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THE PERFORMANCE OF KANSAS FIRMS IN THE SBIR PROGRAM

prepared for

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A Report to

Kansas Technology Enterprise Corporation

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EXECUTIVE SUMMARY

PURPOSE

Congress designed the Small Business Innovative Research program (SBIR) to facilitate small business participation in federally funded research and development. The apparent lack of success of Kansas small businesses in getting SBIR funding concerns many people involved in developing Kansas's technological infrastructure, including the Kansas Technology Enterprise Corporation (KTEC). At KTEC's behest, we explored two basic questions about the performance of Kansas small businesses in the SBIR program:

(1) Why do Kansas firms not obtain more SBIR grants?

(2) How could the number of awards to Kansas firms be increased?

These questions were answered in two parts. First SBIR success was characterized at three levels: regional success, firm success, and state success. Then the performance of Kansas firms in the SBIR program was investigated. The report concludes with a series of policy suggestions.

REGIONAL SUCCESS

A general performance rating was developed to measure a state's SBIR performance relative to its population. Only ten states and the District of Columbia have a rating above average and nine of those states have a rating of twice the average. Thus, if a state is doing well, it is probably doing very well. Of the nine states with a rating above twice the average, six are coastal states and three are mountain states. A comparison of the number of awards received between FY1983 and FY1990 gives an idea of the unevenness of the distribution of SBIR awards. California and Massachusetts have about 14.4 percent of the U.S. population but have gathered about 38.1 percent of all SBIR awards during this period. Kansas has about one percent of the U.S. population, but received less than 0.2 percent of the awards during this period.

Three elements play a role in establishing SBIR activity in a region: quality advanced education, a large number of federal research laboratories, and significant spending on research and development. These three elements can cause clusters of successful firms in the SBIR program. However, they do not seem to be attributes that a state can easily add to its inventory.

FIRM SUCCESS

Qualities of Successful Firms

Stability: The government will take a chance on technology but not on the company. Agencies participating in the SBIR program know that research and development is risky. They want the risky aspect of the project to be the research and development, not the firm.

Customer Oriented: The SBIR program is not an entitlement program and it is not an academic research grant program; SBIR is a contracting program. The contracting agencies, for the most part, know what they want, and the successful firms give it to them.

Understanding Federal Bureaucracy: Working with a bureaucracy is easier if their problems are understood. They want to sponsor successful projects. The more confidence the firm can inspire in them, the better off it is.

Qualities of Successful Proposals

A great idea that matches the solicitation: This component has two equally important aspects — a great idea, and an idea that matches the solicitation.

A thorough understanding of the State of the Art: This involves doing a thorough literature search, talking to others in the field, talking to interested SBIR people, talking to non-SBIR research people in government, and finding out if a nearby university has faculty knowledgeable in the field. Several of the people we interviewed stated that unless researchers know they will have one of the top three proposals, they are probably wasting time.

A detailed research plan: The detailed research plan must explicitly meet all the solicitation objectives. This must be clearly stated and obvious to anyone reading the proposal.

A vision of potential commercial importance: The SBIR program is more and more oriented toward commercial applications.

Access to the facilities, equipment, and personnel: If some resource from outside the proposal writer's firm is needed, the availability of this resource must be fully documented.

STATE SUCCESS

When discussing any type of economic development issue, opinions seem to overwhelm facts. This may not reflect the emotional strength with which these opinions are held as much as the dearth of economic development facts. With this note of caution, we discuss a couple of different roles for the SBIR program in a state's economic development plan.

SBIR as the Centerpiece of any State Technology Development Program

The argument begins with the observation (or theory) that technology firms tend to form clusters. The SBIR program provides the opportunity to funnel outside money to research and development firms in the state. Once a critical mass of research and development firms has developed, then the mass only continues to grow and the process is not reversible. Thus, the state should nurture the development of clusters and funnel firms toward the SBIR program.

SBIR as an Additional Resource for a State Technology Development Program

States should not provide welfare programs for small business. However, states should invest in small business, making sure that the investment pays for itself.

State Programs to Aid SBIR Success

After reviewing a few state programs and their SBIR success rate, we found no correlation

between expenditure and performance. These results are inconclusive because of data problems.

SBIR PERFORMANCE OF KANSAS FIRMS

Kansas had the eighth lowest SBIR performance rating for the years FY1983 to FY1990. We tried to determine the number of Kansas firms that fit the SBIR criteria. However, this was found to be unproductive. Instead, Kansas' SBIR potential was estimated using simple econometric models. Prior to the new SBIR law which makes much more money available for the program, it was estimated that Kansas was on average about $1,000,000 below its potential.

POLICY IMPLICATIONS OF THIS STUDY

The current support for firms interested in the SBIR program is limited by lack of resources. Those people who have come into contact with KTEC in the process of trying to obtain an SBIR award found KTEC personal helpful. No one was critical of KTEC's help except for the lack of resources. Our policy suggestions are divided into two groups: incremental and significant enhancement.

Incremental Enhancement Suggestions

1. KTEC should sponsor a State SBIR Conference.
2. KTEC should ask recipients of KTEC matching grants and other state winners of SBIR awards to mentor firms newly interested in SBIR funding.
3. KTEC should sponsor a workshop for MAMTC personnel explaining the SBIR program.
4. KTEC Matching Grants Program
    a. KTEC should evaluate the proposals rather than the abstracts.
    b. The matching grants should be limited to $2,500.
5. KTEC should create a database of those interested in the SBIR program.
6. KTEC should encourage the Wichita aircraft industry to assist small firms.
7. KTEC should cooperate with nearby states on SBIR matters when feasible.

Significant Enhancement Suggestions

1. KTEC should make SBIR someone's full-time job.
2. KTEC Matching Grants Program
    a. KTEC should add more money to the fund so more firms can be supported.
    b. KTEC should allow the grant recipients greater flexibility in their use of the funding.
    c. KTEC should set up a process for reviewing proposals before they are submitted.
3. KTEC should help firms fill the gap between Phase I and Phase II funding.
4. KTEC should help firms line up Phase III funding.

INTRODUCTION

The Small Business Innovative Research program (SBIR) is designed to ensure that small businesses participate in federally funded research and development. Although the SBIR program is a national program, it has a reputation of being dominated by small businesses from coastal states. The apparent lack of success of Kansas small businesses in obtaining SBIR funding concerns many people involved in developing Kansas's technological infrastructure including the Kansas Technology Enterprise Corporation (KTEC). At KTEC's behest, we explored two basic questions about the performance of Kansas small businesses in the SBIR program:

(1) Why do Kansas firms not obtain more SBIR grants?

(2) How could the number of awards to Kansas firms be increased?

Three guidelines to answer these questions were to: measure the SBIR efforts of Kansas firms, assess the support infrastructure for SBIR funding in Kansas, and determine other states' SBIR characteristics. This report summarizes our study of the SBIR program and the success rate of Kansas firms in obtaining SBIR awards. The Center for Economic Development and Business Research at Wichita State University was asked to investigate the same questions for south-central Kansas. Their report was written by S. Michelle Davis and is included as an appendix to this report.[1]

This report begins with a brief history and description of the SBIR program. The development of the SBIR program is described, placing it in a policy context and illustrating the relative newness of the program. The program is summarized by giving a description of its structure, the basic requirements for eligibility, the funding formula, the agencies involved in the program, and the rights that small businesses which participate in the program have. This section ends with a brief mention of the Small Business Technology Transfer Pilot program (STTR), which is based on the SBIR program.

The second section of this report analyzes the distribution of SBIR awards from the point of view of regional success, firm success, and state success. Regional success is the result primarily of three factors — advanced educational resources, expenditure on research and development, and the number of federal laboratories — which are outside the authority or control of state governments. Firm success is depicted in terms of qualities of successful firms and qualities of successful proposals. If the major factors which influence how well a region does in the SBIR program are outside state governmental control, a natural question to ask is what can a state do to improve the SBIR performance of its small businesses. This section ends by

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[1] ***Analysis of the Small Business Innovation Research Program (SBIR) in South Central Kansas.***

investigating what some other states have done and what effect this activity has had.

The third section takes a closer look at the performance of Kansas firms in the SBIR program. The past performance of Kansas firms is described in terms of getting SBIR funding. Then the possible size of the Kansas clientele for the SBIR program is investigated. This question failed to elicit useful information, and instead the question of what is the potential performance in the SBIR programs of small businesses in Kansas was asked. This question was answered by developing and estimating an econometric model of state SBIR performance. It is concluded that Kansas firms during the late 1980s and early 1990s were falling about $1,000,000 short of their SBIR potential.

The fourth section describes policy recommendations drawn from this study. This section describes the KTEC support for small businesses interested in the SBIR program from the point of view of the interested firms. This information was obtained from our survey of Kansas firms which had applied for SBIR awards.[2] Next, two lists of policy suggestions were developed: incremental and significant enhancement. Finally, a brief discussion of a fundamental policy dilemma for Kansas decision-makers is presented: is spending $50,000 to $100,000 more worth $1,000,000 to $2,000,000 more in SBIR funding? The answer to this question is not obvious.

As we outline our study, a third basic question about the SBIR program should be considered: is the program worth the effort? A series of interviews with firms which had applied for SBIR funding was conducted. These firms provided three types of responses to this question. Those small businesses successful in getting Phase I grants thought the program was an important factor in the development of the firm. Some of those firms which have failed to win SBIR awards still consider their experience with the program to be positive and will continue to look for SBIR opportunities. The others which have failed to win an award are frustrated with the federal government and see their experience as a waste of time. Either they have no future plans to apply for SBIR funding, or they would need striking evidence that applying for an SBIR grant would be worth the trouble. The SBIR program is not for every small business, not even for every small technology firm, but for many firms it can provide an important source of research and development funding and also give the firm additional credibility.

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[2]We were given a list by KTEC of 21 firms which they knew had applied for SBIR funding in the past few years. We were able to interview 14 out of 20 of these firms. Since one of the firms on the list was located in Sedgwick County, the interview with that firm was conducted by S. Michelle Davis of the Center for Economic Development and Business Research at Wichita State University. Ms. Davis was also able to locate another firm in the Wichita Area which had successfully gained SBIR funding. In addition, she interviewed four additional firms which had never applied for a SBIR grant. Finally, she conducted a focus group with five small businesses which had not applied for SBIR grants, but were interested in the SBIR program, in varying degrees.

THE SBIR PROGRAM

This section provides a basic idea of how the SBIR program developed, why it developed, and what the program is like. The first portion of this section is a brief history of the development of the SBIR program. The rest of the section is a summary of the program. Only the general structure of the program is presented. Because of the decentralized nature of the program, each agency has its own rules, regulations, and traditions.

BRIEF HISTORY OF THE SBIR PROGRAM

The genesis of the SBIR program was a 1975 rider to the National Science Foundation (NSF) budget that set aside $20 million for small business research and development. Prior to this set-aside, small businesses had felt that they were at an unfair disadvantage in competing for federal government research and development money. During the early 1970's, an ongoing debate had taken place within NSF concerning whether small business could do the quality of research demanded by NSF. The set aside money was to be a test, and NSF was pleasantly surprised at the quality of research funded by the set aside funds.[3] The Defense Department (DOD) followed NSF in setting aside research and development funding for small business.

In 1980, President Carter held the first White House Conference on Small Business. At this conference, one of the recommendations spawned what has become the SBIR program. The first proposal in Congress for the SBIR program came from the freshman senator from New Hampshire, Warren Rudman. ***The Small Business Innovation Development Act*** was passed on July 22, 1982, authorizing the SBIR program for five years. The program was modified slightly in 1987 when it was reauthorized. In 1992, the program was substantially changed, with the reauthorization running to the year 2000.

SUMMARY OF THE SBIR PROGRAM

Just before adjournment in October of 1992, Congress passed legislation enlarging the SBIR program (Public law 102-564: ***Small Business R and D Enhancement Act of 1992***) with the endorsement of the Bush Administration and the support of the Clinton-Gore campaign. The new law basically doubles the size of the SBIR program, creates the STTR program, places increased emphasis on commercialization of research, and places a series of "Checkpoints of Caution" in

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[3]Telphone conversation with Milton D. Stewart, President, Small Business High Technology Institute, Phoenix, Arizona, March 14, 1994. Mr. Stewart was involved in the SBIR program from the beginning.

the law to evaluate the success of the program. As we outline the program, we will indicate how each of these changes in the program comes into play.

Finally, a note of caution, the implementation of the SBIR program is decentralized, with each agency having its own program and sometimes unique requirements. As a result, no general description of the program with any detail is possible. For example, the DOD has a SBIR program coordinator. Then, eight separate agencies within the DOD have program managers. Each of these agencies works under the general rules and regulations of the SBIR program, the special rules and regulations of the DOD SBIR program, and then each agency has its own unique research regulations.

Structure of the SBIR Program

The SBIR program is designed to provide a competitive structure for small businesses to help fulfill federal government research and development needs. A key point to remember, and one that seems to be forgotten by small businesses at times, is that the SBIR program is designed for small businesses to help meet government research and development needs. It is not necessarily a program primarily designed to help small businesses do the research and development they want themselves. The program is not designed to create small research and development firms. Governmental agencies have research and development problems; small businesses are asked to provide answers to those problems.

The program is organized to lead the successful small business from the research and development through the commercialization of a new process or product. The basic stages of the SBIR program are: Phase I — feasibility study, Phase II — prototype development, and Phase III — commercialization. Each of these stages will be discussed further.

Phase I

Initially, each agency publishes solicitations for research proposals. These solicitations ask for proposed solutions to research problem areas or research topics of interest to the agency. Most agencies publish solicitations once a year; however, the DOD does it twice a year. The interested small business then responds to a specific solicitation with a proposal for a solution. This is referred to as a Phase I proposal. A Phase I award is for up to $100,000 for up to six months. The amount available for a Phase I award varies with the agency offering the proposal; however, most of the smaller agencies limit the Phase I award to less than $100,000. For example, the Department of Agriculture limit is $55,000 for a Phase I award. The maximum allowable award will be reviewed for fiscal year 1997. The purpose of a Phase I award is to provide a feasibility

study of the proposed solution.

For any specific solicitation, the agency is not required to fund a proposal. The agency somehow prioritizes all of its solicitations and then awards grants on the basis of these priorities. Even though a small business may have the best proposal for a particular problem, that does not guarantee funding for that proposal. Thus, the competition for awards is broader than just the competition for the best proposal for a specific solicitation. In essence, the competition is between all proposals submitted to the agency. A firm may submit as many Phase I proposals as it wants, and a firm is not limited to the number of Phase I awards it may receive. Approximately 1 in 9 to 1 in 10 of the Phase I proposals submitted are funded. One of the changes in the SBIR program as a result of the 1992 amendments is the addition of broader solicitation topics in addition to the usual narrow topics used in the past.

Phase II

Phase II awards are only available for projects that have already had Phase I funding. Funding can be for up to $750,000 for a period of up to two years. As with Phase I funding, the smaller agencies usually do not provide funding up to the limit. The Department of Agriculture limit on Phase II funding is $250,000. The maximum allowable award will be reviewed in fiscal year 1997. During Phase I, the firm is required to show the feasibility of its proposed solution. Phase II funding is for continuation of the project's research and development beyond the feasibility stage to the prototype stage. At the end of Phase II, the firm is expected to be ready to actually enter the marketplace with its original idea.

A new, fuller proposal is required for Phase II funding. The new proposal must have a more detailed plan and a convincing description of how the idea will be commercialized. The basis for awarding Phase II grants shifts from the proposal's feasibility, established during Phase I, to its relative importance in technology or science, and to the firm's ability to obtain non-SBIR government procurement contracts and/or its ability to take the product to the commercial marketplace. This last aspect — finding someplace to sell the developed product — is the result of the emphasis on commercialization in the 1992 amendments to the SBIR law. The commercialization expectations of a project may resolve a tie between two applicants for Phase II funding. With most agencies, 40 to 50 percent of all applicants get Phase II funding.

Phase III

Commercialization is a problem every firm faces at some point — funding and finding a market for a new product. Putting the product in the market is the goal of the SBIR program, but

this stage cannot be funded by SBIR funds. Instead, the firm is to find either private money or other government money to support this stage of product development. A "Concerns of Congress" in 1992 was that not enough firms were making a commercialization effort. Another concern was that multiple winners were not trying to commercialize or were not successful at commercialization. Both of these concerns are topics for interim reports to Congress.

Eligibility

Small businesses face two basic eligibility criteria for an SBIR award:

(1) The firm "must be at least 51 percent owned and controlled by an individual(s) who is (are) citizens of or lawfully admitted permanent resident aliens" of the United States.
(2) The firm cannot have more than 500 employees.[4]

During Phase I, at least two-thirds of the research and development must be done by the submitting organization which leaves one-third of the funding that can be given to an outside consultant (such as a university researcher) to work on the project. For Phase II, this requirement is reduced to one-half. The small business receiving the award may work with a state or private university or a federal laboratory when doing the research. However, the firm must have documentation of the agreement between the firm and the other organization before receiving the SBIR award. In fact, most agencies require the documentation as part of the proposal.

Another of the "Concerns of Congress" is with women and minority participation in the SBIR program. As of now, the members of Congress feel that enough effort has been made at outreach. However, Congress is concerned that the outreach will not continue with the same effort. This is another topic for an interim report to Congress.

Funding for the SBIR Program

The 1992 amendments to the SBIR law increased the share of contracted research and development funds which are to be set-aside for SBIR awards. If the quality of the research continues to meet the demands of the agencies, then the percentage of research and development funds set aside will increase from 1.25 percent in FY1992 to 2.5 percent by FY1997. Both the Government Accounting Office and the Department of Defense are to report on the quality of research before 1997. Below is a schedule of when the increases in set asides for the SBIR

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[4]***SBIR Pre-Solicitation Announcement, September 1993***, Office of Innovation, Research and Technology, U.S. Small Business Administration, p. 5. This is in every recent pre-solicitation announcement we have read.

program are to take place.[5]

Share of Extramural R&D	Fiscal Year	Estimated Funds Available
1.25%	1992	$450 million
1.50%	1993-1994	$662 million
2.00%	1995-1996	$887 million
2.50%	1997-2000	$1,170 million

Agencies that Have SBIR Programs

The 1992 amendments required "Each Federal agency which has an extramural budget for research or research and development in excess of $100,000,000 for fiscal year 1992, or any fiscal year thereafter..." to have an SBIR program. The following is a list of agencies which have SBIR programs:[6]

Dept. of Agriculture
Dept. of Defense
Dept. of Energy
Dept. of Transportation
NASA
Nuclear Regulatory Commission
Dept. of Commerce
Dept. of Education
Dept. of Health and Human Services
Environmental Protection Agency
National Science Foundation

Five of these eleven agencies account for 90 percent of the SBIR awards each year. These agencies are Defense, Health and Human Services, Energy, NASA, and NSF.

Small Business' Rights

The SBIR legislation provides for protection of the small businesses which participate in the program. The new amendments added to this protection.[7]

1. Intellectual property rights go to the small business. The small business may patent its product for not less than four years after the conclusion of Phase II. In addition, this includes "retention by a small business concern of the rights to data generated by the concern in the performance of an SBIR award for a period of not less than 4 years."

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[5]Public Law 102-564 — Oct. 28, 1992: 106 STAT. 4251. Initially in 1982, the set aside for the SBIR program was one percent. In 1987 the set-aside was raised to 1.25 percent.

[6]Public Law 102-564 — Oct. 28, 1992: 106 STAT. 4251.

[7]These all come from Public Law 102-564 — Oct. 28, 1992: 106 STAT. 4252-53.

2. [C]ontinued use by a small business concern participating in the third phase of the SBIR program, as a directed bailment, of any property transferred by a Federal agency to the small business concern in the second phase of an SBIR program for a period of not less than 2 years, beginning on the initial date of the concern's participation in the third phase of such program.

3. [P]rocedures to ensure, to the extent practicable, that an agency which intends to pursue research, development, or production of a technology developed by a small business concern under an SBIR program enters into follow-on, non-SBIR funding agreements with the small business concern for such research, development, or production.

4. [T]echnical and programmatic guidance to encourage agencies to develop gap-funding programs to address the delay between an award for the first phase of an SBIR program and the application for and extension of an award for the second phase of such program.

The STTR Program

The Small Business Technology Transfer Pilot Program (STTR) began October 1, 1993, and is to continue for three years. Although not part of the SBIR program, the STTR program is closely modeled after it, with agency topic solicitation and Phase I and Phase II awards. The major difference between the STTR program and the SBIR program is the STTR program requirement for university participation. Only five agencies are now taking part in the program: Defense, Energy, Health and Human Services, NASA, and NSF.[8]

SBIR SUCCESS

Success in the SBIR program can be broken down into at least three constituent parts: success at the regional level, success at the firm level, and success at the state level. We begin with success at the regional level and will explore why SBIR funds do not seem to be uniformly distributed across the United States. Next, we will characterize firms successful at getting SBIR awards. We will focus on two factors: the successful firm and the successful proposal. Finally, we will explore what, if anything, a state government can do to increase its SBIR award rate.

REGIONAL SUCCESS

People involved in the SBIR program seem to all agree on one fact about the program: the

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[8]See ***Title II — Small Business Technology Transfer Pilot Program*** of the amendments: Public Law 102-564 — Oct. 28, 1992: 106 STAT. 4256-61, for more information about the STTR program.

SBIR program is a coastal phenomenon. Most of the interest in the program and most of the successful proposals come from people located on the two coasts. A second fact often stated about the SBIR program is that clusters of successful firms form, and from these clusters come most of the successful SBIR proposals.[9] These appear to be two general facts which are only vaguely linked. Jack Sweeney, Deputy Assistant Administrator for Innovation, Research and Technology for the Small Business Administration, provides a structure which connects these two facts. He argues that two factors are necessary for a geographical region to have success in the SBIR program: (1) the area must have several small research and development firms located close together that work in the same or similar areas, and (2) near these firms need to be located large firms that have had a lot of experience with government contracting. The example that Sweeney gave was the bio-tech industry that has developed in Maryland.[10]

To give a better idea of the unevenness of the distribution of SBIR awards, Table 1 has state SBIR award and funding data (the first six columns) along with the total R&D expenditure within each state (the seventh column) and state population (the eighth column). From this table it is clear that the distribution of SBIR awards and funding is not closely related to population. For example, compare the number of awards each state received between FY1983 and FY1990 with state population.[11] California and Massachusetts have about 14.4 percent of the U.S. population but have gathered about 38.1 percent of all SBIR awards during this period. Maryland and Virginia have about 4.4 percent of the population but they received about 11 percent of the SBIR

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[9]Economic development specialists use the term cluster two different ways. One meaning is simply a grouping of firms. However, a more technical meaning has developed because of the work of Michael Porter [***Competitive Advantage, Creating and Sustaining Superior Performance***, 1985]. He begins with the concept of the value chain to analyze the full relations of a firm: the internal processes, the external environment, and the relationship between the internal processes and the external environment. As a result of these relationships, clusters of competitive industries come into being which mutually reinforce each other. The concept of clusters helps provide a meaningful understanding of how competitive firms in different but related industries relate to each other, and in some cases, how competitive firms in the same or complementary industries relate to each other.

According to Porter, the degree of development in a region depends on the depth and the width of clusters in the region. As regions pass from lower to higher stages of development, industrial interrelationships deepen (competitive end-product industries lead to competitive supplier industries) and widen (related industries coordinate or share activities). In his more recent book, ***The Competitive Advantage of Nations*** [1990], he has provided new analytical tools for analyzing the stages of economic development within a region and the depth of regional cluster development. Porter has argued that government is generally inefficient in directly aiding cluster development; however, government can be a nurturer of cluster development. This generally means studying regional clusters and not hindering their development by putting them at a disadvantage by, for example, imposing special taxes.

[10]Jack Sweeney, telephone conversation November 18, 1993.

[11]The reason we have used the period 1983 to 1990 for comparison is because individual years can have large fluctuations. As an example, Kansas received $685,653 in FY1989, $248,614 in FY1990, $746,448 in FY1991, and $1,058,892 in FY1992. Clearly, FY1990 was an aberration.

TABLE 1

SBIR PROGRAM DATA

	Awards FY1983-FY1990	Awards FY1990	Amount FY1990	Number of FY1992 Awards Phase I	Phase II	Total	R & D Expenditure FY1989 (Million $)	1990 Population
Alabama	275	44	$5,714,675	29	30	59	$1,226	4,040,587
Alaska	5	2	$68,433	0	1	1	$118	550,04
Arizona	196	39	$3,838,402	46	17	63	$1,293	3,665,228
Arkansas	17	2	$792,739	2	1	3	$121	2,350,725
California	4,267	771	$111,678,272	544	344	888	$30,881	29,760,021
Colorado	556	106	$11,899,950	87	42	129	$1,649	3,294,394
Connecticut	488	108	$18,533,888	94	52	146	$2,745	3,287,116
Delaware	45	8	$1,764,000	10	3	13	$887	666,168
Dist. of Col.	71	6	$295,789	8	2	10	$1,979	606,900
Florida	384	65	$12,773,268	61	27	88	$3,375	12,937,926
Georgia	125	23	$2,458,385	14	12	26	$1,302	6,478,216
Hawaii	36	9	$464,392	9	8	17	$123	1,108,229
Idaho	18	2	$181,798	2	1	3	$614	1,006,749
Illinois	313	58	$8,223,296	38	30	68	$5,305	11,430,602
Indiana	104	18	$1,933,200	13	4	17	$2,120	5,544,159
Iowa	33	8	$936,416	3	6	9	$616	2,776,755
Kansas	28	2	$248,614	5	2	7	$523	2,477,574
Kentucky	20	2	$263,732	5	1	6	$343	3,685,296
Louisiana	62	11	$1,216,005	10	4	14	$385	4,219,973
Maine	66	11	$1,151,739	10	3	13	$72	1,227,928
Maryland	947	163	$20,532,619	143	73	216	$5,091	4,781,468
Massachusetts	2,711	503	$72,762,113	430	244	674	$7,949	6,016,425
Michigan	278	43	$5,160,247	46	33	79	$9,058	9,295,297
Minnesota	248	55	$7,973,556	34	19	53	$2,399	4,375,099
Mississippi	20	2	$83,045	4	1	5	$264	2,573,216
Missouri	80	16	$2,085,060	13	8	21	$2,710	5,117,073
Montana	33	3	$430,020	6	0	6	$59	799,065
Nebraska	25	6	$299,955	6	5	11	$182	1,578,385
Nevada	47	10	$1,439,224	3	9	12	$141	1,201,833

TABLE 1 (Continued)

	SBIR PROGRAM DATA						R & D	
	Awards FY1983-FY1990	Awards FY1990	Amount FY1990	Number of FY1992 Awards Phase I	Phase II	Total	Expenditure FY1989 (Million $)	1990 Population
New Hampshire	176	24	$3,264,430	22	18	40	$202	1,109,252
New Jersey	483	106	$13,055,210	74	43	117	$7,229	7,730,188
New Mexico	371	64	$8,301,056	63	40	103	$2,680	1,515,069
New York	806	158	$24,576,145	124	71	195	$9,898	17,990,455
North Carolina	218	42	$5,837,034	38	18	56	$1,821	6,628,637
North Dakota	7	2	$97,064	4	0	4	$79	638,800
Ohio	516	66	$9,809,314	78	38	116	$5,475	10,847,115
Oklahoma	63	9	$1,107,099	13	2	15	$507	3,145,585
Oregon	185	35	$5,088,753	26	25	51	$579	2,842,321
Pennsylvania	711	107	$15,721,715	90	47	137	$5,791	11,881,643
Rhode Island	42	10	$1,300,771	10	3	13	$428	1,003,464
South Carolina	20	2	$121,567	0	0	0	$576	3,486,703
South Dakota	6	0	$0	1	0	1	$23	696,004
Tennessee	234	37	$8,036,770	18	16	34	$1,302	4,877,185
Texas	554	100	$13,816,774	80	45	125	$6,581	16,986,510
Utah	319	53	$5,947,139	43	22	65	$620	1,722,850
Vermont	35	10	$1,478,271	5	2	7	$314	562,758
Virginia	1,029	183	$19,762,014	127	70	197	$2,545	6,187,358
Washington	462	52	$10,738,558	47	28	75	$3,225	4,866,692
West Virginia	11	2	$150,000	1	1	2	$203	1,793,477
Wisconsin	84	21	$2,446,540	14	14	28	$1,399	4,891,769
Wyoming	0	0	$0	1	0	1	$53	453,588

Sources: Columns 1 through 3, "Fast Facts about Federal R&D," unpublished, House of Representatives Small Business Committe; Columns 4 through 6, ***Listing of SBIR Awardees for FY1992***, Office of Innovation Research and Technology, U.S. Small Business Administration; Column 7, Table B-17, ***National Patterns of R&D Resources: 1992***, National Science Foundation; Column 8, U.S Bureau of the Census.

awards during this period. New Mexico has 0.6 percent of the nation's population, but during this same period, has received more than two percent of the SBIR awards. At the other end of the spectrum are states like Kansas which has about one percent of the population, but received less than 0.2 percent of the awards between 1983 and 1990.

Table 2 provides a general performance measure of the relative success of each of the states in getting SBIR awards between 1983 and 1990, and in generating research and development expenditures within the state in FY1989. If a state rating is better than one, then that state is doing relatively better than the national per capita average, and if its rating is less than one, then it is doing relatively worse than the national per capita average. Nine states have a SBIR rating of better than two while only ten states and the District of Columbia have a rating above one. Thus, if a state is doing well, it is probably doing very well. At the other end, 40 states are not even getting the average number of awards, and 25 states have a rating below 0.5.

Figure 1 is a map illustrating the SBIR performance index with the shading of the state representative of the state's SBIR performance rating. The shading runs from grey, Wyoming is lowest with 0, to black, Massachusetts is the highest with 6.29. This map illustrates the cluster phenomenon; for example, notice that Oregon, stuck between Washington and California, does better than most states, or notice how the states in the midwest with smaller populations all have about the same performance rating.

The data confirm the uneven distribution of SBIR awards. A closer look at each of the nine states that have a performance rating above 2 provides some clues as to the conditions which lead to regional SBIR success. These states are California, Colorado, Connecticut, Maryland, Massachusetts, New Hampshire, New Mexico, Utah, and Virginia. These states lack obvious similarities — the land areas, population and population density vary widely. However, Connecticut and New Hampshire share a border with Massachusetts; New Mexico, Colorado and Utah share common borders; and Maryland and Virginia share a common border. When one thinks of Massachusetts, especially Boston, one eventually thinks of major, high-quality private universities. One suspects that much of the SBIR success in the northeastern part of the country can be linked with the education institutions in the region. Education does not explain the other trio. What does explain New Mexico, Colorado and Utah is the existence of numerous federal laboratories. New Mexico has 12, Colorado has 29, and Utah has 11. The total number of federal laboratories is 606. The combined population of these three states is about 6.5 million and they have 52 federal laboratories, while California has a population of 29.8 million and has 45 federal laboratories. However, when it comes to federal laboratories, it is hard to beat Maryland with 63 and Virginia with 27. With 4.4 percent of the population, these two states have about 15 percent of the federal laboratories. This leaves only California unexplained. The state does not have an unusually large number of federal laboratories and its advanced educational institutions are good,

TABLE 2

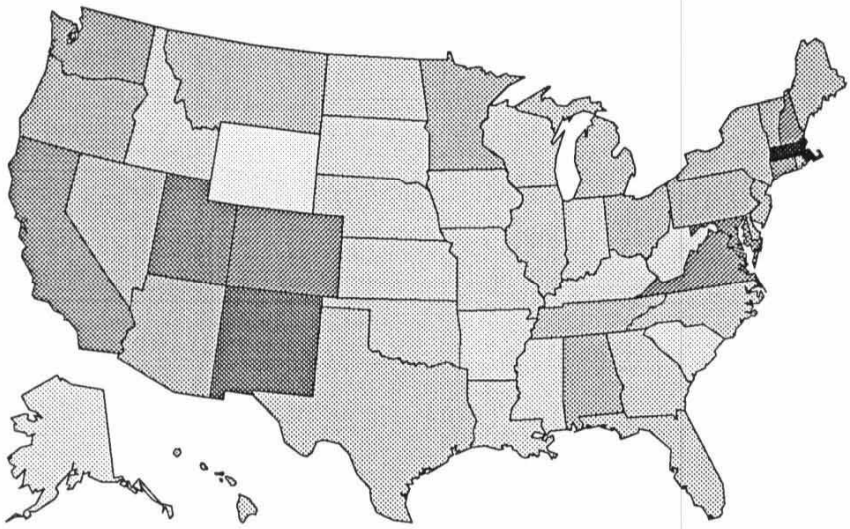
SBIR AWARDS AND R&D EXPENDITURE RELATIVE STATE PERFORMANCE BASED ON POPULATION*

	SBIR Awards FY1983-FY1990	R&D Expenditure FY1989		SBIR Awards FY1983-FY1990	R&D Expenditure FY1989
Alabama	0.95	0.56	Montana	0.58	0.14
Alaska	0.13	0.39	Nebraska	0.22	0.21
Arizona	0.75	0.65	Nevada	0.55	0.22
Arkansas	0.10	0.09	New Hampshire	2.21	0.33
California	2.00	1.91	New Jersey	0.87	1.72
Colorado	2.35	0.92	New Mexico	3.42	3.26
Connecticut	2.07	1.54	New York	0.62	1.01
Delaware	0.94	2.45	North Carolina	0.46	0.51
Dist. of Col.	1.63	6.01	North Dakota	0.15	0.23
Florida	0.41	0.48	Ohio	0.66	0.93
Georgia	0.27	0.37	Oklahoma	0.28	0.30
Hawaii	0.45	0.20	Oregon	0.91	0.38
Idaho	0.25	1.12	Pennsylvania	0.83	0.90
Illinois	0.38	0.85	Rhode Island	0.58	0.79
Indiana	0.26	0.70	South Carolina	0.08	0.30
Iowa	0.17	0.41	South Dakota	0.12	0.06
Kansas	0.16	0.39	Tennessee	0.67	0.49
Kentucky	0.08	0.17	Texas	0.45	0.71
Louisiana	0.20	0.17	Utah	2.58	0.66
Maine	0.75	0.11	Vermont	0.87	1.03
Maryland	2.76	1.96	Virginia	2.32	0.76
Massachusetts	6.29	2.43	Washington	1.32	1.22
Michigan	0.42	1.79	West Virginia	0.09	0.21
Minnesota	0.79	1.01	Wisconsin	0.24	0.53
Mississippi	0.11	0.19	Wyoming	0.00	0.22
Missouri	0.22	0.98			

*The performance rating is simply the ratio of state total to U.S. total divided by the ratio of state population to U.S population. Although adding all the states' population figures does not give the total U.S. population, the sum of all the states' population was used as the total U.S. population. The performance rating was calculated using the following formula:

$$\frac{\left(\frac{state\ R\&D\ total}{U.S.\ R\&D\ total}\right)}{\left(\frac{state\ population}{U.S.\ population}\right)}$$

Figure 1
State SBIR Performance Rating



but its ratio of high quality institutions to population is smaller than Massachusetts. However, governmental research and development spending, especially for defense, increased in California during the 1980s. In FY1989, nearly 23 percent of all research and development spending in the United States took place in California, almost twice its percentage of the country's population which explains California's strong performance in the SBIR program.

Three elements seem to play a role in establishing a region as a hotbed of SBIR activity: quality advanced education, a large number of federal research laboratories, and significant spending on research and development. These three elements can cause clusters of successful firms in the SBIR program. However, these three elements do not seem to be attributes that a state can easily add to its inventory. Establishing quality advanced education is expensive and takes time. Currently some states such as Michigan are cutting back on the quality of education at their state universities because the states executives and legislatures feel the state cannot afford the same high quality of education. The allocation of federal laboratories is made in a political forum in which state governments have only indirect influence, if any at all. State government expenditures on research and development are insignificant compared to total research and

development expenditures, and the pattern of research and development expenditures has been established over a long period of time, dating back at least to World War II. Thus, the principal elements involved in SBIR regional success seem to be beyond of state government's control, at least quickly. This does not mean that state policy is ineffective, just that state's are limited in how much they can affect SBIR activity within their state. It is conceivable that Kansas could improve its performance; it is inconceivable that Kansas could within the next five years be outperforming Colorado.

FIRM SUCCESS

In this section we will delineate why some firms are more successful in the SBIR program than others, or put another way, we will try to describe what seem to be common features of successful firms. We will examine this question in two parts: the common features of successful firms and the common features of successful proposals.

Qualities of Successful Firms

Three basic features of firms successful in the SBIR program have been identified: they have signaled their long-run stability, they treat the contracting agency as a customer, and they understand and work within the limitations of a large bureaucracy.[12] Each of these features will be discussed in a little more detail.

Stability: The government will take a chance on technology but not on the company. This seems to be one of the mottos of the SBIR program. Agencies participating in the SBIR program know that research and development is risky, and they do not expect all grants to work out as planned. However, they do want to be able to go back to a firm when the grant is over. In addition, with the increased emphasis on commercialization of the end product, agencies are looking for even more evidence of long-run stability and access to capital or a partner in commercialization.

The flip side of the stability requirement is the limitation it places on new firms. Firms need to have other sources of income. SBIR grants seldom support companies by themselves, even in the case of new firms. As a result, the SBIR program is not generally a program for potential

[12]These features were gleaned from our interviews with Kansas firms which had applied for SBIR awards, conversations with agency program managers of the SBIR program, state coordinators of SBIR assistance programs, and others.

startups looking for seed money.

Customer Orientation: The SBIR program is not an entitlement program and it is not an academic research grant program; SBIR is a contracting program. This is particularly true with regards to the Department of Defense, whose solicitations tend to be detailed and precise. The contracting agencies, for the most part, know what they want and the successful firms give it to them. Successful firms go the extra mile to please these people, as they would any other large customer with whom they hope to establish a long-run relationship.

Working with the Federal Bureaucracy: This feature is an extension of treating the contracting agency as a customer. The most obvious difference between the firms we interviewed which were successful in getting SBIR funding, and the firms which were unsuccessful, was their attitude toward working with the government. Working with federal bureaucrats is not easy. It helps to understand the problems they face. In business, mistakes can be forgiven if the bottom line is good enough. Governments do not face a bottom line. Bureaucrats face a much larger downside than upside: successes tend to be forgotten and failures tend to be remembered. This makes bureaucrats conservative by nature. They want to sponsor successful projects. The more confidence the firm can inspire in them, the better off it is.

The successful firms we interviewed try to view the program from the government's point of view. They expect the government to be demanding, and realize that they will have to change the way they do business to comply with government rules, regulations, and standards. The unsuccessful firms do not understand what the government wants. These firms feel they have great ideas, but complain that the government seems more concerned with rules and regulations. They know how to run their businesses, and they do not know why the government wants to force them to run their businesses differently just for a grant.

The three features outlined above paint a picture of a firm that is obviously in the business of research and development for the long haul, which knows how the government functions and works within those constraints, and it is a firm whose personnel try to know the idiosyncracies of the federal agencies they work with. Furthermore, the firm's personnel also try to be familiar with the agency personnel who design the solicitations and make the decisions about funding. Several people we interviewed, both successful and unsuccessful, argued that waiting for the solicitations and then responding with a proposal is a long shot. To be consistently successful, one needs to be known by the agencies, talk to them before the solicitations come out, and find out what interests a particluar agency's personnel. An unsuccessful applicant revealed to us that the consultant he had hired asked him if his proposal was for an open or closed solicitation: did the agency already have a firm in mind before the solicitation was released? If so, working on the proposal is probably a waste of time. Because of the nature of government contracting, a successful firms must be persistent and patient.

In contrast to the successful firms, the firms for which the SBIR program does not work well are firms that fight the program and the program directors. One of the people we interviewed in Kansas, who did not get an SBIR award, complained that the SBIR program should be called "Big Government Innovative Research" because Washington determined the topics for investigation. Their complaint was that the government was not close enough to the situation to determine what the problems were. If the bureaucrats would get out in the field with him, then they would see that his proposal was attacking a valid and important problem. This may all be true, and other sources confirm this possibility, but this is not how the program works.

An individual firm can come up with a new problem or a unique solution not covered in the solicitations and be successful. From our interviews, the best approach in this situation is for the firm's personnel to get acquainted with the people in the relevant agency before the next set of solicitations appear, explain to the agency people what the firm has to offer, then keep in communication with these people. Sometimes these good ideas appear as solicitations the next time around. Several people we spoke with confirmed this phenomenon. The importance of getting to know the people in the relevant agencies — not just the program manager, but the researchers who probably make up most of the solicitations — cannot be overemphasized. We interviewed a husband and wife team that has been very successful in the SBIR program. They have submitted eight proposals and have been successful on three, unsuccessful on three, and have not been told their status on the remaining two yet. Of their three unsuccessful proposals, in two cases they were only known to the agency by reputation. They felt if they had known the specific people in the agency on a personal basis, they would have had a better chance. This husband and wife team has extensive experience working in federal laboratories and reviewing SBIR proposals themselves.

Qualities of Successful Proposals[13]

Mark Henry suggests that the key components of a SBIR proposal are:

A great idea that matches the solicitation: This component has two equally important aspects — a great idea, and an idea that matches the solicitation. One of the successful individuals interviewed related that he and his colleagues read all of the solicitations, and then

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[13]The structure of this section is based on a presentation given by Mark Henry at the Washington SBIR Conference, October 14, 1993. We have included examples from our interviews with Kansas firms. Mr. Henry is Director of Communications for Bend Research, Inc., located in Bend, Oregon. As of October 1993, Bend Research has received funding for 81 out of 202 Phase I and 51 out of 64 Phase II proposals. The company has launched three successful spin-off SBIR companies. Mr. Henry is in demand across the country as a speaker explaining how to write successful SBIR proposals.

chose only a few for further consideration. They only preceeded to the proposal-writing stage if they thought they had an excellent idea of how to solve the problem. On the other hand, several interviewed firms had what they thought were great ideas but which did not quite fit the solicitation, so they forced a fit. These proposals were not funded. Another researcher related that during his first year at a firm (in Indiana) he submitted 10 proposals because he wanted to impress his boss. He received no funding. The next year he worked harder on only three proposals and received funding for two. In general, the shotgun approach to proposal writing does not work because the SBIR program has become so competitive.

A thorough understanding of the State of the Art: This involves doing a thorough literature search and more, such as talking to others in the field, talking to interested SBIR people, talking to non-SBIR research people in government, and finding out if a nearby university has faculty knowledgeable in the field. Researchers who do not understand the latest developments or have not kept up in their field are probably wasting time if they try to fake it. These proposals are read by experts. A second reason for doing a thorough search is that it is extremely advantageous to be able to state precisely how an approach is different and superior to other state of the art approaches in the field. Several of the people we interviewed stated that at the start of the proposal writing process, researchers should know their competition and know they will have one of the top three proposals. If this is not the case, then working on the proposal is probably a waste of time.

A detailed research plan: The detailed research plan must explicitly meet all the solicitation objectives. This must be clearly stated and obvious to anyone reading the proposal. Researchers must make sure their proposals demonstrate they know how to do research and development. The writer should try to answer in advance all questions that reviewers might ask. Finally, the writer should sell the approach — explain why it is the best approach.

A vision of potential commercial importance: The SBIR program is more and more oriented toward commercial applications. Someplace in the proposal, the writer needs to make clear the technical and commercial importance of the envisioned product after it is developed.

Access to the facilities, equipment, and personnel needed to successfully complete the proposed work: If outside consultants such as university faculty are part of the research effort, the proposal should have a letter as proof that they are willing to participate. If certain facilities are necessary for the research project, the proposal should document that researchers will have access to these facilities, especially if government facilities, such as federal laboratories, are part of the research plan.

Mark Henry summarized his suggestions on writing SBIR proposals with the following information. He happened to be in communication with a Department of Energy program

manager after this manager had just reviewed 180 successful proposals in a weekend. This program manager stated that all the successful proposals had five common elements:

(a) Demonstrated a clear understanding of the problem.
(b) Had a solid idea for solving it.
(c) Clearly explained the non-trivial challenge to feasibility.
(d) Presented a good plan for making inroads into feasibility.
(e) Identified a strong potential marketplace.

One final note about proposal writing that many people in several different capacities emphasized — authors should follow the rules. If regulations say 1" margins, then the proposal should have 1" margins. If the regulations say double space, the proposal should not have 1.95 spacing. Do everything asked and do it as it is asked. The reviewers are not paid, and they are looking for any reason to stop reading and eliminate the proposal. About 20 percent of Department of Energy and NSF Phase I proposals are eliminated for being "non-responsive" — the proposals failed to follow the agencies rules and regulations for proposals. One year the NSF changed the requirements for the first paragraph of the proposal, and were able to eliminate 40 percent of proposals for non-compliance. This may seem picky, it may seem unfair, it may seem inefficient; however, the writer should remember who the audience is — bureaucrats and academics. Since these people are the audience, it is sometimes a good idea to include academics as consultants to projects and ask them for help in writing the proposal. Finally, if the firm applying for SBIR funding does not have significant experience writing proposals for government grants, then it is probably wise to hire a consultant just for the proposal writing.

STATE SUCCESS

This section will investigate the role a state government should play in helping its state's small businesses to better compete for SBIR awards. We will begin by looking at two different points of view: one represented by a strong advocate of the importance of the SBIR program — Milton Stewart, and another from three technology economic development professionals who put on a seminar at the Washington SBIR meeting. Then we will look at a few states and what activities they have undertaken to improve their SBIR performance. Finally, we will look at a few figures comparing economic development expenditures and state SBIR performance.

Before we begin our discussion, we would like to offer a note of caution up front. When discussing any type of economic development issue, opinions seem to overwhelm facts. This may not reflect the emotional strength with which these opinions are held as much as the dearth of economic development facts. Sadly, this section will continue this tradition. Two distinctly different pro-economic development opinions will be offered on the role of the SBIR program

as part of a state economic development plan. Unfortunately, only a limited amount of data concerning the relationship between state economic development expenditures and state SBIR performance has been found. Thus, the relationship may have limited meaning.

Centerpiece of any State Technology Development Program

Milton Stewart's[14] credentials as a supporter of small business are imposing. He now is co-chairperson of the Regional Council for Project SBIR West, president of the Small Business High Technology Institute, and former editor and columnist for ***Inc.*** magazine. He has been involved in the SBIR program from its inception.

Mr. Stewart makes the argument that regional success in the SBIR program is based on the clustering of small business firms interested in similar research and development fields. This paradigm of SBIR success shapes Mr. Stewart's view of the role of the state government in promoting SBIR success. It takes clusters to have success in the SBIR program; therefore, the state should promote creation of clusters. For a state to be continuously successful in receiving SBIR awards, it must achieve a critical mass of awards. Mr. Stewart defines a critical mass as 10 Phase I's and 3 Phase II's a year for three consecutive years. According to Mr. Stewart, after a state reaches this critical mass, it never falls back.

If a state has not achieved a critical mass in the SBIR program, then the state government needs to get involved in helping small businesses form clusters. To do this, the state must get six communities communicating with each other on a regular basis:

(1) Large Companies: Large companies can help themselves by helping small research and development firms near them. These businesses, through the aid of the SBIR program, can perform research which is too risky for the large company to undertake because of risk sharing with the federal government through the SBIR program. If these small businesses are successful, then the large company already established a working relationship with them.

(2) Universities: Universities can help the development of clusters by providing competent consultants for research and development firms. They can provide entrepreneurs who can start their own research and development firms. They can be the focal points of clusters as in Austin and Boston. The STTR program makes universities even more important.

(3) The State Government: The technology-outreach people in state government need to be in communication with these other five groups and should act more as matchmakers than as go-betweens.

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[14]The following is based on two long telephone conversations with Mr. Stewart on February 14 and March 14, 1994.

(4) Independent Professions: These people can either act as entrepreneurs or as a small, local source for capital.

(5) Financial Community: Banks must become technology-literate. Mr. Stewart argues that this community is the hardest to get involved.

(6) Small Business People

Mr. Stewart's vision of the role of state government is initially as an organizer and means of communication between these other five communities. In the beginning, three to four people need to be educating the different communities in the state about the SBIR program and helping to prepare proposals. Later, eight to ten people will be needed for this work. These people need not all be state employees.

Additional Resource for a State Technology Development Program

Three technology development professionals presented a two and half hour seminar at the Washington SBIR conference entitled ***Actions and Strategies for States to Accelerate Commercialization of R&D.***[15] Although these three men held slightly different views on several technical economic development issues, they agreed when it came to the state aiding firms interested in the SBIR program. After sorting through all of the re-inventing, re-engineering, value addings, and quality-performance-enhancement-investments, all of these men played down the importance of SBIR grants for economic development. In particular, they made the point that states should not in the business of supporting small business — the state should not provide welfare programs for small business. However, they thought that investment in small business which had a monetary payoff for the state was a good idea. An example used several times was of a state investing in a firm which had already gotten a Phase I and had an excellent chance for a Phase II, but needed help with commercialization funding. In return, the state should demand a percentage cut of the revenue if the product makes it to the market.

A note of caution about the technology development professionals. First, two came from Maryland and one from Connecticut. A quick look at Table 2 shows that Maryland already does well in the SBIR program without any state help because of the large number of federal laboratories and the fact that the technology entrepreneurs and the bureaucrats are neighbors. Connecticut also does well and is located next to Massachusetts, which has the highest

[15]The three men were Dr. Walter Plosila, President, Suburban Maryland/Montgomery County Technology Council; Mitchell Horowitz, Technology Advisor to the Secretary, Maryland Department of Economic and Employment Development; David Driver, Executive Director, Technologies Assessment Ctr., Connecticut Innovations, Inc.

performance rating. We suspect it is easier to think in terms of the state getting a cut of the commercialization with an appropriate investment when the state is already swimming in Phase I and Phase II awards.

State Programs to Aid SBIR Success

A single highlight will be mentioned from six state programs to aid SBIR success. Then an analysis of how these states have done will be presented. Minnesota, Ohio and Wisconsin are three states with larger populations than Kansas which have tried to improve their state SBIR performance through state aid. Minnesota has a database, regularly updated, of the interests of the university professors in the state. The state technology agency tries to match professors with small businesses when they receive requests for help. Ohio has an outreach program to firms that includes one person dedicated to traveling the state and trying to keep small research and development firms aware of the grant possibilities. This person knows the program managers of most of the agencies personally and tries to act as a matchmaker between Ohio firms and the federal bureaucracy. Wisconsin has a program that pays one university professor and one successful SBIR grant writer to review an SBIR proposal before it is submitted. The purpose is to raise the quality of the proposals.

Missouri, Nebraska, and Oklahoma are states contiguous with Kansas that have less ambitious programs. Missouri has a newsletter and several other means of trying to keep the state's small businesses informed about the SBIR program. Nebraska's situation is similar to Kansas' situation: one person was allocating something like ten percent of his time to aiding firms interested in the SBIR program. In March, Nebraska had a full day conference on the SBIR program that they felt was well attended. Their one person worried that he would be swamped with requests and not have the resources to help. Finally, Oklahoma has a program like Kansas where they give a small business that produces an SBIR proposal a small grant just for writing the proposal.

From Table 2, one can see that none of these states has a performance rating above one. Minnesota has the highest rating at 0.79, then comes Ohio with 0.66 and finally Wisconsin with 0.24. Missouri and Nebraska have a rating of 0.22, and Oklahoma has a rating of 0.28. This is not intended to suggest that the state programs are not effective. In the case of Wisconsin, the program just began about a year ago. What it does suggest is that a healthy skepticism is necessary when considering the claims for specific programs. It also suggests that disadvantages in advanced education, existence of federal laboratories, location near the bureaucracy, and a large research and development investment are difficult to overcome.

Comparison of State Economic Development Funding and SBIR Performance

Our final approach at examining the relationship between state programs to aid small businesses interested in the SBIR program and actual SBIR performance is to look at actual data. Since this seems like the obvious first approach to the problem, the reason for delay in examining data lies in the quantity and quality of the data available. We have state government expenditures data on technology and innovation for only ten states — those listed in Table 3.[16] Whether this data is a good proxy for state government aid to firms interested in the SBIR program is uncertain, but most likely the answer is no; nevertheless, this is the best data that could be found.

Table 3 contains the data for the ten states. The first five columns have SBIR data, the sixth column has research and development expenditures within each state for FY1989, and the seventh and eighth columns have state government expenditures on technology and innovation. A casual perusal of Table 3 does not seem to turn up any startling discoveries. A simple statistical analysis was tried, and no significant relationship was found between state government expenditure on technology and innovation and state SBIR performance.

There may be several reasons for the lack of a relationship between state expenditure and performance in the SBIR program: the data may not reflect state effort at helping firms interested in the SBIR program, the sample is too small, or there is a lagged effect that we cannot capture because of data limitations. The inability to find a relationship between state aid to small businesses interested in the SBIR program and state performance in the program means that programs like those outlined in the previous section are questionable in their effectiveness.

KANSAS FIRMS SBIR PERFORMANCE

We have already shown Kansas' SBIR performance rating for the years FY1983 to FY1990 — 0.16. This is not the lowest rating among the states, since eight states have a lower rating. In this section a more detailed look will be undertaken at the SBIR performance of Kansas firms and determine Kansas' performance capacity. First, the past performance of Kansas firms in the SBIR program will be examined. Then, a determination is made on how many Kansas firms fit into the SBIR program. Finally, a simple econometric model will be used to estimate Kansas' potential for success within the SBIR program.

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[16]The source of the state investment data is M. Elizabeth Stella and Charles E. Krider, ***Economic Development Investments of Ten States: A Descriptive Analysis***, Report No. 176, Vol. 2, Appendix B.

TABLE 3

COMPARISON OF TEN STATES

	Performance Rating from Table 2 FY1983-90	SBIR ACTIVITY No. of Awards FY1990	Amount Awarded FY 1990 (Million $)	No. of Phase 1 FY1992	No. of Phase 2 FY1992	R & D Expenditure Within State FY1989 (Million $)	State Government Expenditures on Technology/Innovation Budget (Million $) FY1989	FY1990
Arkansas	0.10	2	$0.8	2	1	$121	$1.9	$3.3
Colorado	2.35	106	$11.9	87	42	$1,649	$11.3	$5.4
Indiana	0.26	18	$1.9	13	4	$2,120	$7.9	$7.9
Iowa	0.17	8	$0.9	3	6	$616	$10.0	$8.8
Kansas	**0.16**	**2**	**$0.2**	**5**	**2**	**$523**	**$16.8**	**$5.9**
Minnesota	0.79	55	$8.0	34	19	$2,399	$18.6	$31.4
Missouri	0.22	16	$2.1	13	8	$2,710	$9.8	$12.7
Nebraska	0.22	6	$0.3	6	5	$182	$8.7	$13.0
Oklahoma	0.28	9	$1.1	13	2	$5,475	$15.7	$25.1
Oregon	0.91	35	$5.1	26	25	$579	$30.3	$31.0

Sources: Columns 1 through 5, same as Table 1, Columns 5 and 6, M. Elizabeth Stella and Charles E. Krider, ***Economic Development Investments of Ten States: A Descriptive Analysis***, Report No. 176, Vol. 2, Appendix B.

PAST PERFORMANCE OF KANSAS FIRMS IN THE SBIR PROGRAM

Table 4 provides a comparison between Kansas and the United States for several socio-economic variables and for several SBIR variables. Kansas has slightly less than one percent of the nation's population, less than the nation's median household income, slightly more than the national average of people with bachelor's degrees and slightly less than the national average in advanced degrees. Where Kansas' performance falls significantly below the national average is in terms of research and development expenditures in the state and in the number of federal laboratories. Given that these two figures are between 30 and 40 percent of what would be expected if these variables were distributed on the basis of population, one would be surprised if Kansas firms got more than 0.5 percent of the SBIR awards and funding. However, Kansas does much worse than 0.5 percent. Kansas is always at or below 0.2% in the SBIR categories.

One other aspect of Kansas' SBIR performance involves the geographical distribution of submittals and awards in Kansas. KTEC provided a list of 21 firms in Kansas which had gone through them in the process of submitting SBIR proposals. Four of these firms were located in Garden City, Great Bend, Salina, and the Wichita area. The rest of the firms were located in the Kansas City-Lawrence-Topeka area. Table 5 provides a list of the FY1992 award winners in Kansas, the last year for published data. Five of the winning firms are located in Lawrence and two are in Lenexa. Currently, Kansas SBIR activity is primarily in northeastern Kansas.

Next, it is investigated whether Kansas' below average performance reflects a lack of small research and development firms.

HOW MANY KANSAS FIRMS FIT INTO THE SBIR PROGRAM?

Different techniques have been used to estimate how many Kansas firms might fit the SBIR criteria. ***County Business Patterns*** indicates that in 1990 Kansas had 65,739 small businesses. Of these small businesses, 3,318 were in manufacturing, 460 were in engineering and architectural services, and 106 were in research and testing services. The SBA PASS database of small businesses in the United States lists 342 firms in Kansas with some percentage of research and development involvement in their profile. This database is created by voluntary submission, so it is probably not complete. About five years ago, KTEC, using High-Tech SIC codes, estimated 275 manufacturing firms in Kansas fit the SBIR mold.

These estimates probably do not give a good answer to "How many Kansas firms fit into the SBIR mold?". Kevin Carr of KTEC and others to whom this question was posed suggested that the question was inappropriate for two reasons. (1) Using High-Tech manufacturing firms as the

TABLE 4

U.S. AND KANSAS COMPARISON

	United States	Kansas	Kansas as a Percentage of United States
Population 1990	248,709,873	2,477,574	1.00%
Median Household Income 1989	$30,056	$27,291	90.80%
Bachelor's Degree 1990	20,832,567	221,016	1.06%
Graduate or Professional Degree 1990	11,477,686	109,361	0.95%
Total Degrees	32,310,253	330,377	1.02%
Total R&D Expenditure FY1989 ($1,000)	$135,059,734	$522,856	0.39%
Federal Laboratories	606	2	
SBIR Awards FY1983-FY1990	17,830	28	0.16%
SBIR Awards FY1990	3,179	2	0.06%
Amount Awarded FY1990 ($1,000)	$445,859	$249	0.06%
Phase I Awards FY1992	2,554	5	0.20%
Phase II Awards FY1992	1,485	2	0.13%
Total FY1992	4,039	7	0.17%

Sources: Median household income, bachelor's, graduate and professional degrees came from 1990 Census Tape, STF 3, U.S. Bureau of the Census, Department of Commerce. The number of federal laboratories comes from the master list of the Federal Laboratory Consortium for Technology Transfer. The rest of the data has the same sources as Table 1.

TABLE 5

KANSAS FIRMS RECEIVING SBIR AWARDS

FY1992

Agency	Firm	Amount
HHS	A/s/k Associates Lawrence	$41,839
AF	Aerotech Engineering & Research Lawrence	$50,000
DARP	Aerotech Engineering & Research Lawrence	$49,648
NAVY	Aerotech Engineering & Research Lawrence	$50,000
AF	Crew Systems Consultants Lawrence	$486,197
ARMY	Geo-systems Engineering Inc. Lenexa	$332,860
ARMY	Surfaces Research & Application Lenexa	$48,348
	TOTAL	$1,058,892

Source: ***Listing of SBIR Awardees for FY1992***, Office of Innovation Research and Technology, U.S. Small Business Administration.

criterion ignores a number of other potential SBIR firms such as bio-tech and software development. (2) Since the Department of Health and Welfare has an active SBIR program, the social sciences can also be included in the area of potential recipients. In addition, although the SBIR program is difficult for start-ups, potential start-ups are another group not included and they cannot be estimated.

Instead of trying to find out how many firms might fit into the SBIR program, a different approach is to statistically determine Kansas' SBIR potential.

ESTIMATING KANSAS' SBIR POTENTIAL[17]

The approach used was to look first at the SBIR data in combination with socio-economic data to explain the number of state awards and the amount of state funding. It was assumed that the equations for the estimated calculation took the form:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \epsilon_i \qquad (1)$$

where Y denotes the number of awards (amount of funding) for each state, X_k's is the k^{th} explanatory variable, and ε is the error term. Although SBIR data is available for several years, the year that matches the explanatory variables best is FY1990 with its awards and funding data. Thus, a cross-sectional analysis was made with data from 51 entities: the 50 states and the District of Columbia.

A number of explanatory variables were tried, including socio-economic variables, technology investment variables, and occupational variables. The socio-economic variables were population, median household income, number of people with bachelor's degrees, and number of people with graduate or professional degrees. The technology investment variables were research and development investment by state and the number of federal laboratories in each state. The occupational variables were the number of executive managerial staff, number of technical special production people, the number of special professional people, and the number of special technical people.

The two technology investment variables, research and development investment and federal laboratories, proved to be significant. The socio-economic and occupational variables displayed a great deal of multicollinearity — these variables had approximately linear relations. The multicollinearity was corrected by creating per capita variables — dividing the socio-economic

[17]Nearly all of the statistical analysis was done by Qiang Du including correcting for multicollinearity and heteroskedasticity.

and occupational variables by population (with the exception of median household income.) After testing these new variables, the only significant variable turned out to be the sum of bachelor's and advanced and professional degrees divided by population. A second problem was heteroskedasticity — the disturbance terms did not all have the same variance.[18] The heteroskedasticity was eliminated by transforming the variables again by using the inverse of research and development expenditure by state as a weight. This allowed the use of weighted least squares (WLS) estimation. Because the heteroskedasticity was eliminated, the resulting WLS parameter estimators are efficient.

After these corrections, the resulting models of SBIR performance are:[19]

$$\hat{Y}_1 = \underset{(4.20)}{-21.312} + \underset{(5.65)}{0.026}\, X_{1i} + \underset{(3.28)}{143.995}\, X_{2i} + \underset{(3.34)}{0.900}\, X_{3i} \qquad (2)$$

$$\bar{R}^2 = 0.287$$

and

$$\hat{Y}_2 = \underset{(2.11)}{-144.481} + \underset{(3.73)}{0.274}\, X_{1i} + \underset{(2.11)}{1297.346}\, X_{2i} + \underset{(2.87)}{19.963}\, X_{4i} \qquad (3)$$

$$\bar{R}^2 = 0.154$$

where Y_1 is the number of SBIR awards per state, Y_2 is the amount of SBIR funds per state (divided by 10,000 to reduce the size of the parameters), X_1 is research and development expenditures by state, X_2 is per capita bachelor's and advanced degrees, and X_3 and X_4 are the number of federal laboratories in each state. However, X_3 and X_6 are not the same variable: X_4 is the total number of federal laboratories participating in technology transfer, while X_3 is the number of Army, Navy, Air Force, NASA, Department of Commerce, and Department of Agriculture laboratories for each state from the master list, which is a larger list than those laboratories participating in technology transfer.

Using equations (2) and (3), we "forecast" Kansas' SBIR performance in FY1990 as 12.4 awards and $1.7 million in funding. In fact, Kansas only got 2 awards and $248,614 in funding in FY1990. A comparison of FY1990 funding with FY1990 potential exaggerates the gap between actual and potential Kansas SBIR performance. By putting FY1990 in context, a better

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[18]The Goldfield-Quandt test was used to check for heteroskedasticity. (See Peter Kennedy, ***A Guide to Econometrics***, third edition, MIT Press, 1992, p. 118.)

[19]The numbers in parantheses are t-statistics for the estimater.

picture of the gap between actual and potential is available.

Fiscal Year	Kansas Funding
FY1989	$648,653
FY1990	$248,614
FY1991	$746,448
FY1992	$1,005,892

As the brief table above illustrates, if Kansas small businesses had followed the trend in FY1990, they probably would have brought in about $700,000 in FY1990 funding.[20] Using our "forecast" of FY1990 as a measure of Kansas's potential, in FY1990, if things had gone as expected, Kansas would have still been about $1,000,000 in SBIR funds below its potential.

POLICY IMPLICATIONS OF THIS STUDY

Before our policy recommendations are stated, a brief review is provided on a few observations about the SBIR program. First, the program is dominated by a few states which either have great advanced educational systems, numerous federal laboratories, above average per capita research and development spending, or are located near Washington, D.C. Kansas has none of these advantages, but even taking into account its disadvantages, Kansas still performs poorly when compared to its potential. The evidence indicates that Kansas small businesses have room for improvement when compared to their potential, but that is not all that must be considered. Those who make the decisions about the direction of state policy regarding the SBIR program face a major policy question: Is a $1,000,000 to $2,000,000 possible increase in SBIR awards to Kansas small businesses worth a $50,000 to $100,000 investment? The answer to this question is not obvious.

The first part of this section describes the current support given, primarily by KTEC, to firms interested in the SBIR program. This consideration is investigated predominately from the point of view of the small businesses applying for SBIR awards. Then, two lists of suggestions are provided for KTEC. The first list consists of suggestions which should disseminate more information about the SBIR program to Kansas small businesses. This list, in general, contains the least-cost suggestions. However, it should be kept in mind that any suggestion that stirs interest in the SBIR program is probably going to place greater demands on KTEC's already

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[20]These data were provided by KTEC. As an analytical justification for the statement, "should have been about $700,000," consider an ***ad hoc*** model with the amount of SBIR funding on the left hand side and time starting at t=0 for FY1989 on the right hand side. Since FY1990 data is probably disinformation, that year is ignored as a simple regression is run. The resulting prediction for FY1990 is $727,629. This ***ad hoc*** suggestion was provided by Norman Clifford.

limited staff resources. The second list contains more aggressive suggestions for state support, and naturally, these suggestions require more resources. Finally, an elaboration is offered on our statement of the policy question facing decision makers.

CURRENT SBIR SUPPORT

The current SBIR support for small businesses is described in KTEC's brochure ***Scope and Services***: "KTEC assists Kansas small businesses in obtaining SBIR awards and provides small grants to support proposal preparation." (p. 5) The support provided to firms falls into two basic categories: the distribution of information about the SBIR program, which includes in some cases generating the initial awareness of the program, and assistance with preparing for and writing an SBIR proposal. As part of that assistance, KTEC sometimes provides development grants to help defray the cost of writing the proposal. These two types of support will be discussed separately, beginning with the distribution of information.

The Distribution of SBIR Information

KTEC has made only a limited amount of effort to publicize the existence of the SBIR program or the assistance that they can provide. Besides the mention of the program in the brochure, KTEC has held workshops which explain the SBIR program and provide some information on how to write an SBIR proposal. Without the resources to help many firms, KTEC has probably followed a wise policy of self-selection — helping those firms which have put forth the effort to get help from KTEC. If a firm knows about the SBIR program or goes to the trouble to find out about it, the firm is probably a better bet for assistance than a firm that just happens to run into information about the SBIR program.[21]

Assistance in Developing and Writing SBIR Proposals

The people interviewed mentioned three primary forms of assistance for small businesses interested in the SBIR program. (1) Several people indicated that KTEC helped them find a consultant for their project or a consultant to help write the SBIR proposal. In all cases, these

[21]From fourteen interviews with the Kansas firms that have written SBIR proposals, no pattern emerged to describe how a firm learns of the SBIR program. Several knew of the program before they moved to Kansas because of their previous work. One learned of it from the SBA office in Wichita. One learned of it from MAMTC. Only a few learned of it directly from KTEC.

people were satisfied with the consultant suggested by KTEC. (2) KTEC has, on a few occasions, helped firms with the actual proposal writing. Here KTEC lacks the resources to help everyone. (3) KTEC provides proposal development grants from $2,500 to $5,000 to help defray the cost of writing the SBIR proposal.

All of the people we interviewed thought that KTEC enhanced their ability to work with the SBIR program. One person was thankful for the help in finding someone in the university system to prepare his successful proposal. Those firms that got development grants to write SBIR proposals found these grants to be helpful. Finally, those firms which have been helped by KTEC have done better than the national average at getting SBIR grants. Most persons interviewed gave unsolicited praise for KTEC.

POLICY SUGGESTIONS

Incremental Enhancement Suggestions

The motivating force behind these suggestions is to increase the flow of SBIR information to potential applicants. However, this is a double-edged sword: an increase in information will place greater demands on KTEC for service. This needs to be emphasized — we have found no free way to increase KTEC's support. Every suggestion costs money.

1. State SBIR Conference: An annual SBIR conference was the most requested action by the interviewees. Two specific needs discussed were general information about the SBIR program, and guidance in preparing SBIR proposals. A further advantage of a conference is that it would provide an opportunity for people interested in the SBIR program to get together. Along these lines, one person interviewed suggested that those firms which receive KTEC matching grants should be required to attend a state conference. This same person also suggested that KTEC make a special effort to get previous SBIR award winners to attend any conference. A conference would be a good place to begin the mentoring process.

2. Ask Recipients of KTEC Matching Grants and Other State Winners of SBIR Awards to Mentor: In interviews some recipients of SBIR awards indicated they would do this. Others might be persuaded, especially if a small fee is provided. Also, several people interviewed wanted to see an example of a successful SBIR proposal. If KTEC were to require all firms who receive a matching grant to provide a copy of their proposal, then KTEC could develop a library of successful SBIR proposals.

3. **Workshop or Seminar for MAMTC Personnel:** Many of the MAMTC people across the state felt that they needed to have more information about the SBIR program.

4. **KTEC Matching Grants Program:**

   a. **Evaluate the proposals rather than the abstracts for the KTEC matching grants:** Some of the people interviewed were concerned that some firms only were interested in the money, not the SBIR proposal. This should also provide a means of monitoring the quality of Kansas firms' proposals.

   b. **Limit the matching grants to $2,500:** A rule of thumb used by several researchers successful at getting SBIR awards is one hour of proposal writing per thousand dollars of grant money requested. Since the most that can be asked for in Phase I is $75,000, $2,500 seems reasonable given that not all of the effort put into proposal writing is lost even if the project is not initially funded. In addition, if it is stated up front that everyone who is funded gets exactly $2,500, then the appearance of favoritism is lessened.

5. **Create a Database of Those Interested in the SBIR Program:** KTEC could put together a database of possible technical consultants, in either the private sector or at universities, available to prospective proposal writers. KTEC could begin creating this database by surveying faculty members at state universities to find out if they are interested in consulting on SBIR proposals. For this database to retain value, it would need to be updated frequently. This database would make finding technical help easier.

6. **Encourage the Wichita Aircraft Industry to Assist Small Firms:** MacDonnell-Douglas in St. Louis encourages small firms in the area to use the SBIR program to do research they think is too risky for themselves.

7. **Cooperation with Nearby States:** Both Nebraska and Missouri have about the same amount of state resources dedicated to SBIR assistance as Kansas has. Possibilities for cooperation include joint conferences, shared mailing lists, shared databases, etc. For example, if Kansas and Missouri could put on a joint conference in Kansas City, the probability of getting agency program directors would be higher than if each state did a separate conference. It is doubtful that any relatively small state could put enough resources into an SBIR support program to be competitive with the larger states.

Significant Enhancement Suggestions

These suggestions go beyond providing information to actually providing assistance. Thus, these suggestions will further increase the demand for KTEC's services and cost distinctly more than the incremental suggestions.

1. **Make SBIR Someone's Full-Time Job:** This would probably have the greatest effect of any suggestion.

2. **KTEC Matching Grants:**

   a. **Add More Money to the Fund:** The first step would be to free-up enough resources to fund the matching grants program for the whole year. One person interviewed suggested increasing the amount of funds available for these grants "ten-fold."

   b. **Allow the Recipients of the Grants Greater Flexibility in Their Use of the Money:** An interviewee suggested that the proposal writing grant should be expanded to cover a trip to Washington so that the firm could "look the agency in the eye and shake their hand."

   c. **Review of Proposals:** Recipients of matching grants should be required to submit their proposals to KTEC a month before they are due. Then KTEC can send the proposal out for peer review. Wisconsin does this now, and pays both a university faculty member and an SBIR award winner to review the proposal.

3. **Help Fill the Gap Between Phase I and Phase II Funding:** This does not need to take the form of direct state aid. KTEC could try to develop an awareness of the SBIR program in the Kansas financial community, or KTEC could try to act as a matchmaker between venture capitalists in the state and small businesses looking for funding to fill in the Phase I-Phase II gap. In Connecticut, the state actually has a separate fund established which it uses to invest in firms trying to fill the gap. If the product is successful, then the state fund gets some percentage of the revenues from the product generated.

4. **Help Firms Line up Phase III Funding:** Because of the increased importance of commercialization, having a source already pledged to Phase III funding if the product should reach that stage of development is a tremendous advantage in the evaluation process.

POLICY DILEMMA

The above policy recommendations require additional resources. Even if additional resources are successful in improving Kansas SBIR funding, the cost effectiveness should be monitored closely. Improvements in SBIR success will not appear overnight. The policy dilemma is:

1. **Incremental change probably will have only incremental effect;**
2. **Significant enhancement will be relatively expensive with no guarantee of significant effect.**

If policy makers decide to do nothing more than what is being done now, we would expect Kansas small businesses to continue performing in the SBIR program as they have recently.