Vertically Integrated Pyramid (VIP) Approach to Research, Outreach, and Student Education (ROSE) in Sciences, Technology, Engineering, and Math. (STEM) for Tribal Colleges and University (TCU)

STEM LEADERS FORUM 2011

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1. Introduction

Southwestern Indian Polytechnic Institute (SIPI) is a federally-operated college funded through the U.S. Bureau of Indian Education (BIE). The College is advised by a national tribally appointed Board of Regents, established to provide technical and higher education at the associate degree and certificate levels for members of federally recognized tribes. The enrollment derives from over 100 different Indian tribes among approximately 600 students. In 1993 the SIPI Board of Regents directed the College to begin offering transfer degrees with an emphasis on science and technology.

1.1 Advanced Technical Education Certificate & Degree Programs

- Electronics Technology
- Manufacturing Technology
- Computer Network Management Technology
- Computer Science A.S. Degree
- Pre-Engineering Certificate –Enrichment Year
- Engineering A.S. Degree Program
- Geospatial Information Technology
- Natural Resources Management/Environmental Science/Crops & Soil Science/Agribusiness

1.2 SIPI's Strengths

- Tuition-exempt, also providing students with room, board and textbooks.
- Student population (~650 to 900/trimester) allowing coherent, intimate student/teacher ratio.
- Current student body is 100% American Indian/Alaskan Native representing over 100 tribes from across the country.
- Long-standing partnerships/agreements with local secondary schools, regional higher educational institutions (University of New Mexico, New Mexico Highlands University, New Mexico State University, and Northern Arizona University), Sandia National Labs, and other science centers greatly enhance sustainability for learning and research.
- 6 associate degree programs in the sciences
- Research internship opportunities for SIPI students.
- 72,540 sq. ft. science and technology building (12 research/teaching labs, 10 classrooms, 14 faculty offices 2 conference rooms, 2 distance learning classrooms and a 500 seat auditorium).

1.3 SIPI Engineering Programs

SIPI is a leader in Engineering and Engineering Technology education among Tribal Colleges. SIPI Advanced Technology, Engineering, Engineering Technology programs are fully articulated with all the New Mexico four –year universities: UNM, NMSU, and NMTECH. SIPI offers the first two years of a four-year engineering program. The graduates from the program are accepted as juniors to Mechanical, Civil, Electrical, and Computer Engineering programs. SIPI also offers an "Enrichment Year" program to prepare high school graduates in math, science, communication, and computer skills to be able to enter as SIPI freshman engineering students. The majority of our courses will transfer to any 4-year engineering program in the country. Also, when you check our website, you will find that our labs are state-of-the-art. We can say without exaggeration that they are the best educational labs in the state of New Mexico and among the best in the Southwest.

The SIPI AIHEC and NSF awards were designed to build the "capacity for engineering education and research experience on the Information Technology, Renewable Energy Programs, and the "Advanced Robotics and Automation Technology" at SIPI and, BIE high schools, and other tribal colleges (partners to SIPI such as BHS, Dine, OLC, LBHC, and SKC) through SIPI dissemination of information and summer "Tribal Colleges Faculty Professional Development" Institute supported under NSF TCUP.

For updates on the news and events of the Engineering and Engineering Technology Programs, the Southwestern Indian Polytechnic Institute (SIPI)-a national community college for Native Americans, please visit the following news links page on the SIPI website:

http://www.sipi.edu/acadprog/progstudy/divinstr/ate/

http://www.sipi.edu/about/News/

Please visit the following links on our University of New Mexico partner, Southwest Center for Microsystems Education (SCME) website:

http://scmenm.net/scme_2009/index.php?option=com_content&view=category&id=35&Itemid=56

Please also visit the following link on the New Mexico STEM Education website:

http://www.nmstemed.org/drupal6/content/ROSE-STEMS-Program-SIPI

You may also visit our Facebook pages by clicking on the following links:

http://www.facebook.com/pages/Albuquerque-NM/Southwestern-Indian-Polytechnic-Institute-SIPI-Engineering-Programs/339779393318?ref=ts

1.4 Vertically Integrated Pyramid (VIP) Approach to Research, Outreach, and Student Education (ROSE) in Sciences, Technology, Engineering, and Math. (STEM)

The Southwestern Indian Polytechnic Institute (Albuquerque, N.M.) employs paid student internships not only to retain students majoring in science, technology, engineering, and mathematics (STEM), but also to encourage students in developmental courses to stay in college and pursue STEM careers.

Students are linked to each other as well as graduate students, instructors, and industry professionals via the Vertically Integrated Pyramid (VIP) Model that SIPI's Department of Advanced Technical Education has crafted to build the relationships and the sense of community that are important to Native Americans.

For their paid work on engineering-related projects, SIPI student interns are usually under the direction of graduate or post-doctoral students who also serve as mentors. Increasingly, the graduate students are SIPI alumni who are enrolled at nearby universities.

The projects frequently put the interns into one-on-one contact with community college and university professors, and industry professionals. And some SIPI students have managed to leverage their on-campus internship experiences for internships with federal agencies and corporations.

In addition to their project responsibilities, every intern mentors a SIPI student who is taking developmental classes. The developmental students sometimes shadow the interns; at other times interns serve as guest lecturers on science or engineering topics for developmental classes.

The VIP Model is the thread that runs through several of SIPI's externally-funded programs that utilize interrelated activities to recruit Native American students for STEM fields. For Achieving the Dream, SIPI focused on improving its developmental education program. VIP Model complements these very broad strategies by creating a more intensive learning environment between faculty (college and high school), graduate students, community college students, high school students and industry representatives through project-based learning activities in STEM fields," Montoya said.

With support from the National Science Foundation, SIPI developed a pre-engineering and engineering technology program known as ASEET for Associate of Science in Engineering and Engineering Technology. The new curricula includes an enrichment year to help the students, who come to the Bureau of Education college from tribal communities throughout the United States, get up to speed in math and science so they can compete when they transfer to universities.

ASEET also brings faculty from other Tribal Colleges and Universities to SIPI for summer professional development workshops. These programs also serve as networking and learning opportunities for SIPI's student interns.

The interns are also involved in outreach activities to the Bernalillo School District, where half of the students are Native American. They assist with school presentations, robotics competitions, and summer STEM camps. In addition to easing students' financial burdens, the internships help students gain interpersonal and professional skills by interacting with people who share their interest in STEM. Faculty sees a tremendous change in self-confidence as they see the students go through this VIP Model.

Dylan Maho, a member of the Rosebud Sioux tribe from Wisconsin, said he became less shy while working collaboratively with engineers on campus projects like the Mars Yard, which the college built for robotics experiments and competitions. "In high school I was always the kid in the back of the class," he said during a panel discussion in October 2008 that was attended by more than 700 people at the Advanced Technological Education Principal Investigators Conference in Washington,

D.C.

While working on his associate degree in engineering, Maho maximized SIPI's partnerships with federal agencies by completing internships at NASA's Jet Propulsion Laboratory, Los Alamos National Laboratories, and the Federal Aviation Administration.

"It just opened me up; all these internships and programs," Maho said of the many opportunities SIPI provided with its VIP Model.

☐Five Year Strategic Plans (2010 – 2014)

☐

SIPI STEM Programs Vision:

Science, Technology, Engineering, and Mathematics (STEM) Education for Developing and Sustaining Energy, Environmental, and Human Resources

In what follows, I would like to share some of my thoughts, professional findings, expert opinion and advice, and concerns regarding the current status and future directions in the STEM education and academic programs of SIPI ATE department.
I have more than thirty five years of experience as an STEM educator and researcher. I have been involved with course, curriculum, academic program, and laboratory development, student's education and research internship projects at SIPI since 1994. I have managed more than $5M grant funding either as PI or CoPI for SIPI. I have taught courses from 100 levels all the way to the 600-level graduate courses. I have supervised more than 200 undergraduate student's projects, 15 master level theses, and five PhD dissertations.

SIPI, as the only national federal Indian community college, has clearly stated in its mission statement:

- ***Relevance*. With the impact of global trends affecting Indian nations, the college strives to deliver culturally, socially, and economically relevant information, training, and services that will offer long-term solutions and encourages life-long learning among students.**
- ***Holistic Approaches.* The college provides a holistic learning environment for student including affective, cognitive, and social enhancement.**
- ***Integrity and Professionalism*. The college strives to provide the highest quality instruction, services, and learning resources to American Indian and Alaska Native students and communities.**

New local, national, and global economical challenges, in general, and economical development and employment challenges of Native youth and Native communities, in particular, coupled with fast pace of technological advances has created new problems as well opportunities. US are posed with big challenges in its competitiveness and share of innovative technology-based economy. Several private and government studies have pointed to the problems in STEM education. Most of the advanced technology and engineering programs, nationwide, are suffering from low enrollment and struggling to stay afloat. The problems range from the lack of preparation of HS graduates, lack of faculty professional

development, out-dated and obsolete curriculum and labs to fewer manufacturing jobs due to outsourcing and globalization.

I have identified ten strategic areas that, upon investment of resources, will help our department to grow, stay adaptive and responsive to the new challenges.
We need to incorporate the following thrust and focus areas in our annual planning and requests for funding from our long-term partners such as DOI, DOE, DoL, DoEd, Dept. of Agriculture, NASA, NSF and private and non-profit organizations. I believe there is no shortage of funding for Native American Colleges, especially for SIPI due to its uniqueness and coverage, and there are several well-intentioned funding sources that are willing to support SIPI and share its success and glory.

We need to invest in all the following strategic areas by short-, mid-, and long- term development of 1) outreach and students placement, advisement, retention, education and training, 2)faculty professional development and new hires, 3)student timely graduation, and university transfer or career advisement and placement, in each area.
I am concerned with our students' retention and graduation rates, which in same cases is due to the lack of needed course offerings for timely graduation. I am afraid that, in some cases, we lose, turn-off, or discourage our more talented, prepared and enthusiastic students. We need to finalize an organization chart based on our strategic plans for the nest 10 years. We need to expedite hiring of new and competent faculty and support staff and technicians in the areas of physics, chemistry, Math, civil engineering, CAD, natural resources, and IT. We need continuity, sustainability and stability in STEM areas. A successful education system needs memory, seniority, endurance, and continuity. The study shows more than 50% of what we teach in technology areas is obsolete by the time our students graduate. We are training them for jobs that do not exist in ten years. The world technical information doubles every two years.

Our published catalog of courses, certificate and degree programs is a legal document and contract with the admitted and enrolled students and we need to abide by. For most of our students, SIPI is their last stop and hope. They are first generation college students, in their older years, with family and community ties, obligations, and commitments. They are brimmed with energy and conviction to excel and serve their communities. I have seen them bloom and thrive in confidence whenever I trust them, treat them like professionals, and give them ownership and chance to lead and shine.

STEM curriculum designed for tribal colleges and universities need to have the following features:

1 – Enrichment Year

2 – Multiple entry and exit points with certification

3 – Distance Learning Component

4 – Project-based and hands-on courses front-loaded

5 – Down, across, and up articulation. 4-year, high-school, and other tribal colleges.

6 – Summer research opportunities

7 – Inclusion of Internship, Design Project, and Special Topics course.

8 – CADCAM, GIS/GPS, IT Essentials,

9 – Tele-presence and tele-operated laboratories, distance learning.

10 – Community work and VIP model.

11- Sufficient budget and time for institutionalization- 10 years, $10M

12- Computational tools, Materials Science, Renewable Energy, and Engineering Ethics

13- Educating the administrators and policy makers!

14- ABET accreditation, is it needed?

15- Small business and entrepreneurship, 2 + 1 and 3 + 2 programs

16 - ROSE STEM for Life!

17 – Strategic planning for grants and soft funds.

18 – Introduction to Engineering and Design Course – Upfront

19 – Students Research Experience teams: O&R, I&D, and I&D teams

20 - Indigenous science and technology courses

Course, Curriculum, and Program Development

1 – Develop, enhance and expand ATE department **Internet and web presence, online resources, E- learning, distance education, and remote-controlled STEM labs**. We need to fully automate the outreach, recruitment, and placement, and student registration, library research processes. This will facilitate our outreach, public relations, and flexible and adaptive community reach and better education and training for our on-site and remote learners. .

2 – Expand and enhance the **HS technology/engineering academies, and our partnership with BIE, area and regional middle and high schools with pre-dominantly Native students population**. We need to down-articulate our "Enrichment Year" with those 9-12 schools and articulate with other TCU's for concurrent, dual enrollment and student's lateral transfer. CCTI initiative, which is a version of the tech-prep, program, which SIPI had for years, will save us huge resources we put in ABE and developmental education by sending us more prepared incoming students. A major reason for low enrollment in STEM areas is the lack of preparation of HS graduates in STEM areas. This has transformed colleges into overgrown and glorified high schools.

3 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of ***Native technology-based small businesses and entrepreneurships.*** These areas can be integrated into all ATE STEM academic programs.

4 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **renewable energy and sustainability**. Energy, environment, technology, and life are holistically connected and these areas can be integrated into all ATE STEM academic programs

5 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **Voice over IP (VoIP), wireless networks, and computer security**. These areas can be integrated into all ATE STEM academic programs

6 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **supercomputing, data presentation, visualization, and mining, and computer graphics and animation**. These areas can be integrated into all ATE STEM academic programs

7 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **computer-aided design and drafting**, **GIS, GPS, urban planning, surveying, and resource management**. These areas can be integrated into all ATE STEM academic programs.

8 – Expand, enhance and develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **construction**

management and civil engineering. Theses areas can be integrated into all ATE STEM academic programs.

9 – Expand, develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **bio-informatics and biotechnology**. Theses areas can be integrated into all ATE STEM academic programs.

10 – Expand, develop modules, courses, laboratory experiments, students design projects, special topics courses, internships, certificate programs in the areas of **instrumentation, control, automation, and robotics**. These areas can be integrated into all ATE STEM academic programs

I am confident that these thrust areas will warrant ATE programs becoming adaptive, flexible and responsive to the changing demands of the job market. The investment of resources helps SIPI to live up to its mission and serve the Native communities.

Visually integrated PV array and shade structure

☐ Five Year Strategic Plans (2010 – 2014)

☐ Engineering/SIPI Programs Vision

Science, Technology, Engineering, and Mathematics (STEM) Education for a Sustainable Energy, Environment and Life

☐ Goals:

- ☐ **1 – Minimum enrollment of 240 students: 60 students in each of four programs of Information Technology (IT)- (Computer Networking), Engineering (ENG)-(Electrical, Mechanical, Civil, Chemical), Electronics Technology (ET)-(Instrumentation/Control, Renewable Energy Technology), and Manufacturing Technology (MT)-(MEM's, CIM, 2+1 program)**

- ☐ **2 – A retention rate of minimum 80% in all programs.**

- ☐ **3 – A 100% Job placement or transfer to 4-year programs with a minimum of 100 students graduating class.**

- ☐ **4 – NCA and ABET-Accredited Pre-Engineering Programs.**

- ☐ **5 – Tribal Colleges cooperation in engineering programs**

- ☐ **6 – Tribal Colleges cooperation and sharing resources via web-based distance education, grid computing, tele-science, and tele-presence laboratories.**

- ☐ **7 – Enhancement of SIPI manufacturing program to include concentration areas of 2+1 Entrepreneurship, Microsystems and MEM's technology. Robotics and Automation.**

- ☐ **8 - Tribal college's cooperation in education, research, and outreach for a sustainable energy, environment and life.**

- ☐ **9 - New Cross Disciplinary Renewable Energy Technology (Science, Environment, and Technology Emphasis).**

- ☐ **10- Development of laboratory infrastructure for Research, Education, and Outreach in Sustainable Energy, Environment and Life science and technology.**

☐ Priority Tasks

- ☐ **1 – Five-year Program Area Vision and Strategic Plan.**
- ☐ **2 – Course and Curriculum Standards and Assessment Plans**
- ☐ **3 – Enhancement and Development of Specialty Labs.**
- ☐ **4 – Enhancement of the programs WebPages, Brochures, CDROM.**
- ☐ **5 - Summer Research, Education and Outreach Institute for recruitment.**
- ☐ **6 – Establishment of Advisory Boards in each Program.**
- ☐ **7 – Articulation Agreements with accredited four-year Schools.**
- ☐ **8 – Collaboration and Partnership with local, regional, and national industries.**
- ☐ **9 - Collaboration and Partnership with local, regional, and tribal K-12 Institutions.**
- ☐ **10 – Private, State, Federal, and Tribal Funding for Outreach, Education, and Research**

PHOTOVOICE

Argonne-BIA Renewable Energy Competition – SIPI National Champion Wind Turbine Team

Argonne-BIA Renewable Energy Competition – SIPI National Champion Bio-diesel Team

Engineering students testing their rover on the Moon Yard ‘, NASA Johnson Space Center.

ROBORAVE Robotic Competitions – SIPI gymnasium

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