Technology Centers. This individual would serve to do all the work on patenting up to filing for a patent. At this point the services for a specialized lawyer would be secured and the Patent Agent would be responsible for employing and paying for this legal service. Once the patent was filed the Patent Agent would take on the responsibility for pursuing the commercialization of the patent with preference for working within Kansas.

Resources necessary for these functions would require an annual budget of about $200,000 a year. This would include the salary of the full-time patent agent, secretarial and hourly assistance, funds for searches, funds for lawyer fees and other operating expenses. After a few years it might be expected that income from successful patent ventures would be returned to help finance this activity and/or expanded activity levels.

State funding of $500,000 for these complementary activities would ensure a significant impact on technology transfer and industry liaison in Kansas.

Development of technical and resource information services and networking capacity (excluding the KTR data base system as it is already funded)	$150,000
Management development ubfrastructure	$150,000
Patent assistance	$200,000
	$500,000

F. **Timing of Implementation and Budget Implications**

Table 65 presents how this proposed technology transfer program could be implemented. During the first year of funding (FY 90) all three Advanced Technology Centers (ATCs) would receive seed money of $100,000 each and as many as four Regional Technical Service Centers (RTSCs) started with $100,000 each. Other support programs would receive $125,000 for partial implementation. A total of $825,000 would be needed during FY 90.

During FY 91, all three ATCs and the four RTSCs would be fully implemented, and an additional two RTSCs would be provided with start-up funds. Support program funding would increase to $300,000. FY 91 funding would total $M2.2. By FY 92, all programs would be fully implemented, bringing the total allocation for FY 92 to $M2.9.

Table 65
Technology Transfer Program:
Full Year Funding for a Minimum Threshold Program

Year	Program	Stage and Number	Allocation
FY90	Advanced Technology Centers	Seed money for 3 at $100,000	$300,000
	Regional Technical Service Centers	Target 4 for start-up at $100,000	$400,000
	Support Programs	Partial implementation	$125,000
			$825,000

FY91	Advanced Technology Centers	Full implementation for 3 at $300,000	$900,000
	Regional Technical Service Centers	Full implementation for first 4 at $200,000 and start-up for 2 more at $100,000	$1,000,000
	Support Programs	Partial implementation	$300,000
			$2,200,000
FY92	Advanced Technology Centers	Full year funding for 3 at $300,000	$900,000
	Regional Technical Service Centers	Full year funding for 6 at $250,000	$1,500,000
	Support Programs	Full year funding	$500,000
			$2,900,000

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APPENDIX A

Survey of Kansas Manufacturers

Survey of Kansas Advanced Technology Firms

Survey of Kansas Manufacturers

ID CODE#________
(leave blank)

I. Demographic

If your firm is part of a larger corporation, answer questions as they pertain to your plant only.

Q-1 How many years has the firm been in operation in Kansas?

Q-2 What is the major product or service provided by your firm?

____

Q-3 Do you consider your firm or product to be classified as technology driven or "Advanced Technology?" (Circle number for your response).

1. YES
2. NO

Q-4 How would you rate the overall level of technology used by your firm? (Circle number)

1. Cutting edge
2. Current
3. Traditional

II. Current Problems

Q-5 Rate the severity of the following problems for the firm at this time. (Circle number)

	Severity:			
PRODUCTS, PROCESSES, MARKETS	No problem	Minor	Moderate	Major
1. Analyzing markets	1	2	3	4
2. Developing new products	1	2	3	4
3. Planning marketing strategy	1	2	3	4
4. Upgrading current products/services	1	2	3	4
5. Adopting existing technology	1	2	3	4
6. Developing new or improving existing technology	1	2	3	4
7. Process control	1	2	3	4
FINANCIAL				
8. Obtaining financing	1	2	3	4
9. Obtaining, implementing, managing accounting & control systems	1	2	3	4
MANAGEMENT/ORGANIZATIONAL				
10. Coping with government regulations	1	2	3	4
11. Preparation, use, update of a business plan	1	2	3	4*
12. Setting and implementing goals	1	2	3	4
13. Finding qualified employees	1	2	3	4
14. Managing personnel	1	2	3	4
15. Systems maintenance	1	2	3	4

III. Sales and Asset History

Q-6 What were your total sales/revenue in 1987? (estimates acceptable)

$______________

Q-7 Over the last five years, have the firm's total annual sales/revenue: (Circle number)

1. Increased
2. Decreased
3. Shown no change
4. Other

Q-8 What percentage of the firm's gross income was devoted to research and development in 1987? (Mark 0 if none)

_____%

IV. Employment

Q-9 How many full-time equivalent employees does the firm currently employ? _____

Q10 What percentage of your workforce is:

1. _____Clerical
2. _____Data processors
3. _____Technicians
4. _____Scientists and engineers
5. _____Business/management personnel
6. _____General labor
7. _____Other (specify)____________________________

Q11 Has locating and hiring individuals with critical skills or training been a major problem for the firm?

1. YES
2. NO

Q12 If YES, what types of skills, training, or education critical to the firm are the most difficult to find?

____

____

Q13 Has upgrading skills or retraining of current employees been a major problem for the firm? (Circle number)

1. YES
2. NO

Q14 If YES, what types of skill upgrading or retraining are most difficult to find?

____

____

Q15 How much did your firm spend in 1987 on employee training?

_____Don't know $_________

Q16 What percentage of the training budget was spent on

_____% supervisory/managerial employees
_____% nonsupervisory/nonmanagerial employees
_____Don't know

Q17 In the past five years, has your firm ever used customized training courses? (Circle number)

1. YES
2. NO

Q18 If YES, what type(s) of institution did you work through? (Circle all that apply)

1. State university
2. Community college
3. Area Technical Vocational School
4. Kansas College of Technology
5. Private institution (specify)_____________________
6. Other_____________________________________

Q19 How would you rate the quality of the training? (Circle number)

1. Good
2. Average
3. Poor
4. Don't know

Q20 How will changing technology affect the skill requirements of those you employ over the next five years? (Circle number)

1. Workers will need higher level of skills
2. Workers will need a broader variety of skills
3. Workers will need the same skills they currently have
4. Don't know

V. Technology

Q21 In the next five years, what is your estimate of the impact of technology on the firm in the following areas: (Circle number)

	Great	Considerable	Some	Little	None	Don't Know
Processes and process control	1	2	3	4	5	6
Products	1	2	3	4	5	6
Materials	1	2	3	4	5	6
Information needs	1	2	3	4	5	6
Employee skill level	1	2	3	4	5	6

Q22 What are your firm's source(s) of information on NEW and EXISTING technology? (Circle all that apply)

1. Have no source
2. Sources within the company
3. Equipment manufacturers
4. Trade associations
5. Sales representatives
6. Universities and colleges
7. Magazines/journals
8. Consultants
9. Private laboratories
10. Government laboratories
11. Other (specify)____________________________________

Q23 Are your present sources for science and technology information adequate for you to be competitive and to innovate? (Circle number)

1. YES
2. NO

Q24 Mark the source(s) your firm will maintain or would like to establish in the future to improve access to information regarding scientific and technological changes and advances. (Circle all that apply)

1. Sources within the company
2. Equipment manufacturers
3. Trade associations
4. Sales representatives
5. Universities and colleges
6. Magazines/journals
7. Consultants
8. Private laboratories
9. Government laboratories
10. Other (Specify)____________________________________

Q25 Mark your firm's source(s) of information on NEW or SPECIALIZED MANAGEMENT PRACTICES. (Circle all that apply)

1. Have no source
2. Sources within the company
3. Trade associations
4. Universities and colleges
5. Magazines/journals
6. Consultants
7. Other (Specify)____________________________________

Q26 Mark the source(s) that your firm will maintain or would like to establish in the future to improve access to information regarding business management practices. (Circle all that apply)

1. Sources within the company
2. Trade associations
3. Universities and college
4. Magazines/journals
5. Consultants
6. Other (Specify)____________________________________

Q27 Has your firm ever gained information on or access to new or existing technology or to new management practices through contacts, cooperative activities, etc. with other businesses? (Circle number)

1. YES
2. NO

VI. Technological Changes

Q28 What changes are taking place in your INDUSTRY today? (Circle all that apply)

Technology

1. No major change
2. CAD (Computer aided design)
3. CAM (Computer aided manufacturing)
4. CIM (Computer integrated manufacturing)
5. CAE (Computer aided engineering)
6. FMS (Flexible manufacturing systems)
7. Robotics
8. Automated materials handling
9. Other (Specify)________________________________
10. Don't know

Technical systems

11. No major change
12. Total quality control
13. Statistical process control
14. Just-in-time production methods
15. Zero defect planning
16. Computerized accounting systems
17. Other (Specify)________________________________
18. Don't know

Human systems

19. No major change
20. Work cells
21. Self-managing teams
22. Higher levels of decision making at shop floor level
23. Other________________________________
24. Don't know

Q29 What changes has the firm made in the last five years? (Circle all that apply)

Technology

1. No major change
2. CAD (Computer aided design)
3. CAM (Computer aided manufacturing)
4. CIM (Computer integrated manufacturing)
5. CAE (Computer aided engineering)
6. FMS (Flexible manufacturing systems)
7. Robotics
8. Automated materials handling
9. Other (specify)________________________________

Technical systems

10. No major change
11. Total quality control
12. Statistical process control
13. Just-in-time production methods
14. Zero defect planning
15. Computerized accounting systems
16. Other (specify)____________________________________

Human systems

17. No major change
18. Work cells
19. Self-managing teams
20. Higher levels of decision making at shop floor level
21. Other (specify)____________________________________

Q30 What is your firm's ability to predict or anticipate technological change in your industry? (Circle number)

1. Excellent
2. Good
3. Fair
4. Can't predict
5. NA

Q31 What is the primary source of information you use in predicting or anticipating technological change in your industry? (Circle number)

1. Sources within the company
2. Equipment manufacturers
3. Trade associations
4. Sales representatives
5. Universities and colleges
6. Magazines/journals
7. Consultants
8. Private laboratories
9. Government laboratories
10. Other (specify)____________________________________

Q32 In the next five years, how likely is your firm to make changes in the technologies it uses? (Circle number)

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
5. Not likely

Q33 Over the past 5 years, did the firm discontinue use of any form of technology or technical systems?

1. YES
2. NO

Q34 If YES, what type?____

Why?____

Q35 Has any technology or technical system been identified as potentially valuable for the firm but not been adopted?

1. YES
2. NO

Q36 If YES, what type?____

Why not adopted?____

____

Q37 What are the barriers to introducing new or existing technology or technical systems into the firm? (Circle all that apply)

1. No barriers
2. Lack of engineers
3. Lack of skilled workers
4. Lack of technical expertise
5. Lack of technical information
6. Lack of financial resources
7. Lack of managerial commitment
8. Risk too high
9. Other (specify)____________________

____

Q38 How can barriers to introducing new or existing technology or technical systems into the firm be overcome?

VII. Academic Linkages

Q39 Rate your level of familiarity with Kansas' postsecondary educational institutions. (circle number)

	Level of Familiarity			
	Very	Considerable	Some	None
1. Emporia State	1	2	3	4
2. Fort Hays	1	2	3	4
3. Kansas State	1	2	3	4
4. University of Kansas	1	2	3	4
5. Pittsburg State	1	2	3	4
6. Wichita State	1	2	3	4
7. Kansas College of Technology (formerly Kans.Tech.Inst.)	1	2	3	4
8. Washburn	1	2	3	4
9. Other comm. coll. (specify) ________	1	2	3	4
10. Tech./Voc. school (specify) ________	1	2	3	4
11. Private institution (specify) ________	1	2	3	4
12. Other (specify) ________	1	2	3	4

Q40 How familiar are you with resources listed below that academic institutions do or could offer business and industry? (circle number)

	Level of Familiarity			
	Very	Considerable	Some	None
1. Faculty technology/technical consultation	1	2	3	4
2. Management development training	1	2	3	4
3. Availability of labs/equipment	1	2	3	4
4. Business/managerial assistance	1	2	3	4
5. Science & technology research	1	2	3	4
6. Technical training or workers	1	2	3	4
7. Libraries (general, science, engineering, etc.)	1	2	3	4
8. Computer searches/networking	1	2	3	4
9. Proposal preparation assistance	1	2	3	4

Q41 In the past five years, has the firm used the services of any state university, community college, or vocational/technical school? (Circle number)

1. YES
2. NO (If No, go to Q46)

Q42 Which types of TECHNICAL assistance did the firm use in the past five years? (Circle all that apply)

1. Technical consultation with faculty regarding products and/or processes
2. Plant layout & materials handling
3. Product analysis/improvement
4. New product development

5. Manufacturing process analysis/improvement
6. Technical research for future products or processes
7. Commercialization
8. Explanation of existing technology
9. Explanation of new technology
10. Technical training of workers
11. Library or computer searches
12. Use of scientific instruments and equipment
13. Use of computers
14. Assistance in proposal preparations
15. Other (specify)____________________________________

Q43 What type of BUSINESS/MANAGERIAL assistance did the firm use in the past five years? (Circle all that apply)

1. Market research & planning
2. Financial analysis & cost control
3. Development/management of accounting systems
4. Preparation & use of a business plan
5. Advertising & promotion
6. Feasibility studies
7. Inventory control
8. Personnel and organization
9. Management development training
10. Use of library
11. Use of computer(s)/computer applications
12. Other (specify)____________________________________

Q44 With which institution(s) did you interact? (circle all that apply)

1. Emporia State
2. Fort Hays
3. Kansas State
4. University of Kansas
5. Pittsburg State
6. Wichita State
7. Kansas College of Technology (formerly Kans.Tech.Inst.)
8. Washburn
9. Community college (specify)____________________
10. Technical/Vocational School(specify)________________
11. Private institution (specify)____________________
12. Other (specify)____________________________

Q45 What were the reasons for the choice of institution(s)? (Circle all that apply)

1. Located close to firm
2. School/department has state/national reputation interest area
3. Knew of an individual whose expertise you could use
4. Institution was familiar to you (alumnae, friends attended, etc.)
5. Institution/department/faculty agreed to help while others didn't
6. Institution/department/faculty was recommended to you by others
7. Other (specify)____________________________________

Q46 Why has your firm not used university and college resources more? (Circle all that apply)

1. Do not know how to make contacts
2. Do not know whom to contact
3. Do not have time to make contacts
4. Tried but got no response
5. Problems cannot be solved by faculty (Lack of experience, expertise)
6. Faculty/schools seen as too out of touch with business problems
7. Response time is too slow
8. Other (specify)____

Q47 Would your firm seek more assistance from state/local academic institutions if it were available?

1. YES
2. NO

Q48 How interested would your firm be in the following services? (Circle number)

		Interest Level			
		Great	Moderate	Little	None
1.	Use faculty to do research and development activities to develop <u>new</u> technology, products, processes, etc.	1	2	3	4
2.	Use faculty to do research to develop ways to apply <u>existing</u> technology to improve current products and processes	1	2	3	4
3.	Use faculty consultants to solve firm's technical problems	1	2	3	4
4.	Use faculty consultants to solve business/managerial problems	1	2	3	4
5.	Use extension agents with technical experience/expertise to facilitate technical problem identification & assistance	1	2	3	4
6.	Use extension agents with business/managerial experience/expertise to facilitate business/managerial problem identification and assistance	1	2	3	4
7.	Use computer linkage to university libraries for information retrieval and/or networking	1	2	3	4
8.	Use labs and equipment	1	2	3	4
9.	Use training programs to improve employee technical skills	1	2	3	4
10.	Use management development training	1	2	3	4
11.	Other________________________	1	2	3	4

Q49 Would you prefer to make your own initial contact with universities and other postsecondary institutions, or would it be helpful to have a liaison office help you locate and contact persons who could best solve your business and technical problems? (Circle number)

1. Own contacts
2. Liaison office
3. Other (specify)______________________________
4. Don't know

Is there anything else you would like to tell us about your firm's needs that could be used to design academic/industrial linkages to assist you to be competitive nationally and internationally?

Your contribution to this effort is greatly appreciated.

WHEN YOU HAVE COMPLETED THE QUESTIONNAIRE, PLEASE RETURN IN THE ENCLOSED PREPAID ENVELOPE BY DECEMBER 23, 1988. THANKS -- WE APPRECIATE IT.

I. Demographic

ID Code # ______

Q1 How many years has the firm been in operation? ______________________________

Q2 What is the major product or service provided by your firm?

____

Q3 Do you consider your company or product to be classified as "Advanced Technology" or technology driven? (Circle number of your answer)

1. Yes
2. No

Q4 How would you rate the level of technology used by your firm? (Circle number)

1. Cutting edge
2. Current
3. Traditional

Q5 Are you the founder of the firm? (Circle number)

1. Yes (If Yes, go to Q6a)
2. No (If No, go to Q6b)

Q6a What was your education level when you started the firm? (Circle number)

1. High School
2. Some college
3. Associates degree
4. Undergraduate degree
5. Graduate degree
6. Other______________

Q7 How many years had you worked in industries similar to that of your new firm prior to starting the new firm? _______

Q6b If NO, when did you join the firm?

____

(Go to Q8)

Q8 What is your area of expertise/training?

____

Q9 How would you describe the career shift you made to this firm? (Circle number)

1. School/college to new firm
2. Established firm to new firm
3. One new firm to another new firm
4. Unemployment to new firm
5. Retirement to new firm
6. Other, please specify ________________________________

II. Milestones

Q10 When did members of the start-up team first begin to make major investments - personal time, personal resources - in the new firm?

Month _______, Year _______

Q11 When was the first significant outside financial support obtained?

Month _______, Year _______,

Not applicable ___________

Q12 When did the firm receive its first sales income/revenue?

Month _______, Year _______,

Not applicable ___________

Q13 When did the firm first hire anybody, full or part time?

Month _______, Year _______,

Not applicable ___________

III. Employment

Q14 How many individuals do you employ currently?

________ Full time ________ Part time

Q15 What percentage of your workforce is:

1. _____Clerical
2. _____Data processors
3. _____Technicians
4. _____Scientists and engineers
5. _____Business/management personnel
6. _____General labor
7. _____Other, please specify___________________________

Q16 Has locating and hiring individuals with critical skills or training been a major problem for the firm?

1. Yes (If yes, go to Q16a)
2. No (If no, go to Q17)

Q16a If YES, what types of skills, training, or education are the most difficult to find?

____

____

IV. Choice and Evaluation of Location

Q17 Was this firm started in this city (metro area)?

1. Yes (If yes, go to 17a)
2. No (If no, go to 17b)

Q17a If yes, what were the most important reasons for starting this firm in this city?

____

Q17b If no, why did you relocate to this city?

____

Q18 Listed below are issues often considered when choosing the area in which to locate a firm. Please rate how important each issue is or was in the choice of your firm's location to this city. (Circle number in scale at left). In addition, rate your satisfaction with your firm's current location as it relates to each issue. (Circle number in scale at right)

LOCATION DECISION: LEVEL OF IMPORTANCE						CURRENT LOCATION: LEVEL OF SATISFACTION			
Not Considered	Very Important	Somewhat Important	Not Important			Very	Somewhat	Not	
0	1	2	3	1.	Availability of professional science and technology staff	1	2	3	NA
0	1	2	3	2.	Availability of professional business staff	1	2	3	NA
0	1	2	3	3.	Availability of technical staff	1	2	3	NA
0	1	2	3	4.	Education and training opportunities for professional staff	1	2	3	NA
0	1	2	3	5.	Education and training opportunities for technical staff	1	2	3	NA
0	1	2	3	6.	Access to research and development facilities	1	2	3	NA
0	1	2	3	7.	Access to consumers	1	2	3	NA
0	1	2	3	8.	Access to suppliers of production equipment	1	2	3	NA
0	1	2	3	9.	Access to suppliers of raw materials and component parts	1	2	3	NA
0	1	2	3	10.	Access to business support services (financial, legal, etc)	1	2	3	NA
0	1	2	3	11.	Local government support for business	1	2	3	NA
0	1	2	3	12.	Access to seed capital for initial development	1	2	3	NA
0	1	2	3	13.	Access to venture capital for commercialization	1	2	3	NA
0	1	2	3	14.	Access to operating capital	1	2	3	NA
0	1	2	3	15.	Taxes on business income & property	1	2	3	NA
0	1	2	3	16.	Building space availability	1	2	3	NA
0	1	2	3	17.	Building space expenditures (rent, etc.)	1	2	3	NA
0	1	2	3	18.	Access to airports	1	2	3	NA
0	1	2	3	19.	Access to interstate highway networks	1	2	3	NA
0	1	2	3	20.	Infrastructure (roads, water, sewers, etc.)	1	2	3	NA

V. Sales and Asset Information

Q19 What were your total sales/revenues in 1987? (estimates acceptable)

$________________ Total

Q20 Approximately what percentage of sales were in:

1. Kansas ______%
2. Adjacent states (CO, NB, MO, OK) ______%
3. The rest of the U.S. ______%
4. Outside the U.S. ______%

TOTAL 100%

Q21 Approximately what percentage of sales were in your city? ________%

Q22 What was the 1987 year-end total net asset value $________________

Q23 What percent of the firm's gross income was devoted to Research and Development? ________%

VI. Start-up Problems

Q24 How severe were the following problems as the firm was being established or during its early development phase? (Circle number)

		SEVERITY			
		No Problem	Minor	Moderate Problem	Major Problem
A. Products Processes and Markets					
1. Analyzing markets	NA	1	2	3	4
2. Developing new products and/or services	NA	1	2	3	4
3. Planning market strategy	NA	1	2	3	4
4. Commercialization of product	NA	1	2	3	4
5. Process development and control	NA	1	2	3	4
B. Financial					
6. Obtaining financing	NA	1	2	3	4
7. Establishing a banking relationship	NA	1	2	3	4
8. Developing/managing an accounting and control system	NA	1	2	3	4
9. Obtaining insurance	NA	1	2	3	4
C. Management/Organizational					
10. Coping with government regulations	NA	1	2	3	4
11. Preparation/use of a business plan	NA	1	2	3	4
12. Setting and implementing goals	NA	1	2	3	4
13. Finding qualified managers and executives	NA	1	2	3	4
14. Finding qualified technical and professional staff	NA	1	2	3	4
15. Finding other qualified employees	NA	1	2	3	4
16. Managing personnel	NA	1	2	3	4
17. Systems maintenance	NA	1	2	3	4
D. Selecting/Developing a Location					
18. Identifying/selecting a suitable site	NA	1	2	3	4
19. Locating suitable rental space	NA	1	2	3	4
20. Access to customers, clients	NA	1	2	3	4
21. Access to suppliers, vendors	NA	1	2	3	4

VII. Start-up Assistance

A business incubator is generally understood to be a facility with adaptable space which can be leased by small businesses typically on flexible terms and with affordable rents. Support services and business development services, such as financing, marketing, and management are available and shared by the tenants of the facility. The basic purpose in formulating an incubator is to enhance the chance for survival of young business.

Q25 Was a small business incubator facility available in your area during your start-up phase? (Circle number)

1. Yes (If yes, go to Q26a)
2. No (If no, go to Q26b)

Q26a If YES, did you use it?

1. Yes
2. No (If no, why not?)

____

____

____

Q26b If NO, would you have considered using an incubator incubator facility had one been available in your area?

1. Yes
2. No
3. Don't know

Q27 If no cost or low cost assistance were available and accessible during your firm's early development phases, which of the following services would you have used? Circle 0 if you would NOT have used that service. If you WOULD have used the service, rate how beneficial it would have been by circling a number (1=Slightly beneficial; 2=Moderately beneficial; 3=Very beneficial; 4=Extremely beneficial)

	Would Not Use:	Would Use: Level of benefit			
		Slight	Mod.	Very	Extreme
1. Access to technical consultants (e.g. university faculty, other specialists) regarding:					
1a. products and/or manufacturing processes	0	1	2	3	4
1b. new product development, including technical research	0	1	2	3	4
1c. commercialization of products	0	1	2	3	4
1d. product analysis/improvement	0	1	2	3	4
1e. new or existing technology transfer	0	1	2	3	4
1f. preparation of grant proposals (e.g., SBIR)	0	1	2	3	4
1g. other, please specify ______	0	1	2	3	4
______	0	1	2	3	4
2. Access to scientific instruments and equipment	0	1	2	3	4
3. Access to high-powered computers	0	1	2	3	4
4. Access to library or computer searches	0	1	2	3	4
5. Access to business/managerial professionals regarding:					
5a. starting a business	0	1	2	3	4
5b. market research and planning	0	1	2	3	4
5c. preparation and use of a business plan	0	1	2	3	4
5d. financial planning/management	0	1	2	3	4
5e. advertising and promotion	0	1	2	3	4
5f. inventory control	0	1	2	3	4
5g. personnel management	0	1	2	3	4
5h. other, please specify ______	0	1	2	3	4
______					
6. Access to other professionals regarding:					
6a. legal services	0	1	2	3	4
6b. insurance services	0	1	2	3	4
6c. other, please specify ______	0	1	2	3	4
______					
7. Access to general office services	0	1	2	3	4
8. Other, please specify ______	0	1	2	3	4

VIII. Future Plans

Q28 What are your business plans for the next 2-3 years? (Circle all that apply.)

1. No major changes
2. Development of new products
3. Change mix of products or services
4. Significant **increase** in employees
5. Significant **decrease** in employees
6. Spin off new firm(s)
7. Sell the firm
8. Don't know

Q29 Has this firm already spun off any new firms?

1. Yes   Q29a If YES, how many? ___________
2. No

Q30 If you were to start a new business, rate how interested you would be in using an incubator facility? (Circle number)

Very interested   Not interested

1   2   3   4   5

IX. Technology

Q31 What are your firm's source(s) of information on current technological developments? (Circle all that apply)

1. Have no source
2. Sources within the company
3. Equipment manufacturers
4. Trade associations
5. Sales representatives
6. Universities and colleges
7. Magazines/journals
8. Consultants
9. Private laboratories
10. Government laboratories
11. Other (specify)____________________________

Q32 Are your present sources for science and technology information adequate for you to be competitive and to innovate? (Circle number)

1. YES
2. NO

Q33 Mark your firm's source(s) of information on current management practices. (Circle all that apply)

1. Have no source
2. Sources within the company
3. Trade associations
4. Universities and colleges
5. Magazines/journals
6. Consultants
7. Other (Specify)____________________________

Q34 Are your present sources for business/management practices information adequate?

1. YES
2. NO

X. Technological Changes

Q35 What is your firm's ability to predict technological change in your industry? (Circle number)

1. Excellent
2. Good
3. Fair
4. Can't predict
5. NA

Q36 In the next five years, how likely is your firm to make changes in the technologies it uses? (Circle number)

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
5. Not likely

Q37 Has any technology or technical system been identified as potentially valuable for the firm but not been adopted?

1. YES
2. NO

Q38 If YES, what type?____

Why not adopted?____

____

Q39 What are the barriers to introducing new or existing technology or technical systems into the firm? (Circle all that apply)

1. No barriers
2. Lack of engineers
3. Lack of skilled workers
4. Lack of technical expertise
5. Lack of technical information
6. Lack of financial resources
7. Lack of managerial commitment
8. Risk too high
9. Other (specify)___________________________

____

Q40 How can barriers to introducing new or existing technology or technical systems into the firm be overcome?

XI. Academic Linkages

Q41 In the past five years, has the firm used the services of any non-Kansas university, community college, or vocational/technical school? (Circle number)

1. YES
2. NO

Q42 If yes, was this because the services needed were not available from Kansas institutions?

1. Yes
2. No

Q43 In the past five years, has the firm used the services of any Kansas university, community college, or vocational/technical school? (Circle number)

1. YES
2. NO (If No, go to Q48)

Q44 Which types of TECHNICAL assistance did the firm use from Kansas universities and colleges in the past five years? (Circle all that apply)

1. Technical consultation with faculty regarding products and/or processes
2. Plant layout & materials handling
3. Product analysis/improvement
4. New product development
5. Manufacturing process analysis/improvement
6. Technical research for future products or processes
7. Commercialization
8. Explanation of existing technology
9. Explanation of new technology
10. Technical training of workers

11. Library or computer searches
12. Use of scientific instruments and equipment
13. Use of computers
14. Assistance in proposal preparations
15. Joint research
16. Other (specify)________________________________

Q45 What type of BUSINESS/MANAGERIAL assistance did the firm use from Kansas universities and colleges in the past five years? (Circle all that apply)

1. Market research & planning
2. Financial analysis & cost control
3. Development/management of accounting systems
4. Preparation & use of a business plan
5. Advertising & promotion
6. Feasibility studies
7. Inventory control
8. Personnel and organization
9. Management development training
10. Use of library
11. Use of computer(s)/computer applications
12. Production management
13. Other (specify)________________________________

Q46 With which institution(s) did you interact? (circle all that apply)

1. Emporia State University
2. Fort Hays University
3. Kansas State University
4. University of Kansas
5. Pittsburg State University
6. Wichita State University
7. Kansas College of Technology (formerly Kansas Technical Institute)
8. Washburn University
9. Community college (specify)____________________
10. Technical/Vocational School(specify)____________________
11. Private institution (specify)____________________
12. Other (specify)________________________________

Q47 What were the reasons for the choice of institution(s)? (Circle all that apply)

1. Located close to firm
2. School/department has state/national reputation interest area
3. Knew of an individual whose expertise you could use
4. Institution was familiar to you (alumnae, friends attended, etc.)
5. Institution/department/faculty agreed to help while others didn't
6. Institution/department/faculty was recommended to you by others
7. Other (specify)________________________________

Q48 Why has your firm not used university and college resources more? (Circle all that apply)

1. Do not know how to make contacts
2. Do not know whom to contact
3. Do not have time to make contacts
4. Tried but got no response
5. Problems cannot be solved by faculty (lack of experience, expertise)
6. Faculty/schools seen as too out of touch with business problems
7. Response time is too slow
8. Other (specify)________________________________

Q49 Would your firm seek more assistance from state/local academic institutions if it were available?

1. YES
2. NO

Q50 How interested would your firm be in the following services? (Circle number)

		Interest Level			
		Great	Moderate	Little	None
1.	Research and development activities to develop new technology, products, processes, etc.	1	2	3	4
2.	Access to state-of-the-art science and technology to improve current products and processes	1	2	3	4
3.	Access to technical expertise to facilitate technical problem identification & assistance	1	2	3	4
4.	Access to business/managerial expertise to facilitate business/managerial problem identification & assistance	1	2	3	4
5.	Computer access to university libraries for information retrieval and/or networking	1	2	3	4
6.	Access to labs and equipment	1	2	3	4
7.	Access to training programs to improve employee technical skills	1	2	3	4
8.	Access to management development training	1	2	3	4
9.	Other________________________________	1	2	3	4

Q50 Would you prefer to make your own initial contact with universities and other postsecondary institutions, or would it be helpful to have a liaison office help you locate and contact persons who could best solve your business and technical problems? (Circle number)

1. Own contacts
2. Liaison office
3. Other (specify)______________________
4. Don't know

Is there anything else you would like to tell us about your firm's needs that could be used to design academic/industrial linkages to assist you to be competitive nationally and internationally?

Your contribution to this effort is greatly appreciated.
Please insert in envelope provided and return by December 12, 1988.