Outreach, Education, and Research Report

Engineering and Technology Programs Vision:

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

Advanced Technology Education (ATE) Department

Southwestern Indian Polytechnic Institute

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1. Institution Overview

Southwestern Indian Polytechnic Institute (SIPI) at Albuquerque, New Mexico is a federally operated community college, funded through the U.S. Bureau of Indian Affairs (BIA). The College is governed by a nationally representative tribally appointed Board of Regents, established to provide general education, early childhood education, and business, vocational and technical instruction at the associate degree and certificate levels for members of federally recognized tribes.

SIPI opened in September 1971 on 165 acres in northwest Albuquerque, New Mexico. Student enrollment derives from over 120 different Indian tribes and averages over 900 residential, commuter and distance-learning students during the fall trimester. The school was designated a land-grant institution in 1994 allowing for expansion in research and extension programs to meet the growing needs of tribal nations. SIPI is a member of the American Indian Higher Education Consortium (AIHEC) and has been accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools (NCA), awarding transfer associate's degrees since 1993.

SIPI is located in the center of New Mexico's agricultural and high-tech corridors (Los Alamos and Sandia National Laboratories, and Intel Corporation), major universities and the largest technical force within a 500-mile radius. SIPI has established excellent working relationships with these industries and universities allowing a responsive learning environment within which American Indian and Alaska Native students develop

skills that will be needed by tribal nations to build cohesive and economically strong communities. SIPI is an important part of the New Mexico higher education system. The College has agreements with the University of New Mexico, New Mexico State University, and New Mexico Highlands University that ensure better recruitment, transfer, and retention rates for Native Americans. The College has also begun developing articulation agreements with regional public institutions outside of New Mexico.

1.1 Mission Statement

"It is the mission of Southwestern Indian Polytechnic Institute, a National Indian Community College, to provide quality technical and higher education opportunities that meet the dynamic needs of federally recognized tribes. This endeavor provides the opportunities to: enter the technological workforce as self-sufficient and contributing members of society; acquire higher levels of academic achievement; and enrich and enhance student learning and self-esteem by responding to their mental, social, physical, spiritual, and cultural needs."

1.2 Values and Goals

As a National Indian Community College, SIPI adheres to the following values and goals within its structure, policies and practices: (Source: SIPI Strategic Plan 2002-2010)

- *Respect for tribal sovereignty, self-determination, self-governance, and recognition of treaty obligations.* The college is cognizant of the existence of Indian Nations as sovereign nations with the inherent right of self-determination and self-governance. The goals of the college are accomplished within this scope through collaborative partnerships with tribal entities.
- *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.
- *Respect for Diversity.* The college values and supports diversity within its structure and within the individuals and communities that are served.
- *Holistic Approaches.* The college provides a holistic learning environment for students 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.
- *Promote Enhancement and Excellence for all American Indians.* The college fosters partnerships with other organizations and consortiums that promote educational access, enhancement and excellence for all American Indian and Alaskan Natives.

Science and Technology Building main entrance

1.3 Academic Programs

Advanced Technology Education

- Electronics Technologies (AAS Degree & Certificate Program)
- Manufacturing Technology (AAS Degree)
- Civil Engineering (AAS Degree & Certificate Program)
- Geo-spatial Information Technologies (AAS Degree & Certificate Program)
- Natural Resources Management/Environmental Science/Crops & Soil Science/Agribusiness (AAS Degree & Certificate Program)

Applied Vocational Technologies

- Culinary Arts (AAS Degree & Certificate Program)
- Hospitality Management (AAS Degree)
- Commercial Offset & Pre-press (AAS Degree & Certificate Program)
- Vision Care Technology (AAS Degree & Certificate Program)

Business Technologies

- Accounting (AAS Degree & Certificate Program)
- Business Administration (AS Degree, AAS Degree & Certificate Program)
- Computer Science, Information Systems (AS Degree)
- Network Management (AAS Degree & Certificate Program)

- Office Information Applications (AAS Degree & Certificate Program)
- Business Administration with emphasis in Tribal Administration (AAS Degree)

Liberal Arts (AA Degree)
Early Childhood Education (AA Degree)
Adult Development Education
GED

Advanced Technology Education Department

ATE Department at SIPI consists of 5 science programs: Geo-spatial Information Technologies, Environmental Science, Natural Resources, Engineering, and Electronics. In addition, the Computer Science Information Systems and Network Management programs are housed within ATE. Each of these programs grants a two-year Associates Degree in Applied Science (A.A.S.). Program emphases are listed below; more complete program descriptions are in a following section:

- Geo-spatial Information Technology
- Natural Resources
    - Forestry Range and Wildlife Management; Crop and Soil Science
- Environmental Science
- Electronics
    - Electronics Technology; Manufacturing Technology
- Engineering
    - Civil Engineering;
- Business Computer Science
    - Computer Science Information Systems; Network Management

PRE-ENGINEERING

Pre-Engineering consists of the Pre-Engineering Associate of Science and the Computer Aided Drafting and Design Certification Programs. The Pre-Engineering Program offers an Associate of Science degree in Pre-Engineering. The Computer Aided Design Certification Program offers a Certificate of Completion in Computer Aided Design.

THE PRE-ENGINEERING PROGRAM

The Pre-Engineering Program provides the technical, mathematics, science, and general education courses required in the first two years of most university four-year degree engineering programs. The Associate of Science Degree in Pre-Engineering is a program of study requiring a suggested minimum of five trimesters to satisfy the requirements of the program. The technical course requirements of 28 credit hours are theory and lab courses designed to prepare students for careers as Engineers. A minimum of 15 credit hours of required technical electives are chosen by the student in consultation with an Academic Advisor, depending on the student's area of engineering interest. The offered electives are applicable to several engineering disciplines including Civil Engineering,

Mechanical Engineering, Electrical Engineering, and Computer Engineering. The curriculum is fully transferable for those wishing to pursue a four-year baccalaureate degree at a university. For students requiring additional preparation, an initial enrichment year is also provided.

The Pre-Engineering Program Goals Statement:

The Pre-Engineering program strives to equip students with necessary skills in math, physics, chemistry, computer aided design, and lower division engineering courses. These skills prepare students to apply the learned theoretical foundations and skills of their discipline to solve practical engineering problems by using existing technology knowledgeably, confidently, and effectively.

The Pre-Engineering Outcome Objectives are:

- Be able to communicate analytical theory and problem solutions effectively in both oral and written form.
- Be able to use general mathematical, engineering and physical concepts.
- Be able to use common engineering instrumentation to test and measure phenomena and then to analyze the resulting data.
- Be prepared to continue in a Bachelor of Science Engineering or Engineering Technology degree program.

Control-Automation-and Robotics Laboratory at SIPI

1.5 Environmental Sciences Program

The Environmental Science program at SIPI was developed to provide tribal communities and the national labor force with well-trained environmental technicians and covers a wide variety of contemporary environmental topics, including water and air pollution, environmental chemistry, biological remediation techniques, renewable/alternative energy development and environmental monitoring and safety issues.

The program places emphasis on tribal, regional and global environmental concerns and includes a combined practicum course and an internship, encouraging students to address specific environmental issues of interest to them and their communities. Through awareness of environmental impacts, energy production and usage and pollution prevention, students can begin to objectively address the hurdles that lie before us in the areas of resource allocation, use and recovery.

2. EDUCATIONAL PROGRAMS IN SUSTAINABILITY

2.1 Tribal Energy Program

Under a cooperative agreement developed about 4 years ago with DOE' Tribal Energy Program, SIPI has been developing a curriculum in renewable energy and the environment. As a part of this agreement, DOE provided funds to alter existing facilities at SIPI including a number of photovoltaic, wind, solar- thermal hot air and solar-thermal hot water systems.

Two decisions have had great impact on the evolution of this curriculum. The main theme for the course has been to develop the capability of the Tribes to make informed decisions regarding energy and other resource uses. The facilities and equipment on campus are used as tools to develop understanding infrastructure modifications. Economics are looked at from both capital and recurring cost perspectives. But it is the development of the critical thinking skills using these ideas that are critical to our students' effectiveness.

The most significant part of the evolution has been to see the SIPI campus as a model community. Each class performs analyses on different aspects of this community, from waste and resource management to detailed energy and cost analysis. Partnering with the local utility, PNM, and a Native-owned industrial partner, Sacred Power Corp, SIPI students have been able to develop detailed performance characteristics of the entire campus broken down to individual buildings and activities. This, more than anything else, provides an incentive for student participation.

The community context is the cornerstone used at SIPI to build a sustainable future and for curriculum expansion. We are attempting to enhance the curriculum through a program of Service Education (with our students) and community development with Tribal community partners, rather than changing/expanding the content.

Visually integrated PV array and shade structure

2.2 Introduction to Renewable Energy and Lab

The Introduction to Renewable Energy course provides an introduction to electricity and an overview of various renewable energy technologies compared to existing conventional power systems. The basic physics of energy conversion will be covered along with power conditioning and storage, system sizing, and power economics. Technologies presented in the course include passive and active solar thermal, photovoltaic (PV), wind turbines, small-scale hydropower generation, biomass, geothermal, and fuel cells. The SIPI campus renewable energy installations are integrated into modules on Resource Assessment, System Design, and Long-Term Benefits. Upon completion of this course, the student will have a firm understanding of PV theory, DC electrical energy production from PV modules and wind turbines, inversion of DC to AC electrical energy, and DC electrical energy storage.

The target population for this introductory renewable energy technology course is any SIPI student interested in acquiring a more thorough understanding of RET systems for any of the following reasons:

- Provide irrigation on family ranch/farm
- Create private system on one's own home
- Create private system on the home of a family member
- Securing internship position or future professional employment within the renewable energy industry private sector
- Future professional employment within a tribal utility authority
- Supplemental knowledge and skill in addition to one's primary discipline

This course is designed to provide the student with an understanding of the fundamental principles of electricity and renewable energy technologies along with intensive reinforcement through lab coursework. In this course, the theoretical concepts of basic energy conversion will be explored with special emphasis on specific renewable energy applications and integrated renewable energy systems. Students are required to provide written and oral descriptions of their work to the class. The format includes individual, team, and class discussions and exercises. Classroom presentation will be through lecture, audio/visual aids, and hands-on interactive demonstrations. Monitoring of the student's progress and comprehension will be through standard testing procedures, with major evaluations at mid-term and trimester-end (final).

Equipment/Materials

Portable PV system
Grid-inter-tied PV system
Load-direct PV water pumping systems
Solar water heating systems
Solar space heating system
Stand-alone wind energy generator

Unit #	Unit Title/Description
1.	INTRODUCTION TO ELECTRICITY
2.	ENERGY AND THE ENVIRONMENT
3.	RESOURCE ASSESSMENT
4.	SYSTEM DESIGN
5.	SYSTEM SUSTAINABILITY
6.	LONG-TERM BENEFITS

Students inspecting the SIPI Solar Pump

SIPI Students working on the SIPI solar golf cart

SIPI Solar water pump system

2.3 Tribal Entrepreneurs in Manufacturing Technologies (2 + 1 Program)

SIPI is developing a new program of Manufacturing Technology with an emphasis on Small Business Administration Entrepreneurship. The students will finish the program of study of the two-year MT program and receive an AAS degree. During the third year at SIPI, students will take courses from SIPI Business Distraction program to satisfy the requirements for a second AAS degree in Small Business Administration (SBA). The general education requirements for the SBA is identical to the one for an AAS degree in Manufacturing Technology, therefore could be transferred to satisfy the AAS degree requirements at SIPI Business Department.

This program, which will be called 2 + 1 MT/SBA program, is similar to the 3 + 2 program at the UNM Anderson School of Management. The 3 + 2 program combines a bachelor in engineering programs with an MBA degree in business administration.
A new proposed program at SIPI will link the Small Business Native American Entrepreneurs initiative and the Advanced Technology Education programs. The students will be trained in the development of a technology-based entrepreneurship business plan, management and administration of technology-based manufacturing, financing and

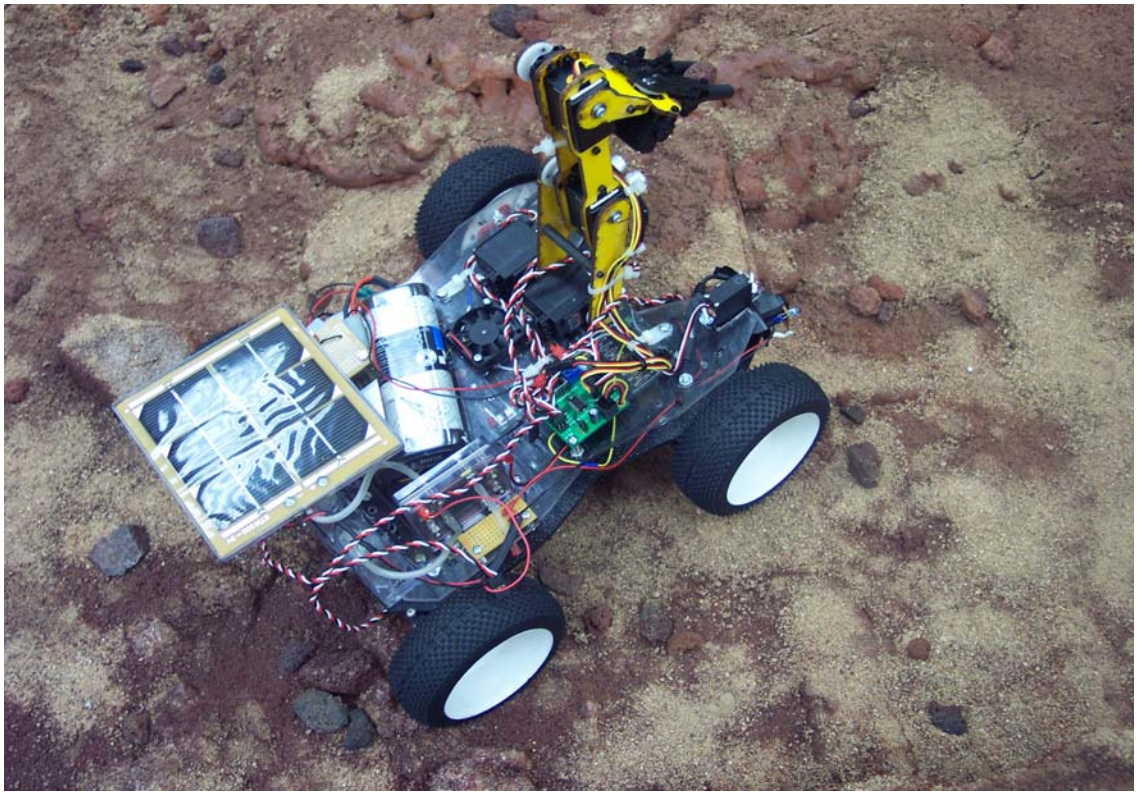
accounting systems. During the third year of the MT/SBA program of study, the students will be assisted to develop a feasible technology-based small business on tribal lands and the Indian country. The students will be assisted to find tribal investors and/or secure business loans from government and private minority small business entities. The technology-based small business entities could include but not limited to environmental technologies, renewable energy systems, power distribution systems, IT technology, computer networks, solar panels, classroom educational kits, and educational technologies. The program will be able to graduate 20 students per year.

3. RESEARCH IN RENEWABLE ENERGY SOURCES, ROBOTICS, TELE-PRESENCE AREAS

3.1 Mobile Robot Platforms with Renewable Energy Sources

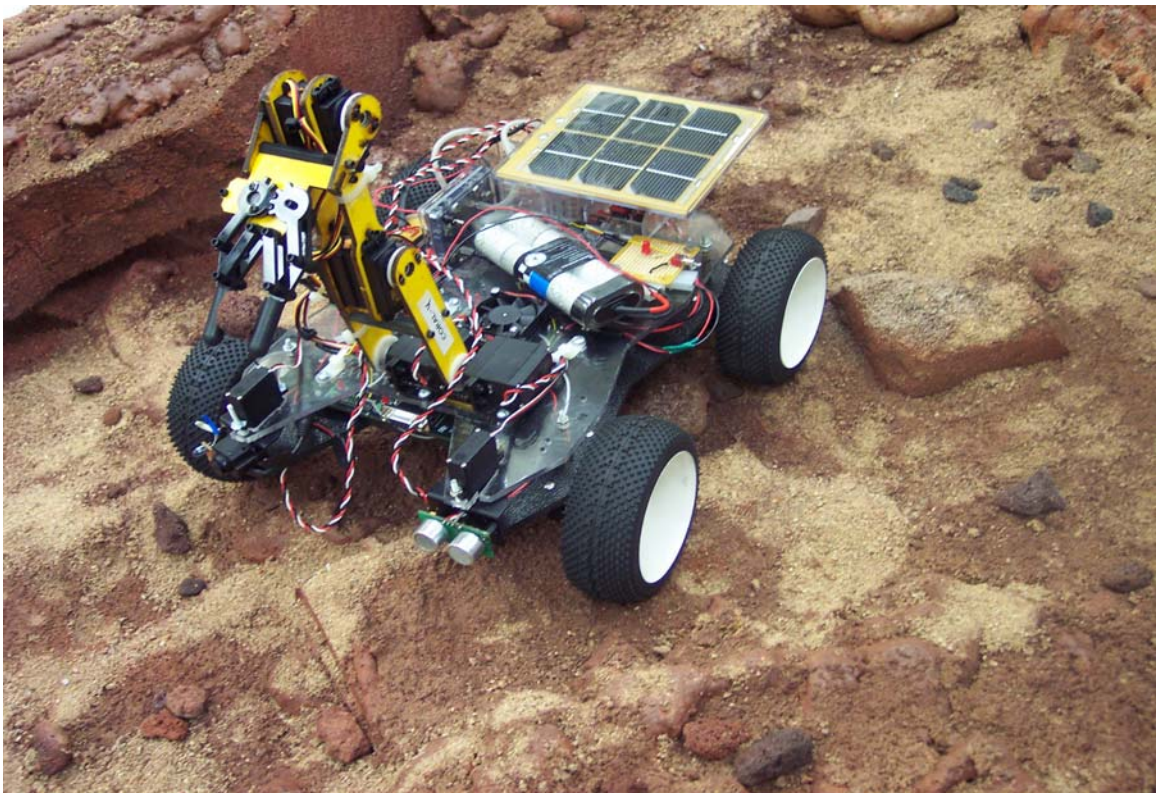
Hydrogen fuel cells have yielded promising test results for the use in exploration robots. Solar power is utilized to provide electricity for electrolysis, which produces hydrogen and oxygen. Through reverse electrolysis, water and energy is created. The energy provided through reverse electrolysis can be utilized for sensors and other systems aboard the robot.

The goal of the alternative energy project is to design and build a hydrogen fuel cell that can be used on an all terrain robot to provide power to sensors and onboard systems.



Dual power CORAL V (Solar + Fuel Cell) rover on a Mars yard

Approach: We obtained our fuel cell from a hydrogen fuel cell kit due to the fact that large hydrogen fuel cells are not yet available on the commercial market. We used a Thames & Kosmos Hydrogen fuel cell kit. The kit consists of a fuel cell attached to a plastic car chassis with two tanks for hydrogen and oxygen attached to the back. When placed under sunlight (or other light source) electricity runs from the solar panel to the fuel cell and car motor. As electricity passes through the fuel cell electrolysis occurs and hydrogen and oxygen are stored in their respective tanks. When the level of light is no longer sufficient to support the motor and fuel cells reverse electrolysis occurs. Hydrogen and oxygen flow from their respective tanks into the fuel cell. The two gases combine in the fuel cell, producing water and electricity. Electricity from the reverse electrolysis can be used to power sensors or to supplement the main power source for the system.



CORAL-V rover on a laboratory scale Mars yard

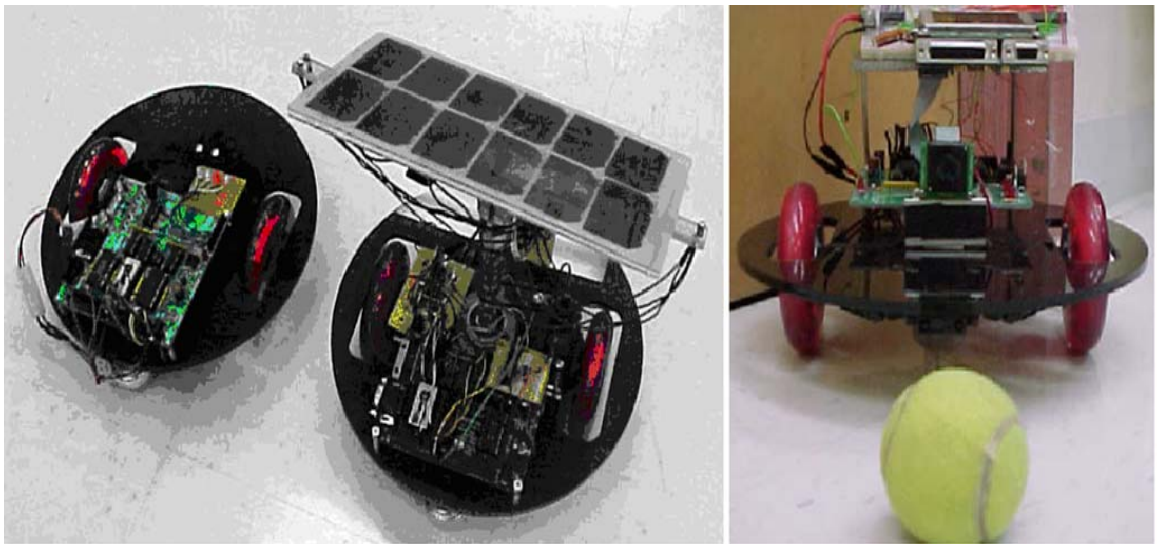
The fuel cell and gas tanks will be retrofitted on the robot to help provide an alternative power source while minimizing the amount of weight added to the robot due to the fuel cell system.

We are hoping to design and build a system that uses a capacitor to store a charge from the solar panel. This will help increase efficiency of the fuel cell. Hopefully future

students will be able to use our project to design a robotic system that uses only a renewable energy source.

3.2 Heat Islands and Urban Sprawl research

Denise Chavez, the SIPI Geo-spatial Information Technology program coordinator is studying the effects of heat islands and urban sprawl on water consumption and vegetation.



Roadrunner 2.0 with 1) sun-tracking solar panel and 2) machine vision "science payloads"

GUI using wireless connectivity or Internet with LabView Interface for the control of several mobile robots

5. CONTACT INFORMATION

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