THE EPSCoR CHALLENGE:

AN ISSUE OF RESEARCH COMPETITIVENESS

Ted Kuwana
Regents Distinguished Professor of Chemistry
Project Director, K*STAR NSF EPSCoR Program
University of Kansas

When Mabel Rice asked if I would participate in this year's Merrill Conference, I was pleased to do so since I would have an opportunity to learn about the role and direction of research among institutions in our region. I was also delighted to talk about EPSCoR–and many of you know that I am an enthusiastic believer in EPSCoR.

What is EPSCoR?

EPSCoR, an **E**xperimental **P**rogram to **S**timulate **Co**mpetitive **R**esearch, is a federal-state partnership program. It began nearly two decades ago when a few senators in Congress questioned the uneven regional distribution of federal research and development dollars. They argued that our nation was better served if such dollars were more evenly distributed so that research could also thrive in their state institutions of higher learning. Legislation provided funds to the National Science Foundation in 1980 for EPSCoR to begin with the states of Arkansas, South Carolina, Maine, West Virginia and the Commonwealth of Puerto Rico. Alabama, Oklahoma, Vermont, North Dakota, Wyoming and Nevada followed in 1986 and shortly thereafter in 1989, the states of Idaho, South Dakota, Louisiana and Mississippi. Kansas and Nebraska were the last to be designated EPSCoR states in 1992–for a total of eighteen states and Puerto Rico. Congress expanded EPSCoR-like programs to six other federal agencies in 1990: Department of Defense (DOD), Department of Energy (DOE), Department of Agriculture (USDA), the National Aeronautics and Space Administration (NASA) and the Environmental Protection Agency (EPA). The total budget for EPSCoR has grown from $8-10 million in 1990 to nearly $100 million in 1998 with NSF continuing to provide about 50% of the total.

What is the Distribution of Federal R&D Dollars to States?

The 20 states with the largest total of U.S. research and development expenditure collectively account for 87 percent of the research and development conducted nationwide; the 20 states with the smallest share for just 4 percent of the total.
John Jankowski, Director, NSF R&D Statistics Program (1996)

From the FY 1996 federal budget, EPSCoR states received less than 8% of the $12 billion funded for research and development (R&D) at universities and colleges. In 1998, two universities, University of Washington and John Hopkins University, garnered more than $850 million in Federal R&D funds–about the same amount as the collective

total of the EPSCoR states! EPSCoR's focus is thus on the research competitiveness of states for those dollars.

How Competitive is Kansas and its Neighbors for Federal R&D Dollars?

Table 1 lists the federal Research and Development (R&D) academic obligations to Kansas and its neighboring states. First, let's look at how the EPSCoR states of Kansas, Nebraska and Oklahoma did during the period from 1991 to 1996. Kansas went from $50.89 million to $80.37 million, while Nebraska changed from $42.82 million to $65.11 million, and Oklahoma $33.15 million to $79.51 million. On a per capita basis, these translate to $31 for Kansas, $40 for Nebraska and $24 for Oklahoma. Oklahoma increased its dollars by a whopping 140 % while Kansas and Nebraska advanced at 58% and 40%, respectively. The 1996 per capita average for the 50 states was $46. Our neighbor, Colorado, sets the benchmark for the region by garnering $279.79 million in Federal R&D obligations for a per capita of $75 in 1996.

The per capita difference indicates that nearly $40 million of Kansas' federal tax dollars for R&D are lost, notably to states on the East and West Coasts and our neighbor like Colorado. So, research competitiveness is an economic issue as well. How long will it take for Kansas to catch up to the national average? At the current yearly rate of increase (9% for Kansas and 5% nationally) it will take at least another decade.

The regional institutional data are tabulated in Table 2. The dollars listed are the total R&D expenditures, which include both the federal dollars and those from other sources. Perhaps what are most interesting about the data are the difference in the percentage change of R&D spending from 1991 to 1996 among institutions. For those institutions in the upper range, what factors made the difference? More important, what will it take to sustain and continue gains? Should institutions bring on-board more faculty in the areas of science, engineering, math and technology–or should the emphasis be on large multidisciplinary research programs? EPSCoR, although limited in funds compared to the total R&D funding to institutions, has experimented with several initiatives, including some to influence the politics to get things done.

Can EPSCoR Make a Difference?

Perhaps we can try to answer this question by looking at the programmatic components and examples of outcome of the Kansas NSF EPSCoR program, K*STAR (Kansas Science & Technology Advanced Research). A key theme of K*STAR from the beginning has been emphasis on fostering partnerships. I believe that K*STAR has helped forge an unprecedented linkage among science, engineering, mathematics and computer science researchers. Cooperation among faculty and administrators of the three Ph.D. granting regents universities of Kansas State University, University of Kansas and Wichita State University was not commonplace earlier. A paradigm shift has occurred so that collaboration is expected and not the practice of few. Strong alliances have evolved among university, state government and the private sector. All of these sectors are now represented on key oversight and governing bodies of EPSCoR. As a consequence,

Kansas EPSCoR remains well supported and stable, unlike EPSCoR in many states. Between 1992 and 1998, K*STAR received $9.050 million from Kansas, through KTEC (Kansas Technology Enterprise Corporation), to match the $9.060 million received from NSF EPSCoR.

At the national level, there are two organizations working for EPSCoR. The first is a law firm in Washington, D.C. retained by the Coalition of EPSCoR States to work on legislative matters. For example, recent goals have been to increase the Department of Defense EPSCoR (called DEPSCoR) to $20 million per year and National Institutes of Health EPSCoR to $100 million per year (from the current $5-$8 million). The other organization is the EPSCoR Foundation, a not-for-profit corporation, formed to promote EPSCoR and to provide direct assistance to states, as needed. The $20,000 per year fee paid to the Coalition by each EPSCoR state and Puerto Rico provides funds to support these organizations.

For K*STAR, there are two grants currently pending at NSF EPSCoR. The first is a $750,000 proposal to support the phase-out of current programs with funding from October 1, 1998 to September 30, 1999. The second is a $3 million proposal to begin a new infrastructure-based K*STAR program for three years, commencing on January 1, 1999. The NSF EPSCoR awards are negotiated as cooperative agreements, not grants. Thus, the programmatic components and budgets are subject to negotiation on a yearly basis during an award period. This yearly budgeting creates administrative headaches and faculty frustrations with regard to spending and reporting deadlines.

K*STAR has adopted two umbrella strategies for improving the state's grant competitiveness: first, support of meritorious, peer/merit reviewed projects–many patterned after the big science, research-team model–and second, improvements to infrastructure, including human resource development and equipment acquisition. The latter has provided more than $4 million in equipment purchases. In addition, K*STAR has provided support for research workshops, statewide conferences, named lectureships and faculty development initiatives, including some focused on women, minorities and the physically challenged.

In addition to the umbrella strategies, K*STAR has:

- Promoted the concept that a strong research base in science, engineering, math and technology (SEM&T) provides the basis for long-term economic development;
- Utilized EPSCoR as an agent for promoting basic-research at Kansas' three research universities;
- Assessed and sought prioritization of Kansas' institutional SEM&T strengths; and
- Assessed EPSCoR's impact on an on-going basis.

Have these initiated any changes? For example in 1994, Kansas through KTEC, adopted a model that positioned basic research as a key to the state's economic development plan. This model is a systems approach to economic development designating EPSCoR as a key stimulus of the state's basic research enterprise. The Kansas Science and Technology Council, that helped influence the KTEC plan, was organized as a part of K*STAR. Deliberations of the Council with KTEC were responsible for the formation of the Futures Fund, which has provided the State's matching dollars for EPSCoR and also funded meritorious EPSCoR-like projects that met the state's strategic technology priorities. From 1992 to 1998, this Fund received $16.035 million from the Economic Development Initiative Fund (EDIF), as appropriated from the State's lottery revenues. With Governor Grave's approval, the legislature has appropriated $3.67 million from EDIF to KTEC for FY 99.

Examples of EPSCoR Projects and Initiatives

In the case of larger research projects, success requires substantial prior strategic planning including a plan of implementation and tracking of outcome. Planning is an on-going process–it must continue throughout the life of a project and have flexibility to alter the course if needed. Faculty members are reluctant to plan, prioritize and set timelines for projects. A warning flag is when a principal investigator of a project does not prioritize and focus resources but instead allocates on a basis of "something for everyone, but not much for anyone." I have learned the hard way that such a project is not self-sustaining. There must be a central research theme with a focus to which participants agree and can contribute, otherwise the enterprise does not have the cohesion to continue without EPSCoR. It is like an old NSF model where researchers banded together to justify a grant to fund a multi-user instrument. In essence, it becomes a mini-grant program where individuals do their own thing rather than working together for the common good.

In contrast, a K*STAR project where prior planning and cooperative effort has paid off is Dr. Shih-I Chu's *Center for Advanced Scientific Computing*. A statewide ad-hoc committee of stakeholders was convened for planning. This project led to the installation of an SGI/Cray Origin 2000 supercomputer at the University of Kansas in March 1997. It has spawned related initiatives, including the six Great Plains Networking (6-GPN) for Earth Systems Science and the designation of the Kansas Association for Networked Supercomputer Applications (KANSA) as one of the NSF supported National Computational Science Alliance (NCSA) partners. The 6-GPN states include the EPSCoR states of North and South Dakota, Nebraska, Kansas, Oklahoma and Arkansas. The 6-GPN is an example of a project where none of the participating states had a large enough footprint to be a player in building a high-speed telecommunication network to connect to INTERNET II. They banded together to obtain a $1.47 million NSF EPSCoR grant, and with matching support from states/institutions, built a high speed network that became the *first to connect to INTERNET II*. This achievement is an example of local, state, regional and national agendas coalescing and being prepared to take advantage of opportunities as they appeared.

The high-speed telecom network enables institutions to develop *virtual* organizations to tackle "Grand Challenge" problems, like those being envisioned in the Earth Systems Science initiative. Some 80 researchers of the 6-GPN states have already met under the auspices of AAAS (funded by NSF EPSCoR), at the South Dakota EROS center to look for areas of common research interest. EROS has one of the largest repositories of Landsat data. With such data, it is possible for a unit, like the Kansas Applied Remote Sensing (KARS) program, to do high resolution imaging of the earth's surface. KARS can, for example, focus on Western Kansas and predict crop yield several months in advance of harvest. Such predictions are beneficial to the farmer and relevant to the commodities market. Another Earth Systems Science workshop is being organized, again under the auspices of AAAS, for November at KU to do the next phase of planning. Other applications are also being explored. For example, K*STAR with Oklahoma EPSCoR is co-funding a workshop on aviation weather hazards at KU this October to explore collaboration among regional research institutions and the FAA weather centers. Commercial aviation companies as well as the military are very interested in being able to predict macro- to micro-weather conditions for flight safety.

In addition to the large programmatic projects, there are three other significant initiatives: one to mainline tenure-track junior faculty; another to provide "venture" capital to new entrepreneurial activities; and a third to support the development of large-scale grants. The first is the K*STAR First Award program. It provides up to $50,000 each to junior faculty members to help them become grant competitive earlier in their careers. Priority is given to faculty who submit a grant proposal to NSF prior to or simultaneously with their submittal to K*STAR. Funding decisions are based on recommendations of a peer review panel that rank-orders proposals according to NSF merit criteria. Since 1995, 31 faculty have been funded for a total of $1.19 million. To date, these faculty have garnered a total of some $7 million in external grant awards and another $5 million in multi-investigator grants. About $7 million in grants is still pending. First Awards represents a highly leveraged investment.

EPSCoR has pushed for a paradigm shift to get faculty to use First Award funds to hire postdoctoral researchers early in their careers rather than waiting for them to become established before doing so. Often, new faculty feel that, since they had just finished being a postdoctoral fellow prior to becoming a faculty member, they were still unqualified to direct postdoctoral researchers. Thus, a prevalent Kansas paradigm was for new faculty to get 1-3 graduate students within two years, begin a research project and perhaps be in a position to submit a research grant by their 3rd year as a faculty member. If the grant were awarded, the research program would really get underway during the 3rd and 4th year, perhaps in time to have publications for a tenure decision by the end of the 5th year of appointment. Now, K*STAR, like many research competitive institutions, encourages faculty to submit their first grant proposal to a federal agency within the first year of appointment and no later than the 2nd year. The faculty member's department is asked to formalize a mentoring process to assist faculty as part of the First Award. Grant success is also enhanced by visiting granting agencies and getting to know program officers so that faculty learn first-hand about the requirement for success; i.e.,

grantsmanship. The program officers in turn associate a "face" with a grant proposal, often important in borderline decisions.

In 1997, NSF EPSCoR instituted a "co-funding" program to assist regular NSF programs to fund grants that are borderline or "on-the-bubble." The State's Project Director has the responsibility to certify those grants that fit state/institutional priorities to qualify for co-funding. Priorities have included the mainlining of junior faculty (e.g., CAREER grants), consortia grants from K*STAR's cluster projects, large programmatic grants such as IGERT, KDI, S&T Centers, and multi-disciplinary or regional collaborative grants. Kansas received slightly more than $1 million in co-funding in FY98. The NSF EPSCoR FY99 co-funding budget will be $15 million so that a total of $30 million will be available when the regular program match is included. Kansas should garner $2 million to $3 million in co-funded grants during FY 1999.

Another NSF EPSCoR initiative is its "standard" grant, which provides up to $500,000 over two years to support one-time innovative research projects. The $1.47 million 6-GPN award, mentioned earlier, was such a grant; a larger amount was awarded since there were 6 states involved. Earlier in 1995 a grant of $325,000 was awarded to Dr. Azadivar of Kansas State University (KSU) to establish the Manufacturing Learning Center. This center was modeled after a teaching hospital; engineering students, both undergraduates and graduates, served as "interns" to conduct research on problems defined by Kansas manufacturing companies. Fees paid by the companies assist in covering operational costs. More than 200 research projects with over 120 Kansas companies have resulted. It is an excellent example of a project serving Kansans. Azadivar's center recently won a $800,000 NSF award to become self-sustaining. In 1996, a standard grant of $644,000 was awarded to Dr. Demarest and Dr. Frost at KU to establish the Lightwave Laboratory. This grant has been leveraged to more than $4 million with private sector funds and other grants. A grant for over $2 million is currently pending at NSF. The technology of this laboratory will pave the way for *ultra*-high speed telecommunication capabilities for the future. The most recent FY 1999 "standard" grant of $500,000 over two years went to Dr. Madanshetty at KSU to establish the Non-Contact Diagnostics Laboratory in Manufacturing. Faculty from KSU, KU and Wichita State University are involved in the research of this laboratory, which has industrial applications. A state match of more than $500,000 for these four "standard" grant projects has been provided by KTEC from the Futures Fund. A characteristic of all these grants is the partnering of universities with the private sector.

What's Next?

The stresses and challenges faced by faculty to be competitive researchers and competent teachers have been discussed by Dr. Eli Michaelis and Dr. Tom Taylor in the 1997 Merrill Conference Report. Their reports reflect the concerns felt by faculty today, especially in establishing and maintaining grant-funded research programs. Many perceive that they are competing for a smaller pool of money so that the success rate for awards hardly justifies the effort. Although this perception may not be true, it serves as a reality for many. Added to this scenario is an emerging idea that future growth will rely

on larger programmatic grants that are multi-investigator and multi-disciplinary. A faculty member, who recently served on a review panel for NSF Science and Technology Centers, said that successful grants were those with collaborative linkages on a national or even global scale. If such is the scenario required to grow the research enterprise, how can EPSCoR states compete? One avenue is via strategic planning. K*STAR can assist by providing grants to support planning activities involving: a) multi-investigator and/or multi-disciplinary research grant proposals; or b) grants in response to or in anticipation of an NSF Request for Proposal for a major initiative such as IGERT, KDI, S&T Centers or other significant programs. Funds could support planning seminars and workshops; bringing outside consultants; getting writing and editorial help; and covering travel expenses to visit agencies and potential out-of-state collaborators.

KTEC, in justifying state matching support, says institutions must prioritize their agendas and put larger investments in fewer high potential payoff areas. While agreeing, the one caveat is that it is never easy to identify which individual or group or research area will bring forth the next breakthrough technology. What is most important is the creation of an environment that fosters scholarly inquiry and provides the infrastructure to conduct leading-edge research. The proposed Phase III K*STAR Cooperative Agreement seeks to address the latter by funding new faculty hires and the acquisition of multi-user major instrumentation. A total of $2.86 million over three years, beginning on January 1, 1999, is proposed for these two infrastructure components. K*STAR program publication (RFP-98-1R, August 1998) describes the guidelines for proposal preparation and their submittal deadlines. Funding decisions are based on recommendations made by an external peer/merit review panel, which reviews all proposals.

K*STAR subcontracts the Institute of Public Policy and Business Research (IPPBR) to conduct yearly assessment of the Science, Engineering and Math Infrastructure at the Three Universities (KSU, KU and WSU) in Kansas. This assessment focuses on the demographics of these institutions including the number, rank and salary of the science, engineering and math (SEM) faculty; the distribution of faculty according to age, women, and cultural diversity; the number of SEM degrees awarded; and grant activity (number submitted, number awarded and dollar value). IPPBR also conducted two additional assessment studies in FY 1998. One was a case study of four institutions of comparable size to KU that had significantly improved their grant competitiveness during the previous decade. The other resulted from a survey of faculty and interviews with administrators on issues dealing with institutional research support and barriers. The survey included questions on EPSCoR. If you are interested in obtaining a copy of these reports, please contact the K*STAR office. *

---

* IPPBR Research Papers: Sixth Assessment of the Science, Engineering and Math Infrastructure at Three Universities in Kansas.

1. Report #243 on Demographics and Grant Activity, December 1997.
2. Report #247 on Case Studies of Four Peer Institutions, June 1998.
3. Survey of Faculty and Interview of Administrators, expected publication in early 1999.

EPSCoR states like Kansas, Nebraska and Oklahoma have made significant relative gains in their research enterprise during the period of their tenure in the EPSCoR program. These gains have been made at a time of modest growth and expansion in the federal research and development funding. The question is whether EPSCoR states can sustain gains during the next several years. Although legislation has been introduced to Congress to double the Federal research and development budget by year 2008, we are entering a period economic uncertainty. Many states have recently augmented federal funding with legislated state initiatives. Examples are Nebraska's yearly $12 million Research Enhancement Initiative, Oklahoma's distinguished professors program, and Kentucky's $110 million distinguished professors initiative. Such initiatives are critical at a time when start-up funds and salaries for new faculty may not be competitive when compared to those offered by research intensive universities. Another challenge is the retention of junior faculty who have achieved high research profile, and are either close to or have recently been promoted to associate status. Although salary is always a concern, faculty retention is more dependent at this level on the institutions' ability to provide an infrastructure that adequately supports research and teaching. The role of EPSCoR in helping to address these challenges will rely on the vitality of the partnership between national, regional, state, and local stakeholders.

Table 1.

FEDERAL RESEARCH AND DEVELOPMENT ACADEMIC OBLIGATIONS BY STATE * (in millions of dollars)

State	FY91	FY96	%Change	per capita FY96	Pop.** (M)
Colorado	$ 182.92	$ 279.79	53	$75	3.75
Missouri	181.89	293.25	61	55	5.32
Iowa	124.81	168.90	35	59	2.84
Kansas	**50.89**	**80.37**	**58**	**31**	**2.57**
Oklahoma	33.15	79.51	140	24	3.28
Nebraska	42.82	65.11	52	40	1.64
U. S. Total	$9,008.00	$12,068.00	34	$46	260.00

* Source: NSF/SRS, Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions, Fiscal Year 1996.

** Population data from 1995 Census.

Table 2.

R&D EXPENDITURES IN SCIENCE AND ENGINEERING AT NEIGHBORING UNIVERSITIES BY SOURCE OF FUNDS, FY91 - FY96 * (in millions of dollars)

Institution	FY91	FY96	FY96 Rank	% change	FY96 Feds	FY96 State & Local Gov.
U. of Colorado	$161.97	$251.30	21	55	$177.52	$ 5.30
U. of Iowa	124.06	178.23	41	44	105.65	5.74
Iowa State U.	134.66	151.91	45	13	54.90	43.71
Colorado State U.	80.47	126.70	60	57	74.93	21.98
U. of Missouri	96.75	123.13	62	27	33.40	16.20
U. of Oklahoma	79.78	109.07	75	37	42.68	14.39
U. of Nebraska	87.53	102.46	77	17	32.35	36.75
U. of Kansas	65.98	100.65	78	53	41.86	7.62
Oklahoma State	67.49	82.96	92	23	25.03	15.36
Kansas State U.	53.01	71.22	108	34	24.77	29.84
Wichita State U.		9.90	NA		2.20	3.00

* Source: National Science Foundation, Academic Science and Engineering: R&D Expenditures, Fiscal Years 1991 and 1996. Detailed Statistical Tables, Table B-35, NSF-96-308 (Arlington, VA, 1996).

* FY91 and FY96 dollars do not include industrial, institutional, and other sources.