Engineering Studies at Tribal Colleges and Universities

Letter Report from the Steering Committee for Engineering Studies at the Tribal Colleges,National Academy of Engineering

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OF THE NATIONAL ACADEMIES

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This report has been reviewed by individuals chosen for their diverse perspectives and expertise, in accordance with procedures approved by the National Academy of Engineering (NAE). The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NAE in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Lance Davis, NAE Executive Officer. He, appointed by the NAE, was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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1
Statement of Work

The National Academy of Engineering (NAE) will conduct a two-day workshop under the sponsorship of the dean of engineering, Salish Kootenai College, a tribally controlled college located in Pablo, Montana. The purpose of the workshop is to provide expert, objective, independent advice to 11 tribal colleges that are working together to offer engineering programs. The workshop will provide advice for the initiation, development, implementation, and sustainment of engineering programs at these colleges.

The NAE president will appoint an ad hoc committee of no more than six people to manage, guide, and report on the proceedings of a workshop of approximately 20 invited experts. The workshop invitees will be provided with available documentation and informational presentations, as required. The final product of this workshop will be a letter report to the sponsor that responds to the following questions[1]:

1. What do Native Americans bring to the practice of engineering that is unique?
2. What does it mean to incorporate cultural relevance into engineering studies?
3. How can Native American cultures be incorporated into modern engineering curricula?
4. What are the most effective ways to attract Native American students to engineering studies, to retain these students, and to motivate them to obtain advanced degrees?
5. What are the most effective ways to motivate them to follow careers in engineering?
6. What can tribal colleges do for their Native American constituencies that existing mainstream institutions cannot do?
7. Is there an educational advantage to student and faculty exchange programs between tribal colleges and mainstream institutions?
8. What is the most appropriate model for initiating, developing, implementing, and sustaining engineering studies at the tribal colleges?
9. How can engineering studies be implemented so that a process for continuous improvement becomes an integral part of the model?
10. What financial strategies will enable tribal colleges to sustain engineering programs in the long term?
11. What are the most effective methodologies for teaching engineering at the tribal colleges in order to meet the needs of Native American constituencies?
12. How can these methodologies be applied to instill the concept of lifelong learning in the student?

The committee's final letter report is intended to be used as a roadmap for initiating, developing, implementing, and sustaining courses, course sequences, and pre-engineering and

[1] Questions 2 and 3 in the Statement of Work were combined to form Question 2 in the report; Questions 4 and 5 were combined to form Question 3 in the report.

engineering degree curricula at the partner tribal colleges. The letter report may make recommendations for further workshops and formal NAE studies, as appropriate.

The National Academies has developed interim policies and procedures to implement Section 15 of the Federal Advisory Committee Act, 5 U.S.C. App. § 15. Section 15 includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the National Academies, through a committee, provides advice or recommendations to a federal agency. In accordance with Section 15 of FACA, the National Academies shall submit to the government sponsor(s) following delivery of each applicable report a certification that the policies and procedures of the National Academies that implement Section 15 of FACA have been substantially complied with in the performance of the contract/grant/cooperative agreement with respect to the applicable report.

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2
Introduction

BACKGROUND[2]

In the summer of 2002, the leadership of the All Nations Louis Stokes Alliance for Minority Participation (ANLSAMP) requested that the director of the National Aeronautics and Space Administration (NASA) Johnson Space Center "loan" a senior engineer to serve as dean of engineering at Salish Kootenai College (SKC)—a tribally controlled college in Pablo, Montana. The engineer would serve a two-year term with the goal of developing culturally relevant programs to enable American Indian students to proceed from pre-curriculum preparation through a fully accredited bachelor of science (B.S.) degree in engineering while attending tribal colleges and universities (TCUs).

The plan was presented to the ANLSAMP Governing Board in October 2002, and a draft prospectus was developed in February 2003 at the invitation of the National Science Foundation (NSF). In April 2003, an invitation to participate in a working group to develop, implement, and sustain engineering studies at TCUs was circulated to all TCUs in the United States by the dean of engineering, Indigenous Math and Science Institute, SKC. Eleven TCUs responded to the invitation (about one-third of the TCUs at the time): Blackfeet Community College, Montana; Chief Dull Knife College, Montana; College of the Menominee Nation, Wisconsin; Crownpoint Institute of Technology, New Mexico; Fort Berthold Community College, North Dakota; Haskell Indian Nations University, Kansas; Salish Kootenai College (SKC), Montana; Sitting Bull College, North Dakota; Southwestern Indian Polytechnic Institute (SIPI), New Mexico; United Tribes Technical College, North Dakota; and White Earth Tribal and Community College, Minnesota. These 11 TCUs formed an informal partnership in June 2003.

The group submitted a prospectus to NSF in June 2003. The partners agreed to form a working group in March 2004 and unanimously approved the first draft of a management plan (Appendix I) and the following program, to be achieved within five years of approval of the management plan:

- At least one program at a partner college would offer a complete B.S. degree in engineering.
- At least two additional programs would be in the planning stages.
- At least two additional partner colleges would offer associate degree programs in engineering.

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[2] The material in this section of the report was derived from the "Management Plan of the Tribal College Working Group" dated December 2004. Since the workshop, but prior to the dissemination of this report, the "Management Plan" and "Financial Needs Statement" were revised and presented to a group of federal agencies at a meeting sponsored by the White House Initiative on Tribal Colleges and Universities.

- Each partner institution would offer designated science, technology, engineering, and mathematics (STEM) courses that would support engineering studies.
- Faculties of programs that offer B.S. degrees would be actively involved in planning for accreditation by the Accreditation Board on Engineering and Technology (ABET).
- All partners would have the capability for students to enroll in STEM courses via distance education. (The partners plan to create a telecampus under the general management of Southwestern Indian Polytechnic Institute [SIPI].)

The group also developed a preliminary five-year financial-needs statement (Appendix I) related to these program goals. The working group defined the following program features and goals:

- All programs and processes must be characterized by cultural relevance, academic excellence, and continuous improvement.
- All curricula and processes must be consistent with the vision and mission statements of participating TCUs and must be approved by the respective presidents and boards of directors.
- The programs will be made culturally relevant to students by including areas in which American Indians can make unique contributions to engineering practice on their home reservations, in government, and in industry.
- The partner institutions will make use of distance education to make courses available to Alaska Natives and other students in distant locations.

In 2004, the partners presented the plan to ABET and, in July 2004, to a number of government agencies: the executive and legislative staffs of Montana and North Dakota and the White House Initiative on the Tribal Colleges and Universities (WHITCU); U.S. Department of Defense/National Security Agency (NSA); U.S. Department of Education; U.S. Department of Energy (DOE); the staff of NASA Headquarters and NASA Goddard Space Flight Center; Central Intelligence Agency; NSF; and the National Academy of Engineering (NAE).

Motivation for Establishing an Engineering Program at a TCU

Reasons for establishing a four-year engineering program at a TCU were outlined in a workshop presentation given by the former dean of engineering at SKC, who was on loan to SKC from NASA at the time the management plan was developed. They include: making it possible for American Indian students to complete a four-year engineering degree entirely within the tribal college system; reducing the high attrition rate of American Indian students who attend mainstream educational institutions; and providing an engineering program that is culturally relevant to tribal students.

ROLE OF THE NATIONAL ACADEMY OF ENGINEERING

The working group requested that NAE conduct a workshop—formally referred to by the National Academies as a consensus study—under the sponsorship of the dean of engineering at SKC for the purpose of providing expert, objective, independent advice to the working group. Funding for the workshop was provided by NSA. This letter report, the final product of the workshop, is a response to the questions in the Statement of Work.

The president of NAE, Wm. A. Wulf, appointed an ad hoc committee to conduct the study. Biographies of committee members are provided in Appendix A. The committee met three times by teleconference to carry out fact-finding activities and identify experts and representatives of relevant organizations to take part in the workshop. The workshop agenda is provided in Appendix B, and a list of invited experts is provided in Appendix C. The committee met at the conclusion of the workshop to draft the letter report.

3
Opportunities and Challenges for Tribal Colleges and Universities

The first tribal colleges were established in the late-1960s in the wake of the civil rights and the American Indian self-determination movements to increase access to higher education for young people growing up on reservations. The first tribal college was Navajo Community College, established in 1968 and funded through the Navajo Community College Act (P.L. 92-189). Since then, 36 tribal colleges have been established in 14 states in the United States. This phenomenal increase in a relatively short time reflects the strong commitment of Native communities, tribal leaders, faculty, and administrators to the unique mission of TCUs.

"Tribal colleges have a dual mission, (1) to provide excellence in education and to prepare their students for employment in the 21st century and (2) [to] provide a place where American Indian language, culture, and the traditional wisdom of the Elders are infused into the curricula and extracurricular activities" (AIHEC, 1999). A primary goal of tribal colleges is to provide higher education for American Indian students without forcing them to assimilate into mainstream white culture.

TCUs are solidly grounded in their respective Native cultures and in traditional wisdom, thus helping their students to preserve their Native identities. In 2004, 13 percent of all American Indian/Alaska Native[3] college students were enrolled in tribally controlled colleges. From 1997 to 2002, American Indian/Alaska Native enrollment in TCUs increased faster than in colleges and universities generally (32 percent vs. 16 percent) (Freeman and Fox, 2005). Enrollments of all students at TCUs have risen 110 percent since 1990 (AIHEC, 2005).

In a 1999 publication, the American Indian Higher Education Consortium (AIHEC) noted that, although TCUs are collectively called tribal colleges, they are in various stages of development and have different structures, sizes, and other characteristics. They do, however, have some common characteristics: most TCUs are less than 30 years old; most have relatively small student bodies (ranging from 109 students at White Earth Tribal College in Mahnomen, Minnesota, to 2,833 students at Diné College in Tsaile, Arizona); students are predominantly American Indian (80 percent of total enrollment in 2004); most TCUs are located on remote reservations where access to other colleges is limited; most were chartered by one or more tribes; all have open admission policies; all began as two-year institutions; all are fully accredited by regional accrediting agencies, except for a few that are currently candidates for accreditation; the majority are two-year institutions that offer associate degrees and certificates or degrees for programs of less than two years. In 2004–2005, nine TCUs offered bachelor's degrees, and two offered master's degrees (AIHEC, 2005). No TCU offers a four-year engineering degree program.

Individual TCUs have different enabling documents that affect the financial and other resources available to them. Haskell Indian Nations University and SIPI, for example, are 100

[3] National data are for both American Indians and Alaska Natives when it is not possible to separate data for each group.

percent federally funded, including faculty and staff. Two TCUs are corporations owned by tribes—United Tribes Technical College, for example, is jointly owned by five tribes. Some TCUs, such as Crownpoint Institute of Technology, are primarily vocational institutions. Tribal colleges also play a vital role in the communities they serve. They all offer basic adult education and remedial or high school equivalency programs. In addition, TCUs have become essential repositories of tribal knowledge.

TCUs are similar to other two-year educational institutions in the United States in that they provide access for local students who might not otherwise receive a postsecondary education. Most tribal college students are first-generation students, and their average age, 31.5, is well above the average age of traditional college students. About two-thirds (67 percent) are women (AIHEC, 2004), and in 2002, more than half were single parents (Freeman and Fox, 2005). Overall, 41 percent attend on a part-time basis, although this varies from 84 percent on the Chief Dull Knife campus to 15 percent at the three federally chartered colleges.

OPPORTUNITIES

Diversity of Cultural and Social Perspectives

NAE, the American Association for the Advancement of Science, and engineering professional societies and stakeholder groups have all advocated increasing diversity in the U.S. engineering workforce, arguing that the paucity of women and underrepresented minorities in U.S. engineering classrooms, research laboratories, design studios, and corporate boardrooms diminishes the range of perspectives and the diversity of ideas/solutions available to the engineering profession (AAES, 2005; ASCE, 2005; ASEE, 2005; Malcolm et al., 2004; NAE, 2002).

Experiences in industry and classrooms have shown that creativity increases and the range of potential solutions is expanded when teams of individuals from different personal, cultural, and disciplinary perspectives work together (Bassett-Jones, 2005; Cowan, 1995; Cox, 1993; Jackson, 1992; McLeod et al., 1996; Watson et al., 1993). In 2001, only 255 of 59,142 (less than 1 percent) of B.S. degrees in engineering were awarded to American Indian students (NSF, 2004). The engineering profession needs the perspectives of American Indians, a diverse group that encompasses 562 federally recognized tribes in the United States, and reservations need the culturally relevant contributions of American Indian engineers.

A Young Population with Rising Levels of Educational Attainment

Following a period of major reductions in numbers in the nineteenth century, the American Indian/Alaska Native population grew rapidly, from about 237,000 in 1900 to 4.1 million, or about 1.5 percent of the total U.S. population, by April 1, 2000—a much higher rate of growth than for the U.S. population as a whole (Babco, 2003). In addition, the American Indian/Alaska Native population—one-third of which is under the age of 18—has a higher concentration of people under the age of 24 than the overall U.S. population.

New data from the 2000 census show that from 1990 to 2000, the percentage of American Indian/Alaska Natives 25 years and older that had completed high school increased from almost 66 percent to 71 percent—a higher rate of high school completion than for Hispanics (52.4 percent) but lower than for the total population (80.4 percent). The higher rate of high school completion, coupled with the large proportion of individuals under the age of 18, suggests that an increasing number of American Indian students will be eligible for college in the near future. In addition, the aspirations of Native students have changed—the percentage of tenth graders who expect to complete a bachelor's degree or higher increased from 31 to 76 percent between 1980 and 2002 (NCES, 2005). Thus, it is not surprising that enrollment in tribal colleges increased 17 percent from 1997 to 2002 (Freeman and Fox, 2005).

CHALLENGES

TCUs face a number of challenges, including barriers to supporting and increasing the quality and quantity of STEM courses, recruiting and retaining students and faculty, establishing ties with other academic engineering institutions and industry, and sustaining financial viability.

Financial Challenges

The reservations on which most TCUs are located have high unemployment rates and low per capita income rates, reflecting the wide disparities between American Indians and the general U.S. population. For a three-year period (1997–1999), the poverty rate for Natives was 25.9 percent, compared to poverty rates of 23.6 percent for black Americans, 22.8 percent for Hispanics, 10.7 percent for Asians and Pacific Islanders, and 7.7 percent for non-Hispanic whites (U.S. Census Bureau, 2000). In Montana, where seven TCUs are located, unemployment rates on reservations range from 57 to 77 percent (BIA, 2005).

Common misconceptions, such as that Native students receive free educations and that Indian casinos fund tribal colleges, mask the stark reality of chronic financial underinvestment and the lack of forward funding for TCUs. In fact, fewer than one-third of federally recognized tribes in the United States have gaming operations and only a tiny percentage of Indian communities benefit from gaming; in 1999, only five TCUs received funding from gaming (AIHEC, 1999).

Whereas other public institutions of higher learning have a foundation of state support, most TCUs are located on federal trust lands; hence, states have no obligation to fund them. In most cases, states do not even provide funding for the approximately 20 percent of TCU students who are non-Natives (AIHEC, 1999).

Funding for TCUs[4] is provided through congressional appropriations, which must be negotiated every year, and because TCUs are not forward-funded, it is difficult for them to develop long-range plans. Congress first funded the Tribally Controlled College or University Assistance Act (the Tribal College Act) in fiscal year 1981, providing $2,831 per Indian student toward the day-to-day operations of the colleges covered under that act. In the 24 years since then, the number of colleges eligible for funding has risen to 27, and enrollments have increased by 353 percent (Goetz, 2005). Although Congress has authorized $6,000 per Indian student, actual funding per student in 2005 was $4,447, only 74 percent of the authorized level. In addition to the funds appropriated under the Tribal College Act, some programs at TCUs are funded through federal agencies. Information on these sources of funding is provided in Appendix E.

[4] Two separate formulas are used to determine the amounts TCUs receive—one for Diné College, the first TCU established in the United States, and one for other schools that qualify.

Quality of Facilities

Of the 11 TCUs in the working group, two schools—SKC and SIPI—appear most likely to be prepared to house a four-year engineering program, if one is initiated. The facilities of other TCUs vary widely in terms of size, age of buildings, and equipment available for STEM programs.

SKC has 14 buildings, including a $1.5-million science building that was designed and built by students enrolled in the college construction-trades training programs (Robbins, 2002). All major facilities at SKC are connected through a fiber-optic local area network, and the campus has 15 computer laboratories and more than 500 computers campus-wide.

Students at SIPI have access to state-of-the-art facilities and equipment in a science and technology building that opened in 2003, the culmination of more than 10 years of planning and fundraising. For construction of the 72,540 square-foot building, the institution received $1 million from the state of New Mexico through a general obligation bond, $1 million through the Capital Campaign under the American Indian College Fund, and $10 million from Congress through the U.S. Department of Interior, Bureau of Indian Affairs.

Recently, however, SIPI has been in the news because of a reported budget deficit of more than $1 million. Although the college receives about $5.4 million annually in federal funds, the amount has decreased slightly over the years, even as enrollment has increased. New Mexico Senator Jeff Bingaman has asked Congress for more than $410,000 to help meet some of the school's operational expenses and is working with the Bureau of Indian Affairs to find ways to close the spending gap and put the institution back on sound financial footing. College president Joseph Martin resigned in February 2005, and the acting president reportedly is not interested in applying for the job. This situation illustrates the financial vulnerability of TCUs (Armijo, 2005).

Student Readiness (Academic Preparedness)

Research shows that the strongest pre-college predictor of completion of college is a high school curriculum of high academic intensity and quality. The highest level of mathematics is the strongest predictor of completion of a bachelor's degree. Longitudinal age-cohort data show that engineering path programs must start in tenth grade, with students reading at grade level, and, at a minimum, students must be proficient beyond the Algebra 2 level (Adelman, 1999).

The National Center for Educational Statistic's National Assessment of Educational Progress (NAEP) measures student performance in reading, mathematics, science, geography, and history at the fourth- and eighth-grade levels, and, where data are available, at the twelfth-grade level. In addition to average scores, NAEP data are expressed as achievement levels—below basic, at or above basic, at or above proficient, and advanced (Freeman and Fox, 2005).

In 2003, only 16 percent of American Indian/Alaska Native fourth graders and 17 percent of eighth graders scored at or above proficient in reading, and only 17 percent of fourth graders and 15 percent of eighth graders were at or above proficient in mathematics. In addition, NAEP data show that a lower percentage of American Indian/Alaska Native students had taken advanced science and mathematics courses, such as pre-calculus, calculus and trigonometry, chemistry, physics, and advanced biology, than students of any other racial/ethnic group (Freeman and Fox, 2005).

The National Commission on Excellence in Education recommends that the core academic track for high school students include at least four courses in English, three in social studies, three in science, three in mathematics, and two in a foreign language (NCEE, 1983). The percentage of Native high school graduates who completed this level of academic coursework increased from 3 percent in 1982 to 26 percent in 2000; nevertheless, Native high school graduates were less likely to have completed the core academic track than their peers in every other racial/ethnic group—48 percent for white non-Hispanic students; 44 percent for black non-Hispanic students; 38 percent of Hispanic students; and 57 percent of Asian/Pacific Island students (Freeman and Fox, 2005).

Anecdotal data from TCU faculty and administrators include the following observations about the academic preparedness of students entering tribal colleges:

- TCUs have little control over recruitment. Only about 20 percent of entering students are really college material, especially with regard to math preparation.
- A great deal of developmental education must occur before most students are ready to transfer to a four-year engineering program.
- Many TCU students are nontraditional, typically single mothers in their 30s or older, presenting additional challenges for student success.
- No TCU can do an engineering program alone. There is a "disconnect" between the visions of engineering program planners and the capabilities of students currently enrolling in TCUs.
- TCUs that have high retention rates and whose students do well after transferring to four-year mainstream engineering programs have invested a great deal of time and resources in working with feeder high schools, running summer and weekend programs, tracking their transfer students, and providing mentors for students after they transfer.

Retention Rates for Native Students

One reason for developing engineering programs in TCUs is that the success rates of Native students at mainstream, four-year educational institutions have historically been very low. In fact, American Indian students have the lowest retention and graduation rates of any ethnic minority group in the country (AIHEC, 1999; Benjamin et al., 1993; Huffman, 1990). Only 11 percent of the cohort of Native twelfth graders in 1992 who were likely participants in post-secondary education had completed bachelor's degrees as their highest degree by 2000, compared to 34 percent of white, 24 percent of black, and 34 percent of Asian/Pacific Islander students (Freeman and Fox, 2005). A major reason posited for this poor success rate is that pedagogical approaches in majority educational institutions have not been successful with Native students (Pewewardy, 2002; Reyner, 1992).

Although systematic data on TCU students are not available, testimony presented by tribal college educators and tribal elders at the workshop indicates that American Indian students who attend TCUs are more likely to achieve their educational goals than Native students who attend mainstream institutions directly after high school. SIPI, a tribal college that has tracked retention rates, retains 80 percent of its students through each trimester; nearby mainstream colleges report dropout rates as high as 90 percent for Native students (Robbins, 2002). A study of Native students who attended SKC and then transferred to the University of Montana showed that these students earned higher grade point averages and had higher graduation rates than Native students who had entered the university directly from high school (Zaglauer, 1993).

Faculty and Staff

Recruiting and retaining faculty and staff at tribal colleges remains a challenge for several reasons: few American Indians are qualified to teach at the post-secondary level; only a limited number of non-Natives are interested in teaching in TCUs, which are geographically isolated; and average faculty salaries ($30,241 for the 1997–1998 school year) are considerably lower than salaries at majority institutions—$45,919 at two-year mainstream institutions and $52,335 at public post-secondary institutions in 1997–1998 (Youth Policy Forum, 2005).

In addition, TCUs face several other difficulties in recruiting faculty. First, because TCUs are predominantly teaching institutions, it is difficult for them to attract faculty who are interested in research. Second, the heavy teaching and counseling load of TCU faculty, along with their involvement with the tribal community and the geographic isolation of many campuses, make it difficult for faculty in TCUs to enhance their credentials. In a 2004 AIHEC survey of the faculty and staff at the "1994s" (land-grant TCUs), most respondents had bachelor's or master's degrees (Phillips, 2005). Eighty-one percent of respondents indicated that they wanted to advance their academic credentials, but many said they could not pursue graduate programs because of a lack of financial support and work-release time. The survey also found that Native faculty needed more home Internet access, personal computers, mentoring, transportation, and child care.

4
Questions Addressed in This Study

The committee was charged with addressing 12[5] questions related to the establishment of engineering studies in tribal colleges. The answers to these questions and the committee's conclusions are based on expert testimony at the workshop, a review of the literature, and interviews with key stakeholder groups.

1. What unique qualities do American Indians bring to the practice of engineering?

Tribal elders and TCU faculty and administrators who participated in the workshop observed that American Indians were the first engineers in North America, noting a number of historic American Indian structural, mechanical, and agricultural achievements involving engineering principles, mathematics, science, and technology.

Today, although their numbers are small, American Indian engineers working in all sectors of the American economy have made significant contributions to the profession and have provided role models for tribal students. For example, several American Indian engineers have made contributions to the U.S. space program, most notably Jerry Elliot, a flight mission controller who worked for 58 hours straight to bring the Apollo 13 astronauts back to Earth from a damaged space module.

Unique qualities American Indians would bring to engineering include a holistic approach to problem solving and design, a commitment to sustainability, and a preference for a team-based, collaborative work style—qualities that U.S. businesses are increasingly looking for in their technical workforces. These qualities make American Indians potentially excellent members of engineering teams. In addition, American Indians could make a significant contribution to the culture of engineering. Most important, American Indian engineers are familiar with the needs of their communities and would bring an understanding of Native cultures and values to engineering projects on reservations.

A related question is what unique advantages American Indian engineers would have in the global marketplace? American Indians have a deep respect for Earth and believe they are accountable for the stewardship of Earth's natural resources. This has led to a special emphasis in TCU STEM curricula on green engineering principles, renewable energy technologies, environmental science, and clean technologies, which would serve tribal students well both in working in their own communities and in the fields of engineering, such as environmental engineering, that incorporate these principles.

[5] Questions 2 and 3 in the Statement of Work were combined to form Question 2 in the report; Questions 4 and 5 were combined to form Question 3 in the report.

2. What does incorporating cultural relevance into engineering studies mean? How can American Indian cultures be incorporated into modern engineering curricula?[6]

Ways in which TCUs currently incorporate cultural relevance into their STEM degree programs, including pre-engineering coursework, include: (1) using Native symbols in school logos and campus designs; (2) offering, and in some cases requiring, courses on tribal culture and language—for example, students in the Oglala Lakota College pre-engineering program must earn 25 credits in core courses, 34 credits of math/science (trigonometry, calculus I–III, university level physics I–II, general chemistry I–II [with laboratory work], and a technical science elective), and 15 credits in Lakota studies; (3) involving tribal elders in classroom teaching; and (4) providing facilities that can be used for adult education, boys and girls clubs, health clinics, assistance with small business development, and programs to reduce youth violence and delinquency and strengthen families, thus keeping tribal college students in touch with the needs of their communities. Crownpoint Institute of Technology, for example, has a new family center on its campus that not only supports students with children, but also provides a wide range of services to the surrounding Navaho community.

TCUs are increasingly rethinking what incorporating cultural relevance into educational content and pedagogy means, that is, what "indigenizing" their institutions means. According to recent articles, more is involved than increasing the number of culturally based classes—more tribal history and philosophy classes, for example. TCUs must look and act less like the mainstream schools after which they were initially modeled in terms of curriculum and pedagogy.

Tribal colleges are now working in a different social and political climate—one that accepts the value of culture and talks the muscular vocabulary of maintaining tribal "sovereignty." Today's movement toward greater indigenization does not reject past approaches to learning. Rather, it builds on the foundation the colleges helped create (Boyer, 2005).

In the same article, Karen Gayton Swisher, president of Haskell Indian Nations University, an intertribal institution, discusses the critical role of tribal colleges in nation building on reservations.

3. What are the most effective ways of attracting and retaining American Indian students in engineering studies and motivating them to pursue advanced degrees? What are the most effective ways of motivating them to undertake careers in engineering?

Attracting American Indian Students

Individuals and organizations trying to attract underrepresented minority students to engineering are working against the prevailing trends, as fewer women and minority students, including American Indians, pursue engineering education. Although the number of B.S. degrees awarded in 2003 by U.S. engineering colleges increased to more than 75,000—9.3 percent more than in 2002—the percentages of women and minorities declined (EWC, 2004).

[6] Tribal representatives attending the workshop felt that the second of these questions implies that Native perspectives are incompatible with modern engineering studies and should be rephrased, omitting the word "modern."

Communicating What Engineers Do

John Brooks Slaughter (2003), president of the National Action Council for Minorities in Engineering (NACME), has observed:

> We have failed in many ways to tell the story about engineering. It is a sad reality that over the past few years too few young people, both minority and non-minority, are choosing to get on the pathway of engineering as a career pursuit. Sadder still is the fact that many of them are robbed of the option to even consider entering the field before they have left high school.

Teachers and advisors of K–12 students (including parents and tribal elders) can be critical influences in attracting children and young people to careers in engineering. First, they can provide descriptions of a wide range of engineering fields so that children understand what engineers do and can relate engineering to creating, helping, and sustaining their communities. Second, they can provide culturally relevant role models by inviting American Indian engineers and engineering students into the classroom to talk to students and illustrate engineering concepts through age-appropriate games and experiments. Third, they can make use of culturally relevant resources provided by organizations, such as American Indian Science and Engineering Society and the Society for the Advancement of Chicanos and American Indians in Science.

Because tribal elders are so important to Native communities, they could also be effective in informing K–12 students about how engineering training and skills can help their communities. This might require designing workshops to educate tribal elders about the broad range of engineering disciplines and environments in which engineers work.

Academic Preparation

Programs for all minority students that have been shown to increase the likelihood that students in STEM majors will continue their studies share the following features (Campbell and Hoey, 1999):

- They work with teachers and parents, as well as children.
- Teachers have high expectations of students.
- Courses are rigorous, and academic support is provided.
- Resources are available to help students get into college, such as SAT preparation, visits to colleges, information on financial aid, and financial support for taking fee-based exams.
- They provide hands-on learning. NAEP science achievement scores were higher for nine-year-olds who used equipment like meter sticks, scales, and compasses in class (Campbell et al., 2002). In general, students who had participated in hands-on learning activities outperformed other eighth-grade students on the NAEP mathematics test (Wenglinsky, 2000). Achievement differences between white and Native students were smaller for students who had participated in a hands-on, outdoor-based science curriculum (Zwick and Miller, 1996). Programs for pre-college girls that combine hands-on activities and role models through mentoring, internships, and field trips tend to make girls feel more self-confident and more interested in STEM courses and careers

and break down sexist attitudes toward these fields (Campbell and Steinbrueck, 1996; Clewell and Darke, 2000).

- Students have access to computers. NAEP mathematics achievement scores were higher for 17-year-olds who had access to computers while learning mathematical principles and solving mathematical problems than for those who had no access to computers.

TCUs are faced with the formidable task of working with K–12 systems on their reservations to develop prerequisites—engagement, capacity, and continuity—for student success in the sciences and quantitative disciplines (Jolly et al., 2004). Piquing students' interest (engagement), ensuring that they have the necessary knowledge and skills to succeed (capacity), and providing ongoing, progressive lessons and classes in science and quantitative disciplines (continuity) are all essential factors of student success.

Anecdotal information gathered from conversations with TCU faculty and administrators indicates that personal relationships with other students, teachers, and counselors in tribal high schools are critical to improving the academic preparedness of the students who might be recruited to TCU programs. TCUs that provide summer programs and weekend academies have as long as four years to work with students, parents, and communities and to bring them onto TCU campuses to provide opportunities for them to interact with faculty and other students. All of these efforts can increase the likelihood that students will come to college better prepared to undertake STEM and other coursework.

TCUs are uniquely positioned to teach students about the relevance of engineering to their lives and their communities. Demonstrating how engineering can improve the quality of life for American Indians (e.g., relating engineering to nation building) could motivate students to pursue engineering careers in their tribal communities and, perhaps, elsewhere.

Outreach Programs

National outreach programs to K–12 teachers and students that focus on academic excellence in the STEM disciplines have also been shown to improve student educational outcomes (MESA, 2005). The Mathematics, Engineering, Science Achievement (MESA) Program is a college preparation program intended to increase the number of college bound students from ethnic minorities and low-income families, as well as first-generation college students, who are eligible to enter a degree program at a college or university. As members of MESA, middle school and high school students participate in hands-on activities related to mathematics, engineering, and science, as well as college-preparation workshops that build strong academic skills and inform students about college and career opportunities. In addition, MESA provides individual academic guidance and student evaluations throughout the school year, promotes life skills, provides information for parents, advises parents and students about financial aid, provides role models from institutions of higher education and the business community, and sponsors special events, such as competitions, campus visits, and field trips.

The MESA Success Through Collaboration (STC) Program, which specifically targets American Indian students—especially students living in remote areas—works collaboratively with American Indian education centers, departments of education, individual educators, and industry. MESA STC is located at more than 10 sites around the country, including several that serve students from reservations (MESA STC, 2005). Unfortunately, the MESA STC Program in California was eliminated at the end of 2004 because of state budget cuts.

An example of a MESA STC activity is the Canoes Institute—a five-day retreat featuring an interdisciplinary curriculum for fourth-, fifth-, and sixth-grade teachers that focuses on the traditional canoes of Washington state. In this culturally based curriculum, the emphasis is on mathematics and science with supplementary instruction in language arts and health education; the curriculum is aligned with essential academic learning requirements. The Canoes Institute demonstrates how a cultural tradition can provide a rich foundation for classroom learning.

Retaining American Indian Students in Engineering

Although the number of American Indian students enrolled in colleges and universities has increased dramatically in recent years, the lack of persistence, low graduation rates, and low overall academic success rates of these students are matters of great concern (AIHEC, 1999). It has long been known that many American Indian students attending mainstream institutions of higher learning encounter difficulties (Astin et al., 1996; Pavel et al., 1994; Swisher, 1990). Barriers that inhibit educational achievement cited in the literature include poor academic preparation, poor motivation, irrelevant educational practices, insufficient parental support, social-psychological frustrations manifested in low self-esteem, and inadequate financial support (Falk and Aiket, 1984; Lin, 1985).

A lack of financial resources has been consistently identified as a major factor in the attrition rate of students of color in STEM majors (Mohrman, 1987; Mortenson, 1995; Rodriguez, 1993; Rotberg, 1990). In addition, family responsibilities, which are more common among minority students than white students, frequently create conflicts with academic commitments (Rodriguez, 1993; Tinto, 1993).

Several approaches have been shown to reduce the attrition rate of minority students:

- College and career orientations—extended orientation programs, including intensive pre-enrollment, on-campus experiences and continuing first-year advising programs—have been shown to increase retention for all students; however, the impact is greater for African American and Hispanic students (Erickson and Strommer, 1991).
- The NSF Research Experiences for Undergraduates (REU) Program encourages students to pursue careers in mathematics, engineering, technology, and science. REU participants are more likely than non-REU undergraduates to attend graduate school in quantitative disciplines and sciences (Lewis, 1991).
- Enrichment programs using field-related materials run by engineering and science departments for undifferentiated student groups are particularly effective for students from underrepresented minorities and women because these programs are not stigmatized as remedial or for minorities only (Bonsangue and Drew, 1995; Seymour and Hewitt, 1997).

Cultural conflict is the most frequently identified contributor to poor academic achievement and attrition among Native students (Carney, 1999; Hornett, 1989; Huffman, 1995; Lin et al., 1988; Scott, 1986; Swisher and Deyhle, 1989). Cultural isolation, alienation from the dominant students and faculty, and cultural conflict all contribute to limited access and poor academic achievement of Native American students, who often feel they have to choose between maintaining their "Indianness" and adopting the dominant culture (Huffman, 1995).

Another form of cultural incompatibility is the lack of relevance of the curriculum (Lippit and Romero, 1992). Some difficulties experienced by American Indian students can be traced to curricula that do not use examples or put problems in contexts that are relevant and meaningful to American Indian learners (Cole and Denzine, 2002).

Seymour and Hewitt examined the undergraduate experiences of non-minority and minority students, including American Indian students. The authors found that the problems of minority students that were not shared by white males could be traced to conflicts between cultural values, family roles, educational socialization, community obligations, and career expectations on the one hand and the values and demands of college science and engineering on the other. The authors argue that unless broad programs that provide "minority support" (including advising and mentoring) are based on the needs and perspectives of particular student groups, they do not improve retention rates. Helping students confront and resolve these conflicts requires culturally specific understanding (Seymour and Hewitt, 1997).

An American Indian student who was interviewed for the study illustrates these problems, especially the difficulty of attending a school far from family and the reservation community (Seymour and Hewitt, 1997):

> Speaking from my traditional background, you have to sacrifice many things from that tradition in order to come to school, to get an education. That's a big problem for me. It feels the longer I stay here, the more I'm being cut off from those ties. That's why I want to return after I graduate; to go back to get in touch with what I may, or may not, have lost.

The authors' conclusions about why some students survive provide further insight into the cultural barriers encountered by American Indian students attending mainstream schools (Seymour and Hewitt, 1997):

> The survival of some students, but not others, despite similar problems, depends partly on their acquisition of particular attitudes and strategies. Whether they find sufficient academic and personal support (from institutional, faculty, peer, and other sources) to sustain their motivation and morale is critical. Their interest in the discipline must also be strong enough to survive a pedagogical style dictated by weed-out objectives. Students must develop a perspective which sufficiently insulates them from loss of self-confidence.

Cultural conflicts are not always severe enough to cause American Indian students to drop out. Some find ways to accommodate mainstream perspectives without letting go of their traditional ways. An American Indian participant in the workshop explained that he accomplished this by thinking of his development as a series of "concentric circles." The widening ring of circles represented "new perspectives and experiences added to the core values and experiences of my tribal upbringing." He said he came to the realization that he did not have to choose between the two, that education was an additive process that "kept my core culture intact."

Providing options for tribal students to complete a four-year engineering degree entirely within the TCU system would give students an undergraduate experience that does not force them to choose between academic success and cultural norms and values. A TCU-based engineering program is one of several approaches to accomplishing this goal.

Motivating American Indian Students to Pursue Advanced Degrees and Careers in Engineering

The committee did not find any research that could provide systematic, quantitative data on the educational trajectories of American Indian students to identify the key factors in persistence to advanced degrees. The testimony of workshop participants suggested that Native American students would be more likely to work toward advanced degrees if their undergraduate experiences were improved.

Research is available that shows that the decision to seek an advanced degree in engineering appears to be related to students having an opportunity to do research as undergraduates (Seymour and Hewitt, 1997). Hands-on summer research programs, internships, and cooperative programs provide students with a practical idea of what engineers do and generate interest in engineering fields to which undergraduate students may not be exposed; in addition, research provides role models and mentors. Two-year TCU Associate of Sciences (AS) programs may not provide these kinds of experiences now, but they could provide them through partnerships with four-year institutions and/or industry.

4. What can tribal colleges offer American Indian constituencies that existing mainstream institutions cannot?

TCUs offer culturally responsive education that includes: cultural literacy; self-reflective analysis of attitudes and beliefs; caring, trusting, and inclusive classrooms; respect for diversity; and a transformative curriculum that engenders meaning. These qualities are particularly important for educating children raised on reservations and others with strong links to tribal communities. TCUs also offer place-based education—programs that explicitly connect students with indigenous knowledge and ways of knowing and help them discover the relationship of this knowledge to modern sciences and social studies (Lipka et al., 1998; Sorensen, 2002).

According to Rebecca Robbins, a Standing Rock Sioux and author of *Tribal College and University Profiles* (2002):

> TCUs are unique institutions that combine personal attention with cultural relevance, in such a way as to encourage American Indians—especially those living on reservations—to overcome the barriers they face to higher education. The common goal of TCUs is to create a positive, student-centered environment that fosters self-confidence and success.

TCUs provide an environment where Native students do not face the cultural conflicts they frequently encounter in mainstream schools. For example, the mission statement of Lac Courte Oreilles Ojibwa Community College in Hayward, Wisconsin, begins with the words, “For the first time, we do not have to make the painful choice between one culture and the other.”

Research shows that all minority students need more peers, faculty role models, and mentors (Pewewardy, 2002). Most tribal colleges are located on reservations where students have access to tribal elders, American Indian faculty and staff, and family members who keep them in touch with tribal values, knowledge, ceremonies, and community needs. Reinforcing self-esteem, as it is understood in Native cultures, is one purpose of role models and mentoring for tribal students.

TCUs also try to encourage resilience in their students—adaptation and transformation despite risk and adversity. Traditionally, resilience has been cultivated by focusing on four developmental areas: (1) spirituality—living according to the belief that all things are interrelated; (2) mental well-being—having clear thoughts; (3) emotional well-being—balancing all emotions; and (4) physical well-being—attending to the physical self (Bergstrom et al., 2003). Thus, TCUs recognize, and take advantage of, tribal students' ways of learning.

5. Do student and faculty exchange programs between tribal colleges and mainstream institutions, *industry, and federal agencies* give students an educational advantage? (italics show wording added by the committee.)

Historically, the lack of financial resources and the lack of release time have been barriers to faculty exchanges between TCUs and mainstream institutions and/or industry. TCU faculties tend to have heavy teaching loads and few, if any, opportunities to engage in research. Exchanges could provide TCU faculty with research opportunities at four-year institutions and industry partners. Student exchanges would provide research opportunities for TCU students. Exchanges could also bring faculty with specialized expertise to TCU campuses. Loaned faculty, administrators, industry personnel, and engineers from federal agencies could provide expertise for capacity building, which will be necessary for the development of a four-year engineering program.

TCU students would benefit from internships in industry and government agencies and from industry cooperative programs. Students from mainstream institutions would benefit from exposure to the TCU model of teaching and learning, especially if the program included courses that are not usually available in their own schools (e.g., green engineering) or work/study experiences on a reservation. It is not clear if TCUs would benefit from hosting undergraduate exchange students from mainstream institutions, but engineering graduate students would provide needed expertise and increase opportunities for TCU students to gain research experience.

Exchanges and partnerships with other academic institutions would also provide opportunities for TCU faculty to improve their credentials. Several programs that have been developed to provide TCU faculty might be scaled up to address the TCU-wide need for faculty professional development (Phillips, 2005):

- South Dakota State University offers a "Prairie Ph.D." to TCU faculty and staff that combines distance learning with intensive on-site sessions.
- Texas A&M and Texas Institute of Technology have a "Doc@Distance" Program that offers courses delivered via the Web, interactive television, and face-to-face meetings.
- The U.S. Department of Agriculture funds a collaboration—the Great Plains Interactive Distance Education Alliance—that offers an online master's program in community development with a specialization track in American Indian communities.

Anecdotal information from discussions with TCU faculty and administrators emphasize the need for TCUs to find the "right" mainstream partner institution—an educational institution interested in reaching out to TCUs and establishing a reciprocal relationship. TCUs do not want to be solely on the receiving end of partnerships with mainstream institutions, although initially this may be unavoidable. Turtle Mountain Community College (TMCC), for example, hires graduate students from North Dakota State University (NDSU) writing theses to qualify to teach part-time; some of these students have decided to stay on as full-time faculty after they finished their degrees. TMCC also provides opportunities for NDSU engineering undergraduate students to learn about its green engineering projects and is discussing with the university the creation of a satellite engineering program on its campus.

With the right partner, student and faculty exchange programs clearly do give students an educational advantage by providing TCU students and faculty with access to education and research resources not available at their home institutions and assisting them in establishing social and professional relationships that can have a positive impact on their careers. These exchange programs can take the form of inter-institutional collaborations that do not require actually moving to the partner campus for extended periods of time.

6. What is the most appropriate model for the initiation, development, implementation, and sustainment of engineering studies at tribal colleges?

Revising the Management Plan

The following questions should be addressed in future iterations of the management plan:

- What kinds of outreach to tribal high schools will be necessary to prepare Native students for a four-year engineering program? Who will be responsible for outreach to high schools, and how will it be funded? A number of TCUs already have programs that focus on K–12 students and teachers. Based on these programs, best practices could be identified and scaled up as part of the planning for a TCU-based engineering program.
- Which TCU will house the first four-year engineering program? Should the selection be limited to the 11 TCUs in the working group? If federal funding is provided, an open competition among TCUs should be considered. Because the invitation to join the working group was issued by SKC, many stakeholders who provided information to the committee assumed that this is an SKC initiative and that SKC will, de facto, house the first program.
- Is a 2 + 2, 2 + 3, or 3 + 3 program the best model for TCU engineering studies?
- Which engineering degree program(s) should be offered?
- How much should the engineering program rely on distance learning?
- Can one TCU engineering program represent the interests of 34 TCUs? How can the working group gain buy-in by more TCUs for their plan?
- Do tribal leaders support this initiative? The committee heard from several stakeholder groups that there has been little participation by tribal leaders in meetings with potential funding partners.
- What partnership model, if any, should be adopted? A number of models were discussed during the workshop: TCUs working together toward a common goal; one or more TCUs forming a partnership with a federal agency; one or more TCUs forming a partnership with a mainstream academic institution—either in the region or, for limited purposes, elsewhere in the country; partnerships between a TCU and public employers; partnerships with other institutions that serve minority students; and partnerships with organizations that have a history of success in graduating minority engineers (e.g., NACME).

The questions listed above presuppose that creating a TCU-based four-year engineering program in the immediate future is the best solution, but the committee recognizes that it may not be. At the same time, the committee recognizes that there may be opportunity costs in not doing so. However, one reviewer of this report, and a great deal of anecdotal evidence collected from TCU faculty and administrators, suggests there may be greater opportunity costs for the other 33 TCUs if the plan is pursued. The reviewer, who identified him/herself as a local spiritual leader and healer, made the following comment:

> While I support some of the TCU efforts to become universities, I worry about the temptation if it means sacrificing the unique opportunity we now have in our hands. To do good and sound preparatory programs is something so very important. To have strategically located indigenous universities is also important. We can be effective preparing students in local transfer programs for engineering, science and mathematics.

He goes on to ask:

> Does being an engineer mean moving away from home, trying to become an accepted part of white society, having to face the loneliness of being too distant for too long from the centering place for your heart?

Creating an engineering program at one of the tribal colleges does not address this desire of most Indian youth to remain close to home.

Alternative Approaches

The management plan developed by the working group contemplates a four-year degree model, but alternatives are also possible, including strategies adopted by other TCUs and other minority-serving institutions, such as historically black colleges and universities (HBCUs). TMCC provides an illustration of an alternative approach.

TMCC, located in rural North Dakota near the Canadian border, has three campus sites—the original facility, located in the village of Belcourt; a 145,000 square-foot facility opened in 1999; and a land-grant facility wellness center. The college plays an important role in the life of the reservation (home to 15,000 members of the Chippewa/Ojibwa people) by supporting tribal business development through the Center for New Growth and Development and by training workers for employment in local industries and careers in professional fields. TMCC offers a B.S. in elementary education, a number of associate degrees in the arts and sciences (including A.S. degrees in computer science, engineering studies, and mathematics), and some certificate programs. A new initiative is being planned that will focus on the health sciences.

TMCC participates in the NSF Rural Systemic Initiative in Science, Mathematics, and Technology Education Program and Tribal College and University Program (TCUP). In addition, TMCC and the four other TCUs in North Dakota (Cankdeska Cikana and Fort Berthold Community Colleges, United Tribes Technical College, and Sitting Bull University) have established a strong pre-engineering/transfer program with NDSU. The partnership began in the early 1990s, when, as part of a math and science improvement program funded by DOE, an engineer from NDSU was brought to the TMCC campus.

Subsequently, TMCC and NDSU submitted a proposal to the Office of Naval Research (ONR) that brought in almost $2 million to develop a program to improve STEM education at the five reservations. The following programs were funded by the ONR grant:

- Sunday academies for high school students at seven sites linked by an interactive video network (NDSU engineering faculty, including department chairs, participate in these site-specific programs)
- a summer program for college students and a summer camp for high school students
- scholarships for TCU students, who are also mentors in the Sunday academies
- a program to bring Native engineers, medical doctors, and other professionals to speak to tribal students and faculty

These programs have been very successful. In 2004, more than 100 American Indian students were involved in STEM courses in the seven Sunday academies. In the summer of 2005, 18 TMCC students spent two weeks on the NDSU campus doing research in engineering, and 20 high school freshmen and sophomores attended the summer camp. In addition, one woman from the reservation received a B.S. in mathematics from NDSU and is currently working on a double major in civil engineering. Another woman was awarded a $20,000 scholarship from NDSU to continue her studies.

The articulation agreement between TMCC and NDSU includes a common course-numbering system, common course content, and the use of the same textbooks. TMCC has weekly contact with the NDSU engineering department, and an engineering instructor recently spent his sabbatical at TMCC. The main difference between classes at the two institutions is that TMCC courses include presentations by spiritual leaders or tribal representatives that bring cultural elements into the classroom/curriculum. As a consequence of steady, incremental relationship-building with NDSU, TMCC now has 42 students enrolled in its pre-engineering program.

Last year, with ONR funding coming to an end, the five TCUs approached DOE about participating in the Experimental Program to Stimulate Competitive Research (DOE/EPSCORE). EPSCORE subsequently granted funding that will enable TMCC to provide research experience for the 42 students interested in engineering and provide funding for the other four TCUs to continue their high school programs.

TMCC is involved in partnerships not only with other academic institutions, but also with tribal high schools and local industry. For example, the college is working with the local power company to develop a wind turbine project, which is under construction. TMCC's wind turbines will generate energy for the campus, and the surplus will be sold on the energy market. North Dakota is also developing a statewide wind turbine project. One hundred turbines will be located only 40 miles from the TMCC campus, which will provide employment opportunities for graduates of TMCC engineering and technical programs. Another TMCC green engineering project, located on the largest TMCC campus site, is a geothermal heating and cooling system that draws water from 450 deep wells adjacent to the facility.

Today, TMCC is in a position to "give back" to NDSU by involving NDSU engineering students in its green energy programs and inviting NDSU to establish a permanent presence on the TMCC campus. The college has also offered space for NDSU to put up a building. Both partners are enthusiastic about this plan and hope that it will lead to other joint endeavors.

TMCC declined the invitation to join the working group to establish a four-year TCU-based engineering program because the school feels it already provides students with an opportunity to obtain a B.S. in engineering through its partnership with NDSU, a trusted local academic institution that has a strong interest in continuing the relationship. The college does not want to develop a full-time engineering program of its own, which they believe would be a huge, very expensive undertaking. Nor does TMCC feel a TCU-based engineering program on a distant campus would be attractive to Native students from North Dakota, who have historically demonstrated that they want to stay in the area. Thus, distance would be a major barrier for them.

The activities of TMCC indicate that at least one model for initiating, developing, implementing, and sustaining engineering studies at a tribal college has been successful, and this model represents an alternative to initiating a four-year engineering program at a TCU. There may be other, equally successful models, including strategies that have been used successfully by other minority-serving institutions. The selection of the most appropriate model for offering engineering studies to tribal students can best be addressed by an umbrella organization that represents all TCUs; an umbrella organization could survey TCUs and their constituencies to gather opinions on this question and provide an interface with funding agencies.

New Models of Engineering Education

Several recently established programs have adopted innovative approaches to engineering education. Two of these programs, Franklin W. Olin College of Engineering and Smith College Picker Engineering Program, are described below.

The Olin model, funded by a grant of approximately $460 million from the Olin Foundation, created a joint engineering/business curriculum, built on Carnegie-One faculty recruitment, an integrated partnership with Babson College; Olin aspires to be one of best boutique schools of engineering in the world. Thus, this model is not relevant to the proposed plan to develop a school of engineering at a TCU.

Many other small colleges and community colleges that are expanding into new areas of engineering and technology programs might be better suited as models for incremental program development. The Smith College Picker Engineering Program is intended to redefine traditional engineering education. The program includes a rigorous plan of study that is integrated with the traditional liberal arts. The philosophy of the program is outlined on the Smith College website (2005): "The value of more liberally educated engineers, who typically bring strong communication and abstract reasoning skills to their work, has recently been acknowledged by the national engineering accrediting board, which has moved to give greater weight to the liberal arts in design curricular standards." The undergraduate curriculum, which leads to a degree in engineering science, focuses on the theoretical and scientific underpinnings of all engineering disciplines. An integral and critical component of the program is a continuous emphasis on the use of engineering science principles in design.

Workshop participants suggested that, rather than replicating mainstream approaches, TCU engineering programs "leapfrog" historic practices in engineering education whenever possible. For example, *The Engineer of 2020: Visions of Engineering in the New Century*, outlines necessary changes in engineering education—some of which (e.g., principles for green engineering and the importance of social context) would be natural components of engineering education at TCUs (NAE, 2004).

7. How can engineering studies be implemented so that continuous improvement is an integral part of the model?

ABET's educational objectives for programs in the 2005–2006 accreditation cycle (Appendix H), require ongoing evaluations and continuous improvement (ABET, 2005):

(a) detailed, published educational objectives that are consistent with the mission of the institution and these criteria

(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated

(c) an educational program, including a curriculum that prepares students to attain program outcomes and that fosters accomplishments of graduates that are consistent with these objectives

(d) a process of ongoing evaluation of the extent to which these objectives are attained, the result of which shall be used to develop and improve the program outcomes so that graduates are better prepared to attain the objectives.

Implementation strategies associated with setting up a TCU-based engineering program must include a plan for evaluating how well educational objectives are being met—both the educational objectives outlined in ABET EC2000 and the objectives established through discussions with stakeholders, such as other TCUs that have articulation agreements with the home institution, tribal leaders, and tribal elders. The evaluation plan might also include periodic benchmarking against other engineering educational institutions to identify best practices.

Program evaluations can be helpful in many ways:

- by increasing or verifying the effect of services
- by improving the delivery system (e.g., showing how it can be made less costly and more efficient)
- by verifying if the program is working according to plan and pointing out new techniques that could improve it
- by verifying results that can be used for promoting services to the community
- by informing management, advisory groups, and funders about how well the program is doing in terms of meeting its goals
- by providing valid comparisons among programs (internal benchmarking) as a basis for deciding which ones should be cut, if that becomes necessary
- by examining and describing programs for replication elsewhere

An ABET representative who participated in the workshop recommended that the working group employ a past ABET commissioner—ideally, a faculty member who has experience with ABET outcomes assessment and continuous improvement processes—who could assess the program from the point of view of an external evaluator. The ABET representative pointed out that outcomes A–K of the ABET criteria are required of all programs and that additional program criteria might also have to be met, depending on the degree offered; other, less specific criteria, such as the number and credentials of faculty, provide flexibility for programs (ABET, 2005). ABET already has begun to interact with TCUs through a recent workshop on faculty training to identify educational objectives and expected student learning outcomes. Most important, the ABET representative at the workshop indicated that the organization is very interested in further interactions with TCUs.

TCUs' goal-setting and evaluation processes will include a cultural component, which does not usually enter into the evaluations of mainstream institutions. TCUs are accountable to tribal councils, elders, business leaders, and stakeholder groups in their communities for meeting their educational objectives. Thus, evaluations of tribal educational institutions must include measurements of outcomes in a cultural context (NSF, 2002).

8. Which financial strategies will enable tribal colleges to sustain engineering programs in the long term?

Long-Term Strategy

Appendix E outlines sources of federal funding available to TCUs. However, in the past, some funds that have been authorized have not been appropriated, and funds that have been appropriated have not been large enough to address the financial needs of TCUs. One question that was raised at the workshop was how the experiences of TCUs with funding sources compare with the experiences of HBCUs.[7] It was suggested that a meeting be arranged between deans of HBCUs and deans of TCUs to explore this topic.

One crucial difference between HBCUs and TCUs is that HBCUs have access to Title III funds, which have been an important source of their funding. The success of HBCUs shows the positive impact minority-serving institutions can have when they are adequately funded. HBCUs have withstood the test of time. Since 1865 they have been educating underrepresented minority students who have subsequently influenced society as a whole in the United States. Although HBCUs constitute only 15 percent of U.S. colleges and universities, they graduate 30 percent of all African American students who earn B.S. degrees in engineering and nearly 50 percent of African American students who go on to graduate school.

Increased financial support for TCUs could have similar effects—strengthening the institutions, improving the prospects of corporate partnerships and government support, and increasing the likelihood of collaborations with majority institutions.

The current administration in Washington, D.C. recognizes that TCUs, like HBCUs, are national treasures. On September 28, 2002, President Bush signed Executive Order 13021 (subsequently revoked and replaced by 13270) authorizing the continuation of the WHITCU (White House Initiative on Tribal Colleges and Universities) (see Appendix G for the complete text). The goals of WHITCU are to ensure that TCUs are recognized and have full access to federal programs that benefit other institutions of higher education. Thus, TCUs will be able to compete for federal funds, just as HBCUs do.

Executive Order 13270 calls attention to the historic and unique role of TCUs in higher education; these institutions serve Americans who might not otherwise have access to educational institutions. The president stated:

> There is a unique relationship between the United States and Indian tribes, and a special relationship between the United States and Alaska Native entities. … Tribal colleges are both integral and essential to their communities. Often they are the only postsecondary institutions within some of our Nation's poorest rural areas. They fulfill a vital role: in maintaining and preserving irreplaceable languages and cultural traditions; in offering a high-quality college education to younger students; and in providing job training and other career-building

[7] Executive Order 999, 195, established 127 historically HBCUs. Ten HBCUs currently offer engineering programs—Alabama A&M University, Florida A&M University, Hampton University, Howard University, Morgan State University, North Carolina A&T University, Prairie View A&M University, Southern University, Tennessee State University, and Tuskegee University.

> programs to adults and senior citizens. Tribal colleges provide crucial services in communities that continue to suffer high rates of unemployment and the resulting social and economic distress. (U.S. Department of Education, 2002)

Although Executive Order 13270 incorporates the spirit and purposes of Title III—to strengthen and develop educational institutions—it authorizes no funding for TCUs; the executive order currently in effect has not led to funding increases. Umbrella organizations, such as the Alliance for Equity in Higher Education, might help TCUs increase their visibility and thus apply pressure to increase Title III funds for TCUs.

It is critical that financial issues unique to TCUs—lack of state funding and failure of Congress to appropriate funds that have been approved—be addressed. TCUs need a great deal more federal funding to fulfill their unique mission. If it can be shown that a sufficient number of students are interested and qualified to participate in a four-year engineering program in the TCU system, then funding considerations should not force TCUs to choose between supporting a four-year program and providing two-year STEM and vocational programs.

The small number of American Indian engineers likely to be produced by TCUs alone, or in partnership with mainstream institutions, will not greatly increase the national talent pool of engineers, but they will make a huge difference in Native communities, where most students report that they want to work. For years, India and China have been educating large numbers of engineers, and their investments are starting to pay off in rapidly improving economies. The same could be true for Indian reservations. For the prosperity of Native communities, the federal government must make a larger overall investment in education to create opportunities for indigenous engineering education.

Near-Term Funding Strategies

It is not clear how the working group will raise the large sum required to start up and sustain one or more engineering programs and, at the same time, fulfill the other goals of the management plan. The working group has had several meetings with federal funding agencies to present its management plan and financial needs statement. However, the committee believes that the implementation plan developed by the working group is overly ambitious.

Although the cost of implementing engineering programs varies in terms of the type of program offered (e.g., computer vs. electrical engineering), the committee concluded that the financial needs statement developed by the working group greatly underestimates the cost of the undertaking. It seems unrealistic to think that, in five years, one pilot engineering program can be implemented while two more are being planned. Resources dedicated to planning the additional programs would be better used to increase the number of TCUs that offer associate degrees and improve STEM courses at schools that currently offer such programs. This would ultimately improve recruitment opportunities for one TCU-based engineering program.

During the course of gathering data for this report, the committee learned that some stakeholders and constituency groups have expressed concerns that the large infusion of funds, especially federal funds, required for the proposed program would substantially reduce financial support for many other deserving tribal education programs and activities, such as language and cultural programs that are central to the dual mission of TCUs and efforts to improve STEM offerings and other courses that are essential to A.S. degree programs.

9. What are the most effective methodologies for teaching engineering at TCUs to meet the needs of Native American constituencies?

Learning and Teaching Styles

Although there are many differences among the 562 federally recognized Indian tribes in the United States, research suggests that they have some common ways of learning, teaching styles, orientations, and preferences: (1) a global, or holistic, style of organizing information (Backes, 1993; Davidson, 1992); (2) a visual style of mental representations of information (Morton et al., 1994; Rougas, 2000); (3) a preference for a reflective style in processing information (Nuby and Oxford, 1998); (4) a preference for collaborative approaches to tasks (Chavers, 2000); (5) and a preference for dialogue between teachers and learners in which prior knowledge and experiences are interwoven with new material to raise understanding to a higher level (Chavers, 2000).

These orientations and preferences contrast sharply with traditional Western methods, which are highly structured and teacher dominated and follow a carefully planned routine (Tharp and Yamauchi, 1994). Cleary and Peacock (1998) outlined the needs of indigenous students in classroom practices:

> Teachers of indigenous students need to build trust; to connect with the community; to establish cultural relevance in the curriculum; to tap intrinsic motivation for learning; to use humor; to establish family support; to provide situations that yield small successes; to make personal connections with students; to use highly engaging, activity-based learning and, in some cases, cooperative learning; to provide role models; to be flexible, fair, and consistent; and to provide a real audience and purpose for student work.

These teaching and learning styles are, of course, approaches that would benefit all students, not just American Indians. As many educators have pointed out, they are simply good pedagogy (Jolly et al., 2004; NRC, 2005; NSF, 2003).

National Science Foundation Programs for Improving STEM Teaching/Learning in American Indian Communities

For more than three decades, NSF has funded programs to improve STEM education in tribal educational institutions (for descriptions, see Appendix D). The NSF Tribal College Rural Systemic Initiative (TCRSI) supports the efforts of individual TCUs to improve the educational experiences of tribal students and teachers by offering STEM courses that meet national educational standards. Typical strategies/approaches of TCUs that have received funding from this program include assessments of student outcomes, professional development for K–12 teachers, and the promotion of parental and community involvement in the educational process (Robbins, 2002).

The NSF TCUP provides awards for improvements in the quality of STEM instructional and outreach programs. The emphasis is on leveraging the use of information technologies at TCUs, institutions that serve Alaska Native students, and institutions that serve Native Hawaiian students (NSF, 2005). In 2002, five of the TCUs in the working group had TCRSI grants, and one was developing a proposal for a full TCUP grant.

10. Can these methodologies be applied to instill a concept of lifelong learning?

Instilling students with the desire and skills to pursue lifelong learning and continuous improvement are key components of the mission of tribal colleges and of tribal cultures in general. Tribal elders are particularly good models of lifelong learning for tribal college students. One way for tribal college faculty to model lifelong learning for students is to give faculty opportunities to increase their credentials.

5
Recommendations

The purpose of this letter report is to provide expert, objective, independent advice to the 11 tribal colleges working toward establishing a four-year engineering program. The conclusions and recommendations in this report are based on a consensus study, the chief data-gathering activity of which was a one and one-half day workshop with invited participation from academic engineering faculty and administrators, representatives of American Indian communities and professional associations, and representatives of governmental policy and funding agencies. Other data-collection activities included a review of relevant literature, the deliberations of committee members who were selected for their broad range of perspectives and knowledge relevant to the questions addressed in this report, observation at a workshop for TCU faculty sponsored by NSF, and telephone interviews with tribal college faculty and administrators.

Although, the charge to the committee suggests that establishing a four-year engineering program at a TCU is a foregone conclusion, the committee does not concur, at least not at this time. Before a recommendation for such an undertaking can be made, the most appropriate model, or models, for initiating, developing, implementing, and sustaining engineering studies at a TCU must be established, and further research must be done to define the needs to be addressed by the proposed program, the population to be served, the sources and continuity of required funding, partnering options, and so on.

Recommendation 1. An advisory group should be established to provide strategic direction to the working group to answer the questions noted above and access to contacts in organizations that can provide funding and other types of assistance. The advisory group should include faculty and administrators who have been involved in starting up engineering programs and in established engineering programs; tribal leaders and representatives of industry, engineering societies, federal agencies, and organizations, such as the American Indian Higher Education Consortium, American Indian Science and Engineering Society, American Indian College Fund, and Alliance for Equity in Higher Education.

Recommendation 2. Studies should be conducted to determine if in the near term, there is a sufficient number of academically prepared students and sufficient interest among these students, many of whom would have to travel long distances to participate in the program, to support a four-year engineering program at a tribal college or university. Research should include overall undergraduate retention rates for Native students and comparisons of retention rates for students who enter four-year programs directly from high school and students who transfer to four-year programs with two-year degrees from TCUs.

Recommendation 3. Benchmarking research should be conducted with other TCUs and other minority-serving institutions to build on, and be informed by, successful initiatives funded by the National Science Foundation and successful strategies of historically black colleges and universities and Hispanic-serving institutions. Benchmarking research would provide a basis for identifying engineering education best practices that are consistent with the values and goals of tribal college constituency groups and enable TCUs to learn from the experiences of both mainstream and nontraditional programs and identify a "niche" for a Native engineering program.

Recommendation 4. Informed by the results of research and benchmarking, the working group should cooperate with the advisory group to further develop the management plan, explore feasible models for initiating, developing, implementing, and sustaining engineering studies at tribal colleges, and address the issue of buy-in by other TCUs for the proposed plan.

Recommendation 5. If there is consensus that a four-year tribal college-based program is needed, the implementation plan should be modified to be consistent with the resources available. At the present time, it appears that the resources dedicated to planning the second and third four-year engineering programs would be better spent to increase the number of TCUs that offer associate degrees and improve STEM courses at all of the partner schools. This would ultimately improve recruitment opportunities for one four-year engineering program.

Recommendation 6. The management plan should include an explanation of how the proposed program would build on, and be informed by, initiatives funded by National Science Foundation programs, such as Tribal Colleges University Program, and national outreach activities of organizations, such as MESA. This would strengthen the plan and, perhaps, increase buy-in for the initiative from tribal constituency groups and funding agencies.

Recommendation 7. Faculty and student exchange programs and partnerships between TCUs and mainstream institutions local industry/business and local, state, and national government organizations should be essential components of a strategy for developing TCU-based engineering programs.

Recommendation 8. Federal funding for tribal colleges/universities should be significantly increased.

Recommendation 9. Because of the importance of tribal elders in Native communities, they should be enlisted in the effort to educate K–12 students about engineering and how engineering training and skills could help Native communities.

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Appendix A

Biographies of Committee Members

Richard Schwartz (*chair*), codirector of the Birck Nanotechnology Center at Purdue University, joined the faculty of the School of Electrical Engineering at Purdue in 1964. He became a full professor and assistant head for instruction in 1972. After serving as dean of the Purdue Schools of Engineering from 1995 to 2001, he returned to the faculty of the School of Electrical and Computer Engineering. Dr. Schwartz has been a consultant to a number of corporations as well as chairman of the Science and Technology Advisory Committee for the U.S. Department of Energy National Renewable Energy Laboratory (NREL). He is currently a member of the Advisory Committee for the National Center for Photovoltaics. Dr. Schwartz has served on the boards of directors of the National Electrical Engineering Department Heads Association, the International Committee for the European Union Photovoltaic Solar Energy Conference, and the International Engineering Consortia. He was general chairman of the 23rd IEEE Photovoltaic Specialists Conference and a member of the International Committee for the World Conference on Photovoltaic Energy Conversion. In 2001, he chaired the National Research Council Committee for the Assessment of NASA's Solar Power Investment Strategy, and in 2004, he chaired a panel to evaluate the Army's basic research program in electronics. He received a B.S.E.E. from the University of Wisconsin-Madison and an S.M.E.E. and Sc.D. from Massachusetts Institute of Technology.

Ashok Agrawal, professor and chair of the Engineering and Technology Department, St. Louis Community College, is responsibilities for the A.S. transfer program in engineering technology and A.A.S. and certificate programs in civil, construction, biomedical, electrical, electronics, computer, mechanical, manufacturing, plastics, quality, and telecommunications engineering technologies. He is currently involved in the establishment of an Advanced Manufacturing Center in Florissant Valley. Dr. Agrawal has been a member of the American Society for Engineering Education (ASEE) Engineering Technology Division (ETD) for more than 20 years and was awarded the 1996 Fredrick J. Berger Award for Excellence in Engineering Technology Education by ASEE. For two years, he was vice chair of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), and he is currently a member of the advisory boards of several National Science Foundation-funded projects to improve engineering technology educational programs. Dr. Agrawal is also a member of the National Research Council Board on Engineering Education. He holds M.S.

degrees in metallurgical engineering and mining engineering from the University of Kentucky and a B.S. in metallurgical engineering from Nagpur University in India.

Sandra Begay-Campbell is a regent for the University of New Mexico and former executive director of the American Indian Science and Engineering Society (AISES), a nonprofit organization dedicated to increasing the number of American Indian scientists and engineers. Ms. Campbell is also a senior member of the technical staff at Sandia National Laboratories, where she heads projects in the Renewable Energy Program. After earning a B.S.C.E. from the University of New Mexico, Ms. Campbell worked at Lawrence Livermore National Laboratory. She then earned an M.S. in structural engineering from Stanford University. She subsequently worked at Los Alamos National Laboratory. Ms. Campbell is a member of the Board of Directors for Women in Engineering Programs and Advocates Network (WEPAN). In 2000, she was a recipient of the Stanford University Multicultural Alumni of the Year Award and the Governor's Award for Outstanding Women from the New Mexico Commission on the Status of Women.

Legand Burge is dean of the College of Engineering at Tuskegee University. Dr. Burge's research focuses on distributed computing, especially global resource management in large-scale distributed systems using low-cost commodity hardware and the design and development of large-scale, nondedicated, heterogeneous software distributed shared memory systems; he is currently the director of the Distributed Systems Research Group. Dr. Burge's previous research includes consistency management in distributed databases and message-passing libraries for distributed parallel computing, which involved the design and development of an actor-based message-passing and thread-migration package for Java, which was used to design a campus-wide nondedicated metacomputer that distributed and performed load balancing of computations based on CPU cycle stealing.

Larry Hall, leader of S&K Electronics, a tribally owned firm, has overseen threefold growth in the company and the spin-off of an IT company. S&K has had four Phase I and two Phase II SBIR grants. Mr. Hall has also been involved with businesses and business development on the Flathead Reservation in Montana for more than 30 years. He received his undergraduate degree from Evergreen State College in Olympia, Washington, and pursued further studies in accounting and business management at Shalish Kootenai College in Pablo, Montana, and Tuck School of Business at Dartmouth College. Mr. Hall is the current president of the Native American Manufacturer Network, a nonprofit business organization, and a member of the Montana Board of Research and Commercialization Technology. He is a past member of the National Advisory Board for the Small Business Administration, past chairman of the Montana Manufacturer Extension Center Advisory Board, and a past member of the Minority Business Resource Advisory Committee for the National Aeronautics and Space Administration.

Helen Klassen, earned a bachelor's degree from Minnesota State University-Moorhead (MSUM) and a doctorate in human development and psychology from Harvard University. Employed in the Counseling Center at MSUM since 1989, Dr. Klassen teaches classes in Native American Studies and introductory courses in multicultural studies. The founder and president of the White Earth Tribal and Community College, Dr. Klassen has helped to create a space for innovation and learning in her community, offering a new generation of students the chance to realize their dreams. Dr. Klassen is Assistant to the Chippewa tribal chairperson.

Henrietta Mann (formerly Whiteman) earned a Ph.D. in American studies from the University of New Mexico, Albuquerque. She is a full-blood Cheyenne enrolled with the Cheyenne-Arapaho Tribes of Oklahoma and has served on their Business Committee. Dr. Mann was the first one to fill the Endowed Chair in Native American Studies at Montana State University, Bozeman. For 30 years, she held administrative posts and/or taught at the University of California, Berkeley; Graduate School of Education of Harvard University; University of Sciences and Arts, Chickasha, Oklahoma; and Haskell Indian Nations University, Lawrence, Kansas. In 1986, she was deputy to the assistant secretary of Indian affairs/director of the Office of Indian Education Programs, Bureau of Indian Affairs, U.S. Department of the Interior. In 1991 and 1992, she was national coordinator of the American Indian Religious Freedom Coalition in the Washington, D.C., offices of the New York-based Association on American Indian Affairs. In 1983, Dr. Mann was selected Cheyenne Indian of the Year, and in 1987, she was honored as the National American Indian Woman of the Year. In 1991, Rolling Stone named her one of the 10 leading professors in the nation. The National Women's History Project has featured her as one of five 20th Century Women Educators on its poster series.

Appendix B

Workshop Agenda, March 15-16, 2005

Workshop on Engineering Studies at the Tribal Colleges
March 15–16, 2005
Agenda

March 15, 2005

8:30 a.m.–9:00 a.m.	Breakfast
9:00 a.m.–9:15 a.m.	Opening Ceremony (Henri Mann)
9:15 a.m.–9:30 a.m.	Welcome, NAE President (Wm. A. Wulf)
9:30 a.m.–10:00 a.m.	Introductions and Opening Remarks (Richard Schwartz)
10:00 a.m.–10:20 a.m.	Remarks, workshop sponsor (Lee Snapp)
10:20 a.m.–11:00 a.m.	Status of American Indians in Science and Engineering (Eleanor Babco)
11:00 a.m.–11:15 a.m.	Break
11:15 a.m.–12:00 p.m.	Pathways to Engineering Careers for Tribal Students: Challenges and Opportunities for Tribal Colleges (Henri Mann, Paul Schultz, James Tutt)
12:00 p.m.–12:45 p.m.	Lunch on your own—3rd-floor cafeteria
12:45 p.m.–1:15 p.m.	Pathways to Engineering Careers for Tribal Students: Challenges and Opportunities for Tribal Colleges (cont.)
1:15 p.m.–2:00 p.m.	Recruitment and Retention of Tribal Students in Two- and Four-Year Educational Institutions (Teresa Gomez, Herb Schroeder, Dawn Valencia)
2:00 p.m.–2:30 p.m.	Experiences of Other Minority-Serving Schools and Engineering Program Start-ups (Legand Burge, Eugene DeLoatch)
2:30 p.m.–3:00 p.m.	ABET (Daniel Hodge)
3:00 p.m.–3:15 p.m.	Break

3:15 p.m.–4:00 p.m.	Industry Perspectives (Michele Morningstar, Sandra Begay-Campbell)
4:00 p.m.–4:45 p.m.	National and Regional Programs (Jody Chase, Diane Cullo, Vigdor Teplitz)
4:45 p.m.–5:00 p.m.	Wrap-up (Richard Schwartz)
5:15 p.m.–6:15 p.m.	Reception (Room 1024)

March 16, 2005

8:30 a.m.–9:00 a.m.	Breakfast
9:00 a.m.–9:10 a.m.	Welcome (Richard Schwartz)
9:10 a.m.–10:10 a.m.	Perspectives of Associations Promoting Engineering Education (Ashok Agrawal, Teresa Gomez, Robert Shepard)
10:10 a.m.–11:45 a.m.	Facilitated Discussion (Richard Schwartz, Mary Mattis) • What have we learned? • Questions for future research • Recommendations
11:45 a.m.–12:00 p.m.	Closing Ceremony (Paul Schultz)
12:00 p.m.	Adjournment

Appendix C

Invited Experts and National Academy of Engineering Staff

WORKSHOP GUESTS AND NAE STAFF

ELEANOR BABCO, Commission on Professionals in Science and Technology, Washington, D.C.
CARRIE BILLY, American Indian Higher Education Consortium, Alexandria, Virginia
JODY CHASE, National Science Foundation, Alexandria, Virginia
DIANE CULLO, White House Initiative on Tribal Colleges and Universities, Washington, D.C.
EUGENE M. DELOATCH, Morgan State University, Baltimore, Maryland
TERESA GOMEZ, American Indian Science and Engineering Society, Albuquerque, New Mexico
RENEE GURNEAU, Red Lake Nation College, Red Lake, Minnesota
DANIEL B. HODGE, Accreditation Board for Engineering and Technology, Inc., Baltimore, Maryland
JOE MARTINEZ, U.S. Department of Energy, Washington, D.C.
MICHELE MORNINGSTAR, IBM, Endicott, NewYork
HERB SCHROEDER, University of Alaska, Anchorage, Alaska
PAUL SCHULTZ, Honorable Elder NAME OF TRIBE-TK, Ogema, Minnesota
VIGDOR TEPLITZ, National Aeronautics and Space Administration, Greenbelt, Maryland
JAMES TUTT, Crownpoint Institute of Technology, Crownpoint, New Mexico
DAWN VALENCIA, California State University, Fullerton, Fullerton, California

NAE Staff

MARY C. MATTIS, Study Director
NATHAN KAHL, Senior Project Assistant
CAROL R. ARENBERG, NAE Senior Editor

Appendix D

National Science Foundation Programs at Tribal Colleges and Universities

Programs Funded by the National Science Foundation to Improve Course Offerings and STEM Research at the Tribal Colleges

All Nations Louis Stokes Alliance for Minority Participation (ANLSAMP)

ANLSAMP provides the federal government with guidance on changing the way federal programs approach Native education, particularly in science, technology, engineering, and mathematics (STEM). ANLSAMP minimizes the geographical challenges of working with 12 states—and 52 participating institutions of higher education—through technology, including the Internet and a listserv. As an NSF-funded program, ANLSAMP has several collaborative projects in place with other NSF-funded programs.

The Advanced Networking with Minority Serving Institutions is an NSF-funded project to EDUCUASE, an international association of institutions of higher education and corporate partners, to assist tribal colleges and universities (TCUs), historically black colleges and universities (HBCUs), and Hispanic-serving institutions in advanced networking issues.

NSF Computer Science, Engineering, and Mathematics Scholarship Program provides educational opportunities to low-income, academically talented students through scholarships that promote full-time enrollment and degree achievement in higher education.

SKC Leadership Development for Master Teachers works with teachers who are involved in the Rural Systemic Initiative (RSI) reform, provides professional development opportunities to teachers in RSI schools, and develops culturally relevant, standards-based curriculum for reservation schools.

Rural Systemic Initiative

The NSF **Rural Systemic Initiative in Science, Mathematics, and Technology Program** stimulates system-wide educational reform of science, mathematics, and technology focused on improving long-term educational opportunities for students in rural, economically disadvantaged regions of the nation, particularly those that have been underserved by other NSF programs. RSI encourages community participation in instructional and policy reform.

RSI targets regions that are rural, characterized by high levels of poverty among school-age children; and share common cultural, social, and economic characteristics. RSI's goals are: (1) to improve science, mathematics, and technology education in rural, economically disadvantaged regions of the nation; (2) to prepare a technologically competent workforce to improve the infrastructure of economic development activities in a community or region by strengthening the science, mathematics, and technology instructional capacities of regional colleges and universities; (3) to raise the level of scientific literacy and the understanding and appreciation of science among students and the general population in rural, economically disadvantaged regions of the nation; and (4) to develop community infrastructure to sustain educational improvements.

Tribal College Rural Systemic Initiative (TCRSI)

TCRSI programs are located in TCUs. Examples are described below.

The goal of the **Blackfeet Community College RSI** is to increase the number and quality of STEM offerings to meet national educational standards. Special emphasis is placed on a holistic approach to community reform using RSI activities as a springboard for a comprehensive effort to reform STEM teaching.

The objective of the **Cankdeska Cikana Community College RSI** is to continue past TCRSI efforts, which have resulted in 100 percent of teachers at the target schools implementing standards-based curricula in their classrooms.

The **Salish Kootenai College RSI** has resulted in a transformation of the educational experience for both teachers and students. The program provides professional development for teachers, effective assessment strategies, and promotion of community involvement in the educational process. The goal is to improve the learning experience for students in STEM subjects inside and beyond the school walls.

Model Institutions for Excellence

The goal of **Model Institutions for Excellence (MEI)** is to assist TCUs in building an infrastructure that can support the development of high quality programs of study in STEM areas.

The National Science Foundation Computer Infrastructure Project

This project encourages TCUs to develop an infrastructure based on a cooperative relationship among the tribal community, tribal schools, TCUs, and four-year comprehensive universities.

The National Science Foundation Tribal Colleges and Universities Program

The NSF **Tribal Colleges and Universities (TCUP) Program** provides grants to help TCUs improve their STEM instructional and outreach programs, with an emphasis on using information technologies. The program also includes institutions that serve Alaskan Native populations and Native Hawaiian-populations.

TCUP supports the implementation of comprehensive institutional approaches to improving STEM teaching and learning in ways that increase access to, retention, and graduation from STEM programs, particularly those that have a strong technological foundation. TCUP helps eligible institutions bridge the digital divide and prepare students for careers in information technology, science, mathematics, and engineering fields. Typical project implementation strategies include curriculum enhancement, faculty professional development, undergraduate research and community service, academic enrichment, infusion of technology to enhance STEM instruction, and collaborations and other activities that meet institutional and community needs.

Appendix E

Sources of Federal Funding for Tribal Colleges and Universities

The **Tribally Controlled College or University Assistance Act of 1978 (TCCUAA)**, administered by the Bureau of Indian Affairs, authorizes funding for tribal colleges and universities (TCUs) in several ways.

Title I provides funding for eligible TCUs through a formula based on the number of Indian students enrolled (the "Indian student count" or ISC). Non-Indian students, who make up a significant percentage of total enrollments at Title I colleges, are not funded. Title I is authorized to provide $6,000 per Indian student, with a maximum total amount of $40 million. Funding per student in 2005 was $4,447.

Title II provides funding for core operations for Diné College.

Title III provides matching funds for endowment grants and is authorized at $10 million. However, appropriations have never surpassed $1 million.

Title IV is authorized at $2 million to finance local economic development projects, but funds have never been appropriated.

Additional funds are authorized for facilities renovation and technical assistance.

Some colleges that are not funded through TCCUAA receive core operational funding through other federal mechanisms, such as the Carl D. Perkins Vocational and Applied Technology Act, which limits funding to only one TCU per tribe.

In 1994, Congress designated 29 TCUs as land grant institutions. Institutions that were not accredited did not qualify for land grant designation, but some of these colleges were grandfathered in at a later date. The land grant institutions (referred to as the 1994s) receive equity grants—$50,000 per institution—for improving their programs in agriculture and natural resources, share the interest from an endowment fund that receives $4.6 million annually, and may compete for funding for extension programs (about $2 million). In addition, the creation of a new research program was authorized in fiscal year (FY) 1999.

Some TCUs—like other minority-serving institutions—receive funding under **Title III of the Higher Education Act**, the Aid for Institutional Development Program. In FY 1998, TCUs had eight ongoing competitive grants under Part A, for a total of $2.6 million out of more than $55 million available. In FY 1999, a separate section under **Title III** was added for TCUs, HBCUs, and Hispanic-serving institutions. Although $10 million was authorized under the new section, only $3 million was appropriated.

TCUs also receive minimal funding from other sources: state block grant programs for adult education; Minority Science Improvement Program; Environmental Management Grants; and other specially directed funds. In 1998, the U.S. Department of Agriculture awarded rural development grants to four colleges to improve aspects of their agricultural programs and make them "Centers of Excellence" in the nationwide rural development network.

When the White House Executive Order on Tribal Colleges was signed in 1996 to affirm the important role of TCUs in reservation development, all federal departments and agencies were ordered to increase their support for TCUs.

Material contained in this Appendix E is drawn from two sources:

TCJ (Tribal College Journal of American Indian Higher Education). 2005. 16(3): 34, and AIHEC. 1999. Tribal Colleges: An Introduction. E1–E5. Some of the information in the AIHEC document was compiled by Carrie Billy, deputy director, AIHEC, in 1998 for the White House Initiative on Tribal Colleges and Universities.

Appendix F

American Indian Higher Education Consortium
Statement on Engineering Initiatives at Tribal Colleges and Universities

American Indian Higher Education Consortium
121 Oronoco Street · Alexandria, Virginia 22314
(703) 838.0400 · Facsimile: (703) 838.0388

September 2005

The American Indian Higher Education Consortium enthusiastically supports efforts to improve engineering opportunities for American Indians. A well-prepared engineering workforce in Indian Country could stimulate engineering-related business development, as well as allow significantly more American Indians to compete for well-paying engineering jobs.

Over the past several years, a number of Tribal Colleges have become engaged in engineering education activities. For example, Southwest Indian Polytechnic Institute, Turtle Mountain Community College, and Oglala Lakota College have established strong pre-engineering programs in partnership with local universities with four-year engineering programs, to which their students transfer to complete their engineering degrees.

In addition to these ongoing initiatives, 11 Tribal Colleges recently organized a "TCU Engineering Working Group", under the direction of a NASA Administrator's Fellow assigned to Salish Kootenai College. The group hopes to develop pre-engineering and 4-year engineering programs at participating institutions. These colleges, together with NASA, other federal agencies, and partnering mainstream institutions, are to be commended for their efforts to establish engineering education opportunities at Tribal Colleges. By proceeding in a coordinated fashion, all Tribal Colleges and Universities can benefit from the collective knowledge and experience of the TCUs, their major partners, and other minority serving institutions that have gone through the process of planning for and developing engineering programs.

Without question, AIHEC is a strong advocate for collaboration and use of best practices, and the examples cited above demonstrate the high potential for success. However, with any collaborative initiative, AIHEC has an obligation to address some fundamental issues. Most important, if a significant investment is to be made, AIHEC must address the key issues of sustainability and parity. In short, can the initiative be sustained beyond initial funding, and can we ensure that the project will provide the opportunity for all interested TCUs to participate in its development, implementation, and ongoing support?

Some key issues that should be considered with respect to engineering education at TCUs include:

1. Sustainability

Four-year engineering programs are costly to establish and maintain. Approval to offer a new program from regional and national accrediting agencies depends upon the demonstration that the requesting institution has the resources to maintain the program. Should funds be identified for establishing engineering programs, plans must be put in place for their continuation when the grants expire.

2. Institutional Preparedness and Impact

Before establishing a major new program, an institution should engage all of their constituents – faculty, staff, students, and community members - in an exploration of the likely impact of the new program on the entire college community. For example, when a new program is established under a grant award, the institution should consider which programs they are willing to reduce or eliminate, if necessary, to keep the new program operating when start-up grant funding ends.

3. Pre-engineering Models

As mentioned above, several tribal colleges have established strong pre-engineering programs in partnership with engineering departments at four-year institutions to which their students transfer to complete their engineering programs. There is a wide variety of engineering education models available that optimize engineering opportunities for students which each tribal college should consider in order to identify a model that is most appropriate for their institution. A comprehensive tribal college engineering initiative should ensure that the most appropriate option be adopted by each college.

4. Optimizing the Impact on all TCUs

A high-profile, multiple federal agency-sponsored TCU engineering initiative necessarily requires a large investment and a certain amount of risk, both to the tribal colleges and their partners. To help ensure success, such an initiative should be based on a comprehensive strategic plan in which each participating TCU adopts the most locally appropriate, cost-effective engineering education approach, incorporating current best practices in engineering education, and in which the specific goals and expectations of each partner are both clearly identified and realistic.

AIHEC'S Recommendation

A comprehensive strategic plan should be developed by the TCUs, federal agency partners, and other engineering education stakeholders that would be the outcome of (a) individual institutional educational program planning and development processes; and (b) a collaborative program development plan, involving the sharing of distributed academic program resources across Tribal Colleges and Universities (TCUs) and their partners. A major focus of this comprehensive strategic plan would include the use of emerging technologies, particularly those associated with cyberinfrastructure, to provide access to distributed education and support services.

AIHEC recommends that this comprehensive strategic plan be developed using a collaborative and inclusive planning process that engages all TCU engineering stakeholders, including the National Academy of Engineering, NASA and other federal agencies, and mainstream university engineering education and research programs. This will ensure that the resulting TCU engineering initiative will be maximally responsive to the needs of tribal college students, is well-grounded in current engineering education research and practice, and represents a strong and prudent investment on the part of the sponsoring agencies in the Tribal College Movement. AIHEC has submitted a proposal to NSF's Engineering Education Program to fund this strategic planning effort.

AIHEC's Role

As the sole national organization established by Tribal Colleges and Universities (TCUs), the American Indian Higher Education Consortium's mission is to assist all TCUs in developing and sustaining high quality programs that will advance the educational, social, and cultural goals of their students and the communities in which they live. AIHEC provides advocacy, information, research, training, and technical support services in a wide range of areas, all of which are intended to help Tribal Colleges and Universities more effectively serve their communities.

Appendix G

Executive Order 13270

Executive Order Tribal Colleges and Universities 13270

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Policy. There is a unique relationship between the United States and Indian tribes, and a special relationship between the United States and Alaska Native entities. It is the policy of the Federal Government that this Nation's commitment to educational excellence and opportunity must extend as well to the tribal colleges and universities (tribal colleges) that serve Indian tribes and Alaska Native entities. The President's Board of Advisors on Tribal Colleges and Universities (the "Board") and the White House Initiative on Tribal Colleges and Universities (WHITCU) established by this order shall ensure that this national policy regarding tribal colleges is carried out with direct accountability at the highest levels of the Federal Government. Tribal colleges are both integral and essential to their communities. Often they are the only postsecondary institutions within some of our Nation's poorest rural areas. They fulfill a vital role: in maintaining and preserving irreplaceable languages and cultural traditions; in offering a high-quality college education to younger students; and in providing job training and other career-building programs to adults and senior citizens. Tribal colleges provide crucial services in communities that continue to suffer high rates of unemployment and the resulting social and economic distress.

The Federal Government's commitment to tribal colleges is reaffirmed and the private sector can and should contribute to the colleges' educational and cultural missions.

Finally, postsecondary institutions can play a vital role in promoting excellence in early childhood, elementary, and secondary education. The Federal Government will therefore work to implement the innovations and reforms of the No Child Left Behind Act of 2001 (Public Law 107-110) in partnership with tribal colleges and their American Indian and Alaska Native communities.

Sec. 2. Definition of Tribal Colleges and Universities. Tribal colleges are those institutions cited in section 532 of the Equity in Educational Land-Grant Status Act of 1994 (7 U.S.C. 301 note), any other institution that qualifies for funding under the Tribally Controlled Community College Assistance Act of 1978 (25 U.S.C. 1801 et seq.), and Diné College, authorized in the Navajo Community College Assistance Act of 1978, Public Law 95-471, title II (25 U.S.C. 640a note).

Sec. 3. Board of Advisors. (a) **Establishment.** There shall be established in the Department of Education a Presidential advisory committee entitled the President's Board of Advisors on Tribal Colleges and Universities (the "Board").

(b) **Membership.** The Board shall consist of not more than 15 members who shall be appointed by the President, one of whom shall be designated by the President as Chair. The Board shall include representatives of tribal colleges and may also include representatives of the higher, early childhood, elementary, and secondary education communities; tribal officials; health, business, and financial institutions; private foundations; and such other persons as the President deems appropriate.

(c) **Functions.** The Board shall provide advice regarding the progress made by Federal agencies toward fulfilling the purposes and objectives of this order. The Board also shall provide recommendations to the President, through the Secretary of Education (Secretary), on ways the Federal Government can help tribal colleges:

(1) use long-term development, endowment building, and planning to strengthen institutional viability;

(2) improve financial management and security, obtain private-sector funding support, and expand and complement Federal education initiatives;

(3) develop institutional capacity through the use of new and emerging technologies offered by both the Federal and private sectors;

(4) enhance physical infrastructure to facilitate more efficient operation and effective recruitment and retention of students and faculty; and

(5) help implement the No Child Left Behind Act of 2001 and meet other high standards of educational achievement.

(d) **Meetings.** The Board shall meet at least annually, at the request of the Secretary, to provide advice and consultation on tribal colleges and relevant Federal and private-sector activities, and to transmit reports and present recommendations.

Sec. 4. White House Initiative on Tribal Colleges and Universities. There shall be established in the Department of Education, Office of the Secretary, the White House Initiative on Tribal Colleges and Universities (WHITCU). The WHITCU shall:

(a) provide the staff support for the Board;

(b) assist the Secretary in the role of liaison between the executive branch and tribal colleges; and

(c) serve the Secretary in carrying out the Secretary's responsibilities under this order.

Sec. 5. Department and Agency Participation. Each participating executive department and agency (agency), as determined by the Secretary, shall appoint a senior official who is a full-time officer of the Federal Government and who is responsible for management or program administration. The official shall report directly to the agency head, or to the agency head's designee, on agency activity under this order and serve as liaison to the WHITCU. To the extent permitted by law and regulation, each agency shall provide appropriate information as requested by the WHITCU staff pursuant to this order.

Sec. 6. Three-Year Federal Plan.

(a) Content. Each agency identified by the Secretary shall develop and implement a Three-Year Plan of the agency's efforts to fulfill the purposes of this order. These Three-Year Plans shall include annual performance indicators and appropriate measurable objectives for the agency. Among other relevant issues, the plans shall address how the agency intends to increase the capacity of tribal colleges to compete effectively for any available grants, contracts, cooperative agreements, and any other Federal resources, and to encourage tribal colleges to participate in Federal programs. The plans also may emphasize access to high-quality educational opportunities for economically disadvantaged Indian students, consistent with requirements of the No Child Left Behind Act of 2001; the preservation and revitalization of tribal languages and cultural traditions; and innovative approaches to better link tribal colleges with early childhood, elementary, and secondary education programs. The agency's performance indicators and objectives should be clearly reflected in the agency's annual budget submission to the Office of Management and Budget. To facilitate the attainment of these performance indicators and objectives, the head of each agency identified by the Secretary, shall provide, as appropriate, technical assistance and information to tribal colleges regarding the program activities of the agency and the preparation of applications or proposals for grants, contracts, or cooperative agreements.

(b) Submission. Each agency shall submit its Three-Year Plan to the WHITCU. In consultation with the Board, the WHITCU shall then review these Three-Year Plans and develop an integrated Three-Year Plan for Assistance to Tribal Colleges, which the Secretary shall review and submit to the President. Agencies may revise their Three-Year Plans within the three-year period.

(c) Annual Performance Reports. Each agency shall submit to the WHITCU an Annual Performance Report that measures the agency's performance against the objectives set forth in its Three-Year Plan. In consultation with the Board, the WHITCU shall review and combine Annual Performance Reports into one annual report, which shall be submitted to the Secretary for review, in consultation with the Office of Management and Budget.

Sec. 7. Private Sector. In cooperation with the Board, the WHITCU shall encourage the private sector to assist tribal colleges through increased use of such strategies as:

(a) matching funds to support increased endowments;

(b) developing expertise and more effective ways to manage finances, improve information systems, build facilities, and improve course offerings; and

(c) increasing resources for and training of faculty.

Sec. 8. Termination. The Board shall terminate 2 years after the date of this order unless the Board is renewed by the President prior to the end of that 2-year period.

Sec. 9. Administration. (a) **Compensation.** Members of the Board shall serve without compensation, but shall be allowed travel expenses, including per diem in lieu of subsistence, as authorized by law for persons serving intermittently in Government service (5 U.S.C. 5701-5707).

(b) **Funding.** The Board and the WHITCU shall be funded by the Department of Education.

(c) **Administrative Support.** The Department of Education shall provide appropriate administrative services and staff support for the Board and the WHITCU. With the consent of the Department of Education, other agencies participating in the WHITCU shall provide administrative support (including detailees) to the WHITCU consistent with statutory authority. The Board and the WHITCU each shall have a staff and shall be supported at appropriate levels commensurate with that of similar White House Initiative Offices.

(d) **General Provisions.** Insofar as the Federal Advisory Committee Act, as amended (5 U.S.C. App.) (the "Act"), may apply to the administration of any portion of this order, any functions of the President under the Act, except that of reporting to the Congress, shall be performed by the Secretary of Education in accordance with the guidelines issued by the Administrator of General Services.

Sec. 10. Revocation. Executive Order 13021 of October 19, 1996, as amended, is revoked.

GEORGE W. BUSH
THE WHITE HOUSE,
July 3, 2002.

Appendix H

ABET Criteria for Accrediting Engineering Programs, General Criteria for Basic Level Programs

12/19/05

Effective for Evaluations During the 2006 - 2007 Accreditation Cycle
Incorporates all changes approved by the ABET Board of Directors
as of October 29, 2005.

Engineering Accreditation Commission
ABET, Inc.
111 Market Place, Suite 1050
Baltimore, MD 21202
Telephone: 410-347-7700
Fax: 410-625-2238
E-mail: accreditation@abet.org
Website: www.abet.org
2006 - 2007 Criteria for Accrediting Engineering Programs

Criteria for Accrediting Engineering Programs
Effective for Evaluations during the 2006 - 2007 Accreditation Cycle
These criteria are intended to ensure quality and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the following criteria.

I. GENERAL CRITERIA FOR BASIC LEVEL PROGRAMS

Criterion 1. Students
The quality and performance of the students and graduates are important considerations in the evaluation of an engineering program. The institution must evaluate student performance, advise students regarding curricular and career matters, and monitor student's progress to foster their success in achieving program outcomes, thereby enabling them as graduates to attain program objectives.

The institution must have and enforce policies for the acceptance of transfer students and for the validation of courses taken for credit elsewhere. The institution must also have and enforce procedures to ensure that all students meet all program requirements.

Criterion 2. Program Educational Objectives
Although institutions may use different terminology, for purposes of Criterion 2, program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Each engineering program for which an institution seeks accreditation or reaccreditation must have in place:

(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria
(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated
(c) an educational program, including a curriculum that prepares students to attain program outcomes and that fosters accomplishments of graduates that are consistent with these objectives
(d) a process of ongoing evaluation of the extent to which these objectives are attained, the result of which shall be used to develop and improve the program outcomes so that graduates are better prepared to attain the objectives

Criterion 3. Program Outcomes and Assessment
Although institutions may use different terminology, for purposes of Criterion 3, program outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that student acquire in their matriculation through the program.

2006 - 2007 Criteria for Accrediting Engineering Programs 2
Each program must formulate program outcomes that foster attainment of the program objectives articulated in satisfaction of Criterion 2 of these criteria. There must be processes to produce these outcomes and an assessment process, with documented results, that demonstrates that these program outcomes are being measured and indicates the degree to which the outcomes are achieved. There must be evidence that the results of this assessment process are applied to the further development of the program.

Engineering programs must demonstrate that their students attain:
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

In addition, an engineering program must demonstrate that its students attain any additional outcomes articulated by the program to foster achievement of its education objectives.

Criterion 4. Professional Component

The professional component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution. The professional component must include:
(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline
(b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs
(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives

2006 - 2007 Criteria for Accrediting Engineering Programs 3
Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints.

Criterion 5. Faculty
The faculty is the heart of any educational program. The faculty must be of sufficient number; and must have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The program faculty must have appropriate qualifications and must have and demonstrate sufficient authority to ensure the proper guidance of the program and to develop and implement processes for the evaluation, assessment, and continuing improvement of the program, its educational objectives and outcomes. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as professional engineers.

Criterion 6. Facilities
Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-student interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of the students and faculty and the educational objectives of the program and institution.

Criterion 7. Institutional Support and Financial Resources
Institutional support, financial resources, and constructive leadership must be adequate to ensure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, maintain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

Criterion 8. Program Criteria
Each program must satisfy applicable Program Criteria (if any). Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline.

Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

Appendix I

Management Plan of the Working Group

DEVELOPING, IMPLEMENTING, AND SUSTAINING ENGINEERING STUDIES AT THE TRIBAL COLLEGES AND UNIVERSITIES (TCUs)

How We Got Here—Where We're Going
Washington, D.C.
December 2004

Presented on Behalf of
the Working Group on
Engineering Studies at the
Tribal Colleges and Universities

A BACHELOR'S DEGREE IN ENGINEERING FROM THE TCUs?

- In March 2004, 11 tribal colleges formed the Working Group on Engineering Studies at the Tribal Colleges and Universities and approved a Management Plan.

Blackfeet Community College, MT
Chief Dull Knife College, MT
College of Menominee Nation, WI
Crownpoint Institute of Technology, NM
Fort Berthold Community College, ND
Haskell Indian Nations University, KS
Salish Kootenai College, MT
Sitting Bull College, ND
Southwestern Indian Polytechnic Institute, NM
United Tribes Technical College, ND
White Earth Tribal and Community College, MN

- **Overall Goal:** Develop culturally relevant programs that will enable a Native American student to proceed from pre-curriculum preparation through a fully-accredited bachelor of science degree in engineering entirely within the tribal college system.

- The partners attended a workshop sponsored by ABET, Inc., in June 2004.

PRELIMINARY FIVE-YEAR FINANCIAL NEEDS

Common Admin Needs (Working Group, Advisory Cttee, NAE Workshop)
$207K $95K $95K $95K $95K Total: $587K

Blackfeet Community College—AS, Pre-engineering
$149K $147K $168K $175K $181K Total: $820K

Chief Dull Knife College
Pending

College of Menominee Nation—AS, Materials Science and Engineering
$144K $125K $125K $105K $80K Total: $579K

Crownpoint Institute of Technology—AS, Engineering
$207K $246K $234K $222K $230K Total: $1,139K

Fort Berthold Community College—AAS, Electrical Engineering Technology*
$114K $113K $170K $181K $188K Total: $766K

Haskell Indian Nations University—AS, Natural Sciences with Pre-Engineering Concentration
Budget allocated by BIA

Salish Kootenai College—BS, Computer Engineering*
$193K $225K $219K $218K $219K Total: $1,074K

*Currently identified for ABET accreditation.

PRELIMINARY FIVE-YEAR FINANCIAL NEEDS (CONTINUED)

Sitting Bull College—AS, Engineering
$134K $134K $134K $139K $144K Total: $685K

Southwestern Indian Polytechnic Institute—AS, Civil, Electrical, Mechanical Engineering*
$416K $399K $416K $424K $432K Total: $2,087K

Southwestern Indian Polytechnic Institute—Distance Education for the Partners
$289K $138K $137K $137K $137K Total: $838K

United Tribes Technical College—AAS, Engineering
$171K $222K $226K $229K $237K Total: $1,085K

White Earth Tribal and Community College—AS, Bioengineering
$198K $214K $205K $203K $202K Total: $1,022K

Preliminary Program Total: $10,682K

*Currently offers Civil Engineering Technology and Electronics Technology, both identified for ABET accreditation, the latter in the next review cycle.

WHAT IS THE WORKING GROUP'S PRESENT STATUS?

- The model described in the Management Plan was very well received by the Washington, D.C., community.
- The Working Group has been awarded $150K in grants since March 2004.
- Four of the eleven partners are currently represented on the Working Group by their presidents or acting presidents.
- At its October 2004 meeting, the group set general funding criteria.
  —Degreed engineers, not development of coursework, is the measure of success or failure.
  —Fund the critical programs first (i.e., those requiring immediate development of mathematics courses), but fund the whole program, not just the math courses.
  —Fund the partners in such an order that, as the students progress, they have somewhere to go next.
  —Include the capability to recruit, motivate, mentor, tutor, and retain students.
  —Include funds for preparatory class work and for laboratories and equipment.
  —Work together to leverage opportunities.
  —Treat distance education as its own enterprise.
  —Ensure adequate administrative support.

WHAT ARE THE WORKING GROUP'S NEXT STEPS?

- Request a budget update from the partners (December 2004).
- Work with interested Executive/Legislative Branch organizations to obtain initial five-year funding.
- Seek long-term sustainability via private foundations and corporations.
- Conduct National Academy of Engineering Workshop (January 2005).
- Plan and assign Working Group implementation tasks (April 2005).
  —Development of Working Group subgroups.
  —Develop common standards to permit seamless transfer of students among partners.
  —Curriculum development.
  —Distance education.