Report of the AAAS Research Competitiveness Program Review Team

Presented to

South Dakota EPSCoR Program

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Introduction and Overview

Process

This is a report of findings and recommendations of a panel convened by the Research Competitiveness Service (RCS) of the American Association for the Advancement of Science (AAAS). The goal of the panel is to provide an external perspective and evaluation of needs and opportunities that can guide the South Dakota Experimental Program to Stimulate Competitive Research (SD EPSCoR) as it prepares to develop a proposal for the next National Science Foundation EPSCoR Research Infrastructure Improvement (RII) grant competition in FY09. The review was requested by the SD EPSCoR Director, Dr. Jim Rice. The statement of work for the panel is given in Appendix A.

The review panel was led by Dr. Ed Derrick, Director of the AAAS Research Competitiveness Program, and was comprised of five senior experts:

Dr. Chris Allen, Professor of Chemistry, University of Vermont, and former Vermont EPSCoR Director and University Technology Transfer Director;
Dr. Al Clark, Professor of Materials Science and Engineering, Cornell University;
Dr. David Ferry, Regents' Professor of Electrical Engineering, Arizona State University;
Dr. Barbara Seiders, Director of Chemical and Biological Defense Programs, Pacific Northwest National Laboratory; and
Dr. Lee Williams, Vice-President for Research and Graduate Dean, University of Oklahoma, former Oklahoma EPSCoR Director and Director of Science and Technology Research for Oklahoma State Regents for Higher Education.

The review team visited campuses and offices throughout the state July 30 – August 2. The agenda for the visit is given in Appendix B.

This report follows the format of the statement of work which poses seven questions. However, the review team identified two fundamental underlying issues that impact South Dakota's prospects for research competitiveness. The responses to the specific questions posed to the review team reflect these issues, which will be elaborated upon first. While SD EPSCoR was the focus of the team's review, our observations and recommendations cover a wide range of issues in research competitiveness, many extending inevitably beyond the scope of SD EPSCoR itself. While we attempted to limit these extensions, the EPSCoR program exists and operates within the broader research environment in South Dakota, and it cannot be discussed in isolation. We hope that our comments and observations about broader issues are taken in this context. Further, the nature and purpose of our visit were such that our exposure to the whole of the system is rather limited and through a particular lens. We are therefore not in a good position to predict systematically the impact of our recommendations on other system elements. We intend that each of our recommendations be understood in this context – that they are made in the context of sustaining the momentum of EPSCoR investments – and recognize that implementation will have to take into account other factors and stakeholders.

General Findings and Recommendations

In this report, we refer frequently to the term "enterprise" in the context of education, research and economic development. By this term, we include all of the following:

- the state colleges and universities, including the tribal institutions, as well as the K-12 school system;
- the Board of Regents;
- the state political bodies, which includes the Governor's office and the legislature;
- businesses within the state and business organizations; and
- the public.

We also refer repeatedly for the need to achieve ***integration*** throughout the enterprise. By this we mean:

- horizontally across the universities and colleges,
- horizontally across the instructional and research faculty and administrative components of the universities;
- vertically from the Governor's office, through the Board of Regents, through the University administration to the faculty, staff and students; and
- vertically, through the above, but also externally interactive with the SD business community and the public at large.

South Dakota faces many of the same challenges encountered by other EPSCoR states. In addition, the SD state universities face an additional hurdle (compared to some EPSCoR states) in that until recently, research at SD universities was not supported by state funding. At present, however, the state government encourages and expects its higher education system to participate in a research and technology-based economic development enterprise. The three primary universities (USD, SDSU, SDSMT) have had a teaching emphasis and are attempting to make the transition to having a research-active faculty. The state Regental system is similarly adopting a research focus.

It is clear that the key players (institutions, organizations, and individuals) have the same general vision and agree on the outcome, as shown by their support for the document "A 2010 Vision, The Future of Research and Technology in South Dakota, A State Plan." While this document presents a compelling vision, and one that is ambitious and appropriate for South Dakota, it does not lay out a specific plan to implement the vision.

The goal of research-active universities and their role in the 2010 Vision document are worthy and achievable, and necessary for the future success of SD EPSCoR, but the review team identified two core issues that must be addressed if these goals are to be realized.

First, it is not clear that the true extent and depth of the cultural shift required in the higher education system to transition from "teaching" to "research AND teaching" has been appreciated. The transition from a teaching focus to a research-active culture requires a major paradigm shift, yet we saw evidence that the most fundamental measure of a faculty member's expectations and activities is still based on a teaching model. There appears to be a disconnect between the Regents stated policy, and implemented practice, concerning the connection between new faculty lines and credit hours generated. If there is to be strategic development of selected research areas, the state system has to get past this kind of linkage,

and develop new models of faculty productivity that reward all aspects of performance of research-active faculty.

In a teaching institution, financial resources (state appropriation, tuition and fees) are the starting point that defines the scope and extent of faculty activities (i.e. teaching) – *vision follows resources*. In a research institution, the vision and ambition of the faculty define what is to be accomplished, and external resources (grants, contracts, partnerships) are sought to complement state funding to realize that vision – *resources follow vision*. In a teaching institution, faculty behave and are treated as employees. In a research institution, faculty are treated and behave as entrepreneurs, seeking the resources (external and internal) to realize their scholarly ambitions. The system must recognize and implement this transition from faculty employee to faculty entrepreneur.

Second, there appear to be fundamental disconnects between the key stakeholders. Simply put, while the various players share the same general vision, they are not all working together to develop and implement a plan to achieve that vision. Each is pursuing what they believe is an appropriate path, but are doing so independently. While we are not in a position to assess the reasons, we infer that this may be in part because of a lack of confidence that the others both understand and can deliver what is needed.

The reality of the modern research enterprise (and recall that we use the term enterprise deliberately) is that all the stakeholders – faculty, campus, Regents, government, private sector – must be engaged in a collaborative and mutually supportive (and trusting) effort in order to be competitive. The campuses are simply too small to do it alone, and will fail both politically and in terms of national competitiveness if they attempt to go it alone. The Regents cannot dictate a specific research agenda to the campuses (the best research-active faculty are entrepreneurs and don't respond well to top-down direction). Government has to provide base funding for the infrastructure of the research enterprise, which includes support for tenure-line research-active faculty in targeted research areas. This can not be done via term funding (while term funding can be used to boost target areas once the infrastructure and faculty are in place, no research university can attract and retain faculty via term funding). The private sector must be an integral part of the research and technology process, not just the passive licensee of university intellectual property (IP). These are the lessons learned by other EPSCoR states – it is not enough to have the components, they must work together, throughout the enterprise. The campuses have to work together as a true integrated system, the Regents have to work with the campuses, the Regents/campuses have to work with the government, and the State (education/government) has to work with the private sector. The NSF EPSCoR program has shown leadership in this approach and has been used by other states as a model to validate this enterprise approach. The panel was very impressed by the SD EPSCoR Director and his knowledge of the structural and cultural changes needed, and is confident in his ability to be a leader and team player in the SD science and technology development enterprise.

Ultimately, state resources flow from the Governor and Legislature, and previous examples have shown that Governor Rounds responds to well-conceived business plans. The South Dakota research enterprise needs to develop a coherent, integrated, vision and business plan. However, while the EPSCoR REACH committee and the Research and Commercialization Council (RCC) should have a unified vision and plan, and while they share some committee membership, they do not appear to be sufficiently coordinated at the present time to produce the needed vision and business plan.

Based on these observations, we are led to the following three recommendations:

Recommendation 1. The campuses and Regents system should engage in a joint retreat to articulate and affirm the cultural and paradigm shifts needed to engender the transition to a research-active

university culture, which demonstrates the expected value and climate to work collaboratively at all levels – faculty, administration, system. There are two reasons for such a retreat. First, it would provide a venue to encourage existing joint activities and to develop additional activities that will foster a "community of scholars" among the universities. Examples include student and faculty exchanges, workshops and specialized graduate courses offered over the access grid, joint research projects and programs, and coordinated interactions with policymakers and the public. The objective is not to condense the separate schools into one institution, but rather to make the best use of the capabilities and resources at all of the universities. Evolving from the current environment to a robust research active academic system will be challenging. Without the coordinated efforts of all the universities brought together, the likely success for any one institution on its own is very low. Second, it would provide an opportunity to reconcile system-wide the specific extant procedures and policies that impede the transition from teaching to research-active strength. Examples of such procedures and policies (e.g. teaching-effort based performance metrics and resource allocation) should be articulated and the necessary changes defined and agreed upon. *This process should be moderated by an external facilitator or facilitators well familiar with the challenges of administering a multi-institutional research-active university system*.

Recommendation 2. The key stakeholders in the research enterprise – campus, Regents, government, and private sector should convene to develop a specific implementation plan, which may be based upon the 2010 Vision document. This plan should include specific tasks, responsibilities, timelines, and identify resources and their source. The plan should address the multiplicity of issues facing the state S&T environment, to include the individual campuses, the state educational system, and the business community, with a view to achieving greater integration across the entire enterprise – both horizontally and vertically. We believe that the South Dakota REACH committee (in collaboration with the RCC) is an appropriate forum for this planning activity, as the key stakeholders are represented on the committee. The stakeholders might consider "scenario planning," where 3 or 4 likely scenarios are developed. This avoids the trap of becoming wedded to one single plan as the political and economic ground changes with time. *Again, this planning process should be moderated by an external facilitator(s)* (not necessarily the same as in Recommendation 1).

Recommendation 3. For the purposes of evaluation, one or two appropriate states should be selected, and South Dakota should benchmark its vision, strategy, plans, and performance against these states. These would not necessarily be contiguous states or even necessarily other EPSCoR states, but rather states that would serve as appropriate models for where South Dakota wants to be in 10-15 years.

In summary, we reiterate that South Dakota's success in the next round of the NSF EPSCoR RII program in FY09 will be predicated on its research enterprise developing a coherent integrated vision and plan for research and technology, in the form of a State Science and Technology Plan (presumably based on the 2010 Vision document) and a clear articulation of the specific role of the RII in the Plan.

Responses to the specific questions

1. What is the status of the current EPSCoR research foci (especially the NSF PANS focus area) with respect to:

a) their current developmental status;

b) their opportunity for further development;

c) their relationship to South Dakota's knowledge-based economic development activities;

d) their relationship to research infrastructure development activities undertaken by the SD Board of Regents system and its campuses.

i. NSF EPSCoR – Photo Active Nanoscale Systems (PANS)

The AAAS panel had the opportunity to discuss aspects of the NSF, DOE, and NASA EPSCoR programs several times during our visit, including having an Access Grid meeting on Monday, a presentation at SDSU on Tuesday, and a presentation at SDSMT on Thursday. In addition we had brief tours of various facilities.

We were pleased with the planning and coordination (e.g. the May 2007 workshop) which went into defining and establishing the NSF EPSCoR PANS program. In addition the PANS program appears to be actively managed, with weekly Access Grid meetings.

The facilities which the panel viewed as part of PANS appear to be reasonable, given the present state of the research infrastructure in South Dakota. These include a clean room for microfabrication at SDSU, a photovoltaic (PV) test facility, various laser facilities for processing and characterization, and a dedicated facility for printable electronics at SDSMT. There are standard facilities for analytical chemistry as well as SEM's and TEM's at various sites. There most likely will be a need for access to more sophisticated surface analysis equipment at various stages of the project. Until these facilities can be established, there is ready access at places such as the National Renewable Energy Laboratory (NREL), the National Nanostructure Integration Network (NNIN), and the Pacific Northwest National Laboratory (PNNL). (We were a bit surprised at the rather passive response to use of NNIN facilities in nearby Minneapolis).

Compared to its original proposal to NSF, the SD EPSCoR program received an award with the budget reduced to concentrate its support on two focus areas of PANS. The PANS effort involves two research programs: (1) third generation PV cells involving polymers in connection with metals and semiconductors, and (2) direct-write techniques for circuitry using a variety of curable inks.

The panel felt that this program was well organized and proactively managed. There seems to be good use of the Access Grid for weekly communication among the partners, although there was concern on the part of the panel that the collaborations seem somewhat forced and suboptimal. For example, there seems to be little feedback from the user end to the ink formulation end (chemists at USD) about characterization and polymer composition required for successful inks. Nevertheless, the facilities available to the teams (for both tasks) seem reasonable for the goals, particularly as they are supplemented by NREL and national labs as part of the larger Northcentral States Nanoscience Consortium. The faculty involved seem generally well qualified in their respective subfields. In addition, there appears to be good student involvement, both at the graduate and undergraduate level. We urge the PANS leadership to look critically at the fit of the various collaborations and ensure that there is tight feedback between the various elements, particularly between synthesis and characterization.

Yet, there are some problems in the program. It is not clear that a full and careful impact study has been done on the possible application of the photovoltaics, even if successful in the development of new cells. For example, is the use of dyes and concentrators really a competitive approach to the development of new cells, given the sophistication and effectiveness of current technology in this area? It was not at all clear to us that this will be the case, and there is considerable doubt that this will lead to a successful technology which, in turn, leads to a successful spin-off into economic and industrial development. Over the past 30 years, a large number of alternative approaches to PV have been explored. Thus far, no alternative has displaced PV technology based on some form of silicon PV cells (*c*-Si, *pc*-Si, or *a*-Si), with tandem cells already providing enhanced performance through using more of the solar spectrum. The PANS program will thus undertake a very challenging task in developing dye concentrator systems for multi-photon up-conversion or down-conversion and integrating these concepts into stable, low cost PV systems. We view the challenges for technical success in this area as very difficult to overcome.

On the other hand, we view the printable inks effort as a good engineering program which can likely lead to commercial viability. The fabrication facilities which we saw appeared to be essentially commercial equipment. We did not see any photo-activated fabrication facilities, but perhaps there was not time to show that aspect of the program. Because of its downstream, applied nature, and people who understand the engineering issues, we see the printable electronics program as likely to be successful, with a reasonable chance of developing sustainable spin-off companies in South Dakota. The connection with the chemistry effort at USD seems forced, and there remains some doubt on the panel that the engineers at SDSMT fully appreciate such collaboration. We feel that an opportunity exists for some exciting fundamental chemistry in this area (which was somewhat downplayed by some participants), which can itself lead to both publications and economic development through commercialization, especially if new applications of these technologies are discovered and pursued.

Thus, based on our brief exposure to the program, we see very difficult challenges to technical success in the PV component and a modest chance of success in the printable electronics component. That said, the science and technology which will come from these components can still strengthen the competitiveness of the state, provided that the participants (1) emphasize development of good science programs to underpin the technology, and (2) become continually aware of new applications of the emerging technology to other areas. As shown by a recent publication by Professor May (in the prestigious Journal of the American Chemical Society), upconversion technology using metal sol gel films show potential as one of these areas.

We were pleased to see that student projects in marketing, economics, and systems related to PANS are underway. We encourage more of this activity, with strong links to business education programs

wherever possible. In particular, we encourage these participants to build on the emerging technologies and look beyond PV and printable electronics to other applications.

We were disappointed that most participants were not able to give a clear and concise picture of their competitive situation (i.e., Who are the 3 or 4 most important competitors nationally and internationally and where does their South Dakota program sit relative to this population?). One notable exception was the co-Director of the Polymer Composites program at SDSMT (not part of PANS), who immediately could analyze his major competition. In our opinion, understanding the competition is critical to achieving competitiveness. It might be useful for the SD EPSCoR Director to require a brief annual analysis of the competition (benchmarking).

ii. DOE EPSCoR

In reviewing the DOE EPSCoR activity, the panel learned there were no active SD DOE EPSCoR projects at present. With respect to the SD process for applying to the DOE program, the proposal process for developing and selecting candidate proposals to go forward seems to be working well, operating openly and transparently, providing good statewide representation. Proposals selected from the state process had been sent out for technical review prior to the arrival of the AAAS panel.

In the absence of an existing research program, the South Dakota DOE EPSCoR team briefed their revised CBRD proposal. In prior rounds, this proposal had been unsuccessful. The team had redefined the scope and refined the proposal, and were looking for general advice and counsel on proposal development. The proposal investigators had given a thorough, conscientious, and creative review of previously received comments in developing their revised proposal.

The investigating team demonstrated reasonable appreciation of potential utility of extremophiles for cellulose digestion in support of state-wide energy and agricultural state economic development goals. While this is one of four possible programs being reviewed at the time, the effort to study the evolution of these organisms, which have adapted uniquely in the harsh underground environment, and the application of these to cellulose conversion for possible alternative fuel usage, is an example of a unique program (to South Dakota), with a large possible payoff, that is already providing excellent collaboration between SDSU and SDSMT.

The panel provided additional context on strategy and tactics for structure, formulation and context of the proposals. Among the suggestions from the panel was the recommendation to document how many, or whether there is evidence of, other cellulose-degrading extremophiles reported in the literature as a way to reinforce the value of the organisms that they had found in the unique DUSEL environment.

Some members of the AAAS panel were unfamiliar with the process of evolution as it applied to development of highly specialized extremophiles. If the proposal was read by others who were similarly not familiar with the evolutionary development aspects of the research, it would be good for the investigators to be sure that the fundamental biological background was covered, if only briefly. The package briefed seemed to represent a balanced portfolio of activities, all building off the same infrastructure. The diversity of potential similar projects offers opportunity to bring other potential users of the mine.

iii. NASA EPSCoR

The review team was briefed on the process and results of the latest NASA EPSCoR competition. Good results were evident from the prior award, and the team was impressed that a competition for new proposal areas was conducted even with very short lead time. The addition of a new project direction (with new PI's) which is relevant to NASA's new emphasis on manned space exploration is a good strategic decision.

The committee was not briefed on Project 2 (carbon fiber composites from pyrolysis of electrospun PAN), but from the provided written material it appears to be sound and directly relevant to NASA's materials program. The project takes a well established bulk process for carbon fiber production combined with newer methodologies for preparing smaller precursor fibers. The importance of the project is in the improvement of established materials, rather than the development of new materials.

It was encouraging to see the SD NASA EPSCoR Director added to the REACH Committee to facilitate effective research cooperation.

iv. DoD (DEPSCoR)

The national DEPSCoR program is focused on individual investigator awards rather than the more global infrastructure development which is the hallmark of other agency EPSCoR programs. Thus, the state EPSCoR management responsibility involves promoting available funding opportunities, prescreening proposals and managing linkages to the federal DEPSCoR program.

The SD EPSCoR team has done a good job managing the program and transitioning Investigators to regular DoD funding. The competitiveness of SD researchers in this area is at the level of those in comparable (and some larger) EPSCoR states.

v. The Role of NIH Programs in South Dakota S&T Infrastructure Development

There are numerous federal funding opportunities for research infrastructure development in resource poor states. South Dakota (SD) has wisely developed a management structure for the majority of these programs under the Research Affairs Council of the Board of Regents. The state EPSCoR Director serves on this committee and he in turn oversees the NSF, DoD, DOE and NASA programs. This structure allows for maximum interaction between the individual program's research and education/outreach activities while retaining their separate identity and missions. This close connection and direct tie to the state system allows for the most efficient coordination and maximum utilization of the resources available from each of the participating agencies. Unfortunately, the NIH IDeA program (INBRE and COBRE) is conspicuously absent from this cooperative venture. The resulting operation of the IDeA program in SD as a totally independent venture is a missed opportunity to coordinate the relatively resource rich NIH activity with global needs in a state-wide systems approach that would encompass both research and education/outreach. At best, this results in a parallel and independent activity and at worst potential duplication of investments in a state (like other EPSCoR states) where every investment dollar counts. As a potential example of the latter, the review committee saw some

evidence of two parallel proteomics facilities (one supported by the NIH program and one separate) both of which were operating at less than full capacity. The lack of coordination of investment in general helps neither the state system nor the medical research network (which is not large enough nor competitive enough for federal funds to be on its own). While it is true that the NIH does not encourage IDeA programs to report to an "EPSCoR" state committee, other states, particularly smaller states, have highly correlated activities between the EPSCoR and IDeA programs including having the same director for each. This is important also because the new NIH Roadmap strategic plan points to the new emphasis on full-spectrum research, such as the Clinical Translational Science Awards (CTSA), that require close collaboration between the medical and non-medical campuses.

The committee recommends that SD consider the following changes in the current situation of totally independent EPSCoR and IDeA programs.

1. The EPSCoR and IDeA directors meet on a regular basis to develop a strong, interactive working relationship.
2. That new proposal development by both parties is conducted in such a way that each party is fully appraised on the direction and specific plans of the other at an early enough stage that modifications can be incorporated to maximize the return on investment for SD.
3. That the IDeA Director brief the Research Affairs Committee on the current and planned programs supported by the NIH.
4. That strong consideration be given to making any COBRE (which are in fact large multi-investigator research programs) proposals systems-wide in participation where feasible.
5. That strong coordination of outreach to the baccalaureate and tribal colleges between the INBRE and various EPSCoR programs take place so a seamless provision of services occurs.

vi. Overall EPSCoR Leadership and Management

It is our impression that the overall programs are well-managed. Dr. Rice clearly has built relationships throughout the enterprise of the state and is dedicated to connecting the EPSCoR program to the multiple efforts underway to promote research and innovation in South Dakota.

2. Are there infrastructural developments that could advance the EPSCoR program while still preparing the State to take advantage of developing initiatives nationally and within the State (e.g. DUSEL and the Sanford biomedical research initiative)?

The University System (University of South Dakota, South Dakota State University, and South Dakota School of Mines and Technology, and three smaller universities) is striving to transition from a set of primarily teaching universities to a collaborative research system. The various EPSCoR programs comprise one tool in creating a collaborative environment and set of collaborative research efforts. In addition, the 2010 Initiative, created by the Governor and Legislature, has created a set of focus Centers which span the various universities and have a goal of stimulating economic development, particularly as a result of directed research which is collaborative among the various universities. In many cases, the EPSCoR efforts are endemic to these centers and provide the driving force for collaboration between the institutions.

In addition, the state has established the REACH committee to oversee the EPSCoR programs. Nevertheless, a great many challenges exist within the overall System which limits the effectiveness of the various programs. Some of these have become evident to the panel, and include:

- The state lacks an overall Science and Technology Plan. Such a plan would establish a shared vision and the role to be played by each of the members of the System, as well as the roles of industry, government, and the populace at large in reaching the defined missions of the Plan. Moreover, such a plan needs an implementation component which defines how the goals are to be reached. Without these critical elements, the universities will not be able to take full advantage of the initiatives presented.
- Creation of the 2010 centers appears to be based upon a plan in which the funding from the state, by which the Centers are established, will end at the end of the five year cycle. Unfortunately, in the view of the panel, this is somewhat shortsighted, as there does not appear to be a plan on how new faculty hires can be used to establish a base upon which long-term maintenance of the research program core to each Center can exist. Instead, new faculty lines are connected to new doctoral programs, which may or may not lie in the focus of the 2010 Centers.
- In some cases, the panel found that connections to industry, and the creation of new companies, has already begun to occur. However, the larger connection, in which the industrial partners can act as motivators for new research directions does not seem, at least in the scope of the panel's exposure, to have been very effectively established. In particular, this effort needs to be driven by the overall Plan described above.
- In the view of the panel, there were elements of a new vision at each of the campuses, but there was no coordinated vision or plan. Indeed, only SDSMT seemed to be aware that there was a State policy on intellectual property, which in turn was not effective in helping the universities with their own policies on intellectual policy.
- With a real implementation plan connected to the 2010 Centers, and buy-in by all parties, barriers can be broken and cultural changes induced on the campuses. Such a plan must have real time lines. It is likely that the REACH committee is the proper place for the Plan and implementation procedures to be developed.
- The state university system, as well as the individual campuses, have not set proper "peer" levels, using existing comparable schools as opposed to successful schools which operate at the desired level of success. We suggest that South Dakota EPSCoR consider selecting one or more appropriate states for benchmarking. These states should not necessarily be contiguous to South Dakota, nor necessarily other EPSCoR states. Rather they should represent models for the changes that the state must make if it wishes to be truly competitive at the national level.

3. What are existing barriers to academic research productivity in South Dakota?

The panel saw ample evidence of individual effort and success in building research programs contributing to the university mission. We also saw signs - as exemplified in the presentation from the SDSMT VP of Research – of the emergence of an enterprise vision bringing together research encouragement, tech transfer/IP management/economic development, and state initiatives. Nonetheless, there needs to be a broader view of the mission, both within each university and within the state

university system itself. Each individual researcher or administrator needs to be aware of and 'buy in' to the larger mission and goals of the EPSCoR program so their individual actions can take place in the context of and contribute to these goals. In a sense we are calling for a modern incarnation of the classical concept of the university as a 'community of scholars' or 'community of ideas', where the participants buy in to and engage communally in the scholarly venture. However, we did not sense that by and large the individual faculty, administrators, campuses, and organizations were aware of the bigger picture, what their role was in it, and what the roles of the other players was. For example, researchers on one campus were often unaware of similar or complementary work on other campuses. So long as the universities continue to pursue their goals independently, they will forfeit the benefits that could accrue to them with a critical mass of capability and resources.

In the view of the panel, the most serious practical barrier is the lack of incentive for research activities at the resource allocation level. That is, new research thrusts, such as the 2010 Centers, are funded separately from the university funding source, and these two are disconnected. While there appears to be some real growth in individual research programs which contribute to the individual university mission, there does not appear to be an incentive to build collaborative programs either within a single university or between universities. Simply put, the individual institutions are not large enough to have the critical mass to compete nationally, and individual funding pots are not large enough to support a program big enough to become nationally competitive. There needs to be collaboration at the scientist level and the funding level. Further, it is more difficult to argue for additional state support when in-state funding is fragmented and potentially duplicative.

Despite encouraging signs throughout the state system, funding distributions within each university still appear to be based upon student credit hour teaching production, even though this is apparently no longer true at the System level. We use the terms 'appear' and 'apparently' advisedly as we heard contradictory ideas by faculty and administrators at the BOR and campus level. As best we can tell, credit hour production does not influence the allocation from the BOR to the campuses, but within the campuses the allocation of resources either explicitly or implicitly is based on a teaching/credit hour production funding model. This compensation and reward structure needs to be changed so that the metrics can reward and sustain research-active faculty, particularly those filling the new positions.

It is not clear that the true extent and depth of the cultural shift required in the higher education system has been appreciated. The transition from a teaching focus to a research-active culture requires a major paradigm shift, yet we saw evidence that the most fundamental measure of a faculty member's expectations and activities is still based on a teaching model. The historical role of the faculty as solely educators for undergraduate programs has instilled within the faculty one lifestyle, so that it is quite difficult to redirect the faculty to a new mission as "entrepreneurs." In the view of the panel, it may be necessary to bring into the System new "role models" who can help to retrain the faculty in their new roles.

There appears to be a lack of understanding of the role of research in both graduate and undergraduate education, particularly as it applies to the view of research as intense one-on-one education of graduate students by their mentors. Faculty are still expected to teach a full load unless their time is bought out on research grants, whereas in a research institution faculty have research as a core part of their work effort (typically 40% research , 40% teaching, 20% service). New models for faculty workloads, which include the role of research and mentorship, need to be developed and implemented explicitly.

It is unrealistic to expect a research faculty member to generate grants to cover their salary after just three years, if ever (research universities cover the base salary of their faculty and expect grants to provide summer salary and maybe some academic year release). In fact this would not be a particularly wise use of very limited grant resources. Investment in post doctoral and graduate student support is much more likely to produce the outcomes (such as peer reviewed publications) which will provide a strong case for competitive renewal of the grants in question.

Secondary, but still a significant indicator of the continued prevalence of the non-research culture, is the apparent practice of including graduate teaching assistants in the staffing formula as Staff, thereby making the institutions appear over-staffed. This is example of a funding formula that implicitly is based on teaching production.

It seemed from our limited exposure that university administrators have a focus upon "bricks and mortar," in reference to new and remodeled buildings, rather than upon a plan of how these buildings can be coupled to inclusion of critical new equipment. The more comprehensive vision of infrastructure is needed to seed research growth, particularly as required for sustenance of the 2010 Centers.

The respective University Vice Presidents for Research seem to communicate well and appear to be intent on collaboration to develop joint projects, at their own initiative and on specific projects. This cooperation should be encouraged. However, to build a strong research base in the SD universities, the commitment to communication and collaboration must be enterprise wide and systemic. The VPR position at the Board of Regents is a logical focal point to encourage enterprise-wide coordination of the research agenda, and should be encouraged to initiate and support regular communication and collaboration between the campus research VP's.

Ostensibly, the Research Affairs Council could contribute to development of a culture of collaboration across the state, but the Council does not have the charge of either decision making or budget authority.

The panel appreciates the tremendous challenge facing the state in trying to transition from an environment in which research at the state educational facilities was secondary to now where research active university community is a priority. Given the radical shift in emphasis required, the panel strongly encourages that the research community work to inform and bring a research perspective into all of the state's boards and advisory bodies.

Finally, the panel saw some labs where compliance with current OSHA rules for research and teaching laboratories, such as signage and MSDS data sheets, was lacking. The panel did see extensive implementation of these requirements at SDSMT. A thorough safety plan and designation of safety response teams must be implemented system-wide.

4. (a) How would you rate the extent and nature of the collaboration between the investigators and the 3 campuses involved in EPSCoR?

Historically the campuses have been funded based on student enrollment so the prevailing culture had been one of competition between the campuses for their share of the (fixed) resource pie. The campuses are still early in the cultural transition to a research focus, which brings the opportunity for research to

increase the size of the resource pie by winning external grants. They are, therefore, learning to shift from competition for a larger share of a fixed pie, to cooperation to increase the size of the pie. We see some evidence at the individual investigator level of this new paradigm, particularly in the EPSCoR projects, but even there, it is not optimal. More significantly, the panel did not see a system-wide collaboration at the programmatic and administrative levels that is needed to encourage and support PI collaborations.

b) Can you identify any barriers to expanding collaborations between campuses, and propose policies to eliminating them?

Many of the suggestions in previous sections address this question. The single biggest impediment however is the general disconnect between the various components of the enterprise. It is a simple truth that research-active faculty are opportunistic and entrepreneurial, and they will respond to the appropriate incentives. If the enterprise encourages, expects, and provides resources for collaborative work, the faculty will respond. The EPSCoR program has been used in other states to stimulate these collaborations. The earlier recommendation for South Dakota to benchmark against successful states (EPSCoR and non-EPSCoR) includes review and adoption of successful best practices.

5. Is EPSCoR adequately addressing economic development, commercialization and entrepreneurship in its activities?

The question is not so much of SD EPSCoR addressing these issues but more globally, can EPSCoR help the state system in addressing these issues? The simple answer is that the state system could use the help. The panel recognizes that this is a new priority for the SD system and certainly it is at the core of the rationale for establishing many of the 2010 Centers. Consequently, there is an expectation of improvement in this area system wide. SD EPSCoR can be expected to be a partner in development and execution of a rational coordinated plan but the ultimate leadership for this must come from the highest levels of academic leadership in the state.

a. Barriers

i. The biggest barrier is that there is not much in the way of experience nor does the academic culture in SD enthusiastically embrace this mission.

ii. The administrative infrastructure for technology transfer (TT) in the state is primitive and there is a variable degree of visibility of TT on the campus. One institution, SDSMT, has embraced this concept and has a half-time position dedicated to the administrative aspects of TT and more importantly for working to educate the faculty in this area. Given that technology is at the core of the SDSMT mission, it is not surprising that SD leadership in this area would start there. On the other two campuses TT is yet another responsibility of already busy VPRs.

iii. There does not appear to be well developed connectivity between Mel Usted in the Governor's office and his colleagues who have commercialization expertise and the technology transfer programs in the university system. Certainly, individual collaborations and successes occur but not on a systematic basis. This is part of the primitive nature of the technology transfer activities and the possible difference of

one being associated with the Governor's Office and the other with the Board of Regents.

b. Recommendations

i. The centrality of EPSCoR in the state system and the reporting line of the EPSCoR director to the REACH committee gives the EPSCoR director the opportunity to use the EPSCoR "voice" to keep these issues on the agenda but ultimate leadership and power to "make it so" has to come from the highest levels of leadership in the state academic community and the state's executive branch.

ii. A system wide office for dealing with the entire IP process (disclosure, patent, licensing, and commercialization) in a seamless fashion would be highly desirable and an efficient use of sparse state resources. The volume of demand (the standard for University generated IP is four disclosures for every $10M in extramural funding) argues for a single office which could handle reasonably the state system. Additionally, this would be a good model for system wide behavior in the SD higher education community. (While not directly part of the panel's charge, consideration might also be given to some systems-wide coordination of safety and environmental compliance programs. Such systems were apparently lacking at some sites, and the potential for EPA fines is huge.)

iii. Some potential EPSCoR initiatives which should be considered for the next RII proposal are summarized below:

- continue to play a leadership role in enhancing, in collaboration with the state SBIR office, the SBIR Program in SD by supporting workshops, and funding participation in national SBIR meetings/workshops for both faculty and private sector entrepreneurs.
- if it doesn't already occur, pilot fund participation in the national Association for University Technology Managers meetings (AUTM.net) for the individual(s) identified in point i above.
- explore collaboration possibilities in terms of funding an MBA student to work with start ups at the technology park slated for SDSU.

6. Is the private sector taking advantage of the academic research infrastructure that is currently available? If not, can you identify why not?

The key players in the state do have a strong commitment and vision for the role of S&T in economic development. In particular, our conversation with Dave Link and Curt Hage clearly showed this was a high priority and primary role of the Research and Commercialization Council, and there was no lack of commitment and ideas on how to accomplish the goal.

However, while the SD EPSCoR program has demonstrated a recent success story in this area in the development of the PhotoBioMed capability, there is not yet a systematic culture of private sector reach-in or university reach-out from university research.

Although the emphasis in this Question is on the interaction into the university system, not out, in many ways the issues are the same as those identified in Question 5 above. Thus the solution is most logically

in the system wide service/office identified above. A TT Director is the person in the best position to make the private sector / academic connection that best fits the need of the project, since his or her job necessitates detailed knowledge of faculty and institutional (equipment etc) expertise. Having a common portal to the system will be preferable to having a mixed response depending on which institution is approached.

Again EPSCoR can take a leadership role in moving this forward but ultimately it requires a state-wide approach and commitment. It would be reasonable for EPSCoR to fund planning activities, consultants, workshops etc. to aid the state in the development of a strategic plan in the whole TT area but ultimate funding of such an office is not an EPSCoR role (EPSCoR is an initiating not a sustaining activity).

The major players in the state have a vision for the role of S&T in economic development, but there is not a strategic plan nor coherent implementation plan that includes the major elements in a collaborative enterprise (university research, technology transfer, private sector, government). EPSCoR can be a partner in the solution, and is already doing what it reasonably can in the context of targeted university research. It may also play a gap-filling coordinating role in bringing the players together to develop a shared vision and plan.

The technology transfer infrastructure at SDSMT is more developed than at the other campuses, and ideally in a collaborative enterprise could be a role model and supporter for TT efforts at the other campuses. Given the size of the state research enterprise, it would not be resourceful to have duplicative offices on each campus, and the AAAS panel discussed options of unifying the function at the state level (e.g. in the economic development office), but that would raise questions of contact and familiarity with the campuses and faculty. EPSCoR could play a role in evaluating the options and supporting the initial implementations, perhaps as part of the new RII proposal.

7. Can you propose strategies for further engaging the state's tribal colleges and universities?

The panel was scheduled to meet with a representative from the tribal colleges; unfortunately, the individual was not present at the scheduled session. Comments to the panel from various individuals suggested that there were opportunities for engagement in theory but difficult to execute in practice.

Members of the panel were impressed with the depth of appreciation by the REACH committee of the importance of engaging the tribal colleges as well as the degree of sensitivity to the challenges presented by trying to communicate across multiple cultures. One member of the REACH committee suggested that with respect to engagement of the tribal colleges and universities, it may be necessary to develop a new perspective on what constitutes "success" of such engagement.

The panel noted that there had been some degree of success at engaging the tribal institutions, notably the NASA Space Grant. The Space Grant engages students at various education levels, and has provided over $150K in support for Native American Student Programs over a two-year period.

Appendix A: Statement of Work

AAAS will recruit and lead a senior advisory panel to review the research infrastructure of South Dakota. The goal of the project will be to provide an external perspective and evaluation of needs and opportunities that can guide the South Dakota EPSCoR program as it prepares to develop a proposal for the next NSF EPSCoR Research Infrastructure Improvement grant competition in FY09. The panel will be comprised of at least four knowledgeable and experienced researchers and research administrators from a variety of disciplinary backgrounds and perspectives, and a senior AAAS staff member experienced in leading such panels. South Dakota is particularly interested in an assessment on the following research areas: direct write technology, nanoscience and materials, renewable energy (photovoltaics, bio-based fuels, and wind energy), and the use of satellite remote sensing for resource management.

The panel members will receive and review background documents and information to be provided by South Dakota EPSCoR. The panel will conduct a four-day site visit in South Dakota, listening to presentations and engaging in discussions with researchers, research administrators, university and government officials and other stakeholders across the state, as appropriate. The date for the site visit has been determined mutually by South Dakota EPSCoR and AAAS as the week of July 30, 2007. During the site visit, the panel will work to address the following questions:

1) What is the status of the current NSF, DoE and NASA EPSCoR research foci (especially the NSF PANS focus area) with respect to:
   a) their current developmental status;
   b) their opportunity for further development;
   c) their relationship to South Dakota's knowledge-based economic development activities;
   d) their relationship to research infrastructure development activities undertaken by the SD Board of Regents system and its campuses.
2) Are there infrastructural developments that could advance the EPSCoR program while still preparing the state to take advantage of developing initiatives nationally and within the state (e.g., the Deep Underground Science & Engineering Laboratory [DUSEL] and the Sanford biomedical research initiative).
3) What are existing barriers to academic research productivity in South Dakota?
4) a) How would you rate the extent and nature of the collaboration between the investigators and the 3 campuses involved in EPSCoR?
   b) Can you identify any barriers to expanding collaborations between campuses, and propose policies to eliminating them?
5) Is EPSCoR adequately addressing economic development, commercialization and entrepreneurship in its activities?
6) Is the private sector taking advantage of the academic research infrastructure that is currently available? If not, can you identify why not?
7) Can you propose strategies for further engaging the state's tribal colleges and universities?

AAAS will be responsible for recruiting and chairing the panel and for the preparation of a final report. AAAS will be responsible for all compensation and travel expenses of panel members. AAAS will prepare a final report of findings to be delivered not later than 30 days after the end of the site visit.

The South Dakota EPSCoR program will be responsible for providing background information to the panel members no later than two weeks prior to the site visit. SD EPSCoR will be responsible for setting the agenda for the site visit to include appropriate and sufficient presentations and discussions to allow the panel to consider the questions to be addressed.

Appendix B: Site Visit Schedule

July 30-August 3, 2007

Sunday 29	Monday 30	Tuesday 31	Wednesday 1	Thursday 2	F
AM	**AM** **USD Campus** Presentation 8:00 a.m. to Noon Slagle Hall, Room 104	**AM** **SDSU Campus** Presentation 8:30 a.m. to Noon Enterprise Institute T3A	**AM** **Sioux Falls** REACH Committee Presentation 8:30 – 10:30 a.m. SD Technology Business Center, Conference Room B (3rd Floor)	**AM** **SDSM&T Campus** Presentation 8:30 a.m. to Noon McKeel Mtg. Room Surbeck Center	A **F** **D** **C**
PM **Review Team arrives in Sioux Falls** **?6:00 p.m. Orientation dinner w/ Jim Rice**	**PM** **NSF EPSCoR RII** Access Grid Presentation 1:30 – 5:00 p.m. USD Lead Campus	**PM** **DOE EPSCoR** Access Grid Presentation 1:30 – 5:00 p.m. SDSU Lead Campus	**PM** **Pierre** State Government & Board of Regents 1:30 – 3:30 p.m. Basement Conference Room GOED 4:00 – 5:30 p.m. 711 E. Wells Ave. 2nd Floor Conf. Rm.	**PM** **NASA EPSCoR** Access Grid Presentation 1:30 – 3:00 p.m. SDSM&T Lead Campus 3:00 - 5:00 p.m Review Team Exit Discussion	