Sitting Bull College Pre-Engineering Program Review
March 10, 2017

0. EXECUTIVE SUMMARY

This report is an evaluation of the Sitting Bull College Pre-Engineering A.A. program during the five-year period from Spring 2012 to Fall 2016. The report is comprised of three sections, which are summarized as follows:

I. *Program Description* – SBC offers a variety of math & engineering classes that prepare students for the final two years of a B.S. engineering degree at a mainstream institution (such as NDSU). Average enrollment is 3.4 students per semester. Two students have successfully completed the A.A. degree in Pre-Engineering.

II. *Program Self-Evaluation* – There are ample grant-based funding resources, and many opportunities for faculty growth via workshops, conferences, and regular discussions with instructors at other TCUs engaged in similar programs. Such engagements also ensure the integrity and quality of the curriculum. The low enrollment and graduation numbers suggest that the program may need modification to meet the learning and employment needs of typical students.

III. *Program Planning* – In order to establish the viability of the program, it will be necessary to explore ways in which students can be increasingly recruited and supported. This may take the form of enhanced training and outreach in K-12, and/or modified funding and other academic support for enrolled students. The integrity of the program also hinges on the establishment of formal articulation agreements with mainstream institutions such as NDSU.

This review was prepared by:
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I. PROGRAM DESCRIPTION

a. Mission Statement

The Pre-Engineering program is designed to prepare students for transfer to a four-year institution of higher learning in an engineering discipline. Students who complete this program will have a background in mathematics, science, and engineering that enables them to succeed in the 3rd and 4th year of an ABET accredited 4-year engineering program. The provision of this academic and technical preparation is in alignment with the SBC Mission.

The program works collaboratively with other ND TCU pre-engineering programs via the NSF PEEC-PtiPS grant. Thus, SBC students take some courses from other TCU instructors via IVN.

Students successfully completing the program will have developed skills in critical thinking, written and oral communication, preparing them for the remainder of a BS in Engineering. Students will also have cultivated an understanding of the ethical and social implications of the engineering craft.

b. ENGR Courses Offered

ENGR 115	Introduction to the Engineering Profession w/ CAD	4 cr.
ENGR 204	Surveying	4 cr.
ENGR 206	Circuit Analysis I	4 cr.
ENGR 221	Statics	3 cr.
ENGR 222	Dynamics	3 cr.
ENGR 224	Thermodynamics	3 cr.

Non-ENGR Courses Offered

MATH 107	Precalculus	5 cr.
MATH 129	Basic Linear Algebra	2 cr.
MATH 165	Calculus I	4 cr.
MATH 166	Calculus II	4 cr.
MATH 265	Calculus III	4 cr.
MATH 266	Calculus IV	3 cr.
PHYS 252	University Physics II	4 cr.
CSCI 299	C++ Programming for Engineers	3 cr.

c. Degrees Offered

Associate of Arts

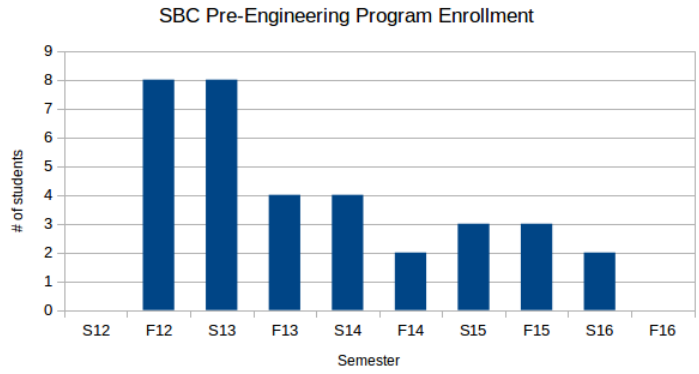
d. Program Personnel

Dr. Sharon Marcotte – NSF PEEC-PtiPS grant coordinator & co-PI. Administrative role.
Dr. Joshua Mattes – Full-time Pre-Engineering Instructor – offers courses via IVN (typically Calc I, II, III, DiffEq, Statics, and Dynamics), and also in-person classes (such as Physics II and PreCalculus). There are no adjunct faculty.

There are also faculty at the four grant partner institutions (Turtle Mountain Community College, Nueta Hidatsa Sahnish College, Candeska Cikana Community College, North Dakota State University) that teach classes to SBC students via IVN. There have been over 10 different non-SBC instructors, in addition to non-instructional staff at the other institutions.

e. Program Productivity Summary

e1. Enrollment By Semester



Average number of students over this period = 3.4. Two Pre-Engineering A.S. degrees have been awarded; these students are currently not pursuing the four-year degree. Only two students have persisted to degree; the remainder have dropped out after 1-3 semesters. One student attended 4 semesters and then switched degrees to Agriculture.

e2. Courses Offered By Semester

Course offerings were tailored to the needs of prospective and currently enrolled students. Including both locally taught courses and also the IVN courses taught from other PEEC sites, at least 8 courses were offered per semester. An illustrative 71 credit 4-semester plan is as follows:

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Math 165 (4) Engl 110 (3) Engr 115 (4) Psyc 100 (3) Csci 101 (3)	Math 166 (4) Chem 121 (4) Math 129 (2) Engl 120 (3) Comm 110 (3) PE Elect (2)	Math 265 (4) Engr 221 (3) Chem 122 (4) Engr. Elective (3) Humanities/SS Elect (3)	Math 266 (3) Engr 222 (3) Phyr s 152 (4) Soc 120 (2) Humanities/SS Elect (3) NAS 101 (4)
17 cr	18 cr	17 cr	19 cr

To lessen individual semester loads, students can take some classes during Summer sessions. Furthermore, most students do not enter the program ready for Calc I (Math 165), and need to start with earlier math classes, meaning that for many students the program is more than 4 semesters.

e3. Comparative Enrollment Numbers

The fact that the standard deviation of student enrollment is comparable to the mean, combined with small sample sizes, renders comparative statistical analysis largely meaningless. The decline in engineering enrollment numbers is just as likely due to an initial spike in initial program interest (which was unsustained as the difficulty of the program became known) or to random variance as it is to whatever is causing SBC enrollment decline generally. Exit interviews with students have indicated

that the two primary obstacles to persistence with the program are the difficulty level of the courses and the lack of additional financial assistance (which we cannot provide as per financial aid policy).

f. Program Revenue

Year	Fall ISC	Spring ISC	Tuition	Total
2012-2103	$23,995.00	$22,874.00	$28,800.00	$75,668.00
2013-2014	11,436.75	14,127.75	14,525.00	40,089.50
2014-2015	5,295.83	9,002.91	6,850.00	21,148.74
2015-2016	7,557.75	8,397.50	7,200.00	23,155.25
Total 2012-16	48,285.33	54,402.16	57,375.00	160,061.49

In addition to the above revenue, the NSF-funded PEEC grant itself provides $200,000 in revenue per annum.

g. Program Budget Categories

Description	2012-2013	2013-2014	2014-2015	2015-2016
Salary	55,152.96	52,244.00	43,408.91	68,095.75
Salary Temporary	4,745.00	3,325.00	.00	1,539.12
Fringe	8,849.77	12,920.95	9,900.22	18,005.39
Travel	4245.62	4054.73	1,963.96	205.20
Consultant costs	3,306.66	.00	.00	.00
Supplies	16,070.94	3,029.97	14,261.90	10,681.90
Indirect	16,070.94	12,991.02	10,505.47	14,749.93
Participant costs	35,407.48	25,196.97	2,649.18	8,445.26
Total	**139,016.52**	**113,762.70**	**82,689.64**	**122,029.53**

Notes: participant costs does not include any faculty salaries. It indicates direct support to participating students, in the form of financial aid, laptops, outreach activities, etc. Furthermore, there is no grant revenue outside of the academic program: the only influx of non-grant revenue is through student enrollment.

h. Advisory Committee: N/A

2. PROGRAM SELF-EVALUATION

a. **Faculty Quality Control**

There is only one faculty, so all of the questions related to cross-faculty communication and planning are N/A. There is regular communication with pre-engineering instructors at other ND tribal colleges, and this helps facilitate instructor growth. There are no mechanisms in place to observe or evaluate faculty, aside from the annual review process applicable to all SBC faculty. The PEEC instructors at different colleges typically talk via conference call 3 or 4 times per semester, and have in person meetings monthly to discuss the general state of the program and curriculum.

b. **Student Relations**

The Pre-Engineering program is tailored to student needs. Course offerings and times each semester are informed by the needs of current students. Office hours are set in collaboration with students. Given the small number of students, classes are easily structured to meet the students where they are at while maintaining core standards. A combination of tutoring, group activities, mini-lectures, and open Q&A allows for a class setting that is tailored to the individual students. The general course content is in alignment with that of larger institutions like NDSU, and follows ABET (Accreditation Board for Engineering and Technology) standards.

Some students attended tutoring (often the PEEC instructor was the tutor) and found it helpful, others did not attend. In-class group activities happen on average once per week, and after students picked up the relevant skills and comfort in group communication they found the activities helpful. Some students found them to be the most helpful part of the class. Mini lectures have little efficacy, though some students seem to appreciate the comfort of having previous educational modalities mirrored in their current setting. The mini-lectures covered regular course topics.

Only two SBC students have graduated the program and continued on to the four-year degree at NDSU. Neither of these students finished their 4-year degree, for reasons not entirely clear to the NDSU staff and faculty. In the context of SBC students, there is little to no evidence that the program successfully meets the learning and employment needs of students.

Curriculum Design, Content, Delivery

The curriculum is set largely by the inter-college PEEC collaboration, informed by the constraints of ABET accreditation and transferability of courses to NDSU, and as such does not undergo substantial review or alteration. The course texts and syllabi largely mirror NDSU courses, and as such rely upon their institutional processes related to quality control. Transfer issues impose significant constraints on modifying the course content of core engineering courses, and as such there is minimal modification of course content to address particular student needs, aside from make activities culturally/socially relevant, etc. *The uniqueness of the program lies in the extensive support and coaching that students receive outside of class, not in the courses themselves.*

Regarding program assessment, while attempts have been made to construct meaningful assessment measures, it remains true that in over 5 years there have been only two students who made it into the second year of the program; all other SBC students failed to make it past the first-year introductory courses such as Statics or Calculus II. Thus, either from a quantitative or qualitative standpoint, there simply isn't enough of a student sample size from which one could make meaningful inferences of the program's effectiveness. *This lack of student enrollment and graduation is perhaps the only salient*

indicator of the program's success here at SBC, where by "success" we mean preparing students to obtain an engineering degree.

Indigenous culture is incorporated into the curriculum largely through contextualizing course topics in issues of community concerns. Examples include using calculus to understand the economics of wind-turbine energy generation, or using statistics to understand measurements of local water-quality, or group projects where students play the roles of engineers working to develop responses to oil spills. Addressing culture in this way – by addressing concerns of the local people as shaped by their history, values, and concerns – was deemed appropriate by several SBC instructors in cultural studies.

Institutional Support

Facilities, equipment, and library resources were ample. The grant-provided professional development funds and opportunities are abundant and not problematic; many conferences on engineering education and curriculum development have been attended. The fundamental issues related to institutional support are related to student support, of which two are most important:

i) The policies of the financial aid office prohibit offering student stipends, and allow the grant funds only to be used to match a student's minimal financial aid needs. Given that the Pre-Engineering program is amongst the most difficult on campus, as regards the difficulty and time-commitment of coursework, the ability to provide ample financial support for students is critical. Worrying about whether they have to work a job to pay rent, day-care, cell-phone bills, etc. are serious blows to their ability to succeed in the program, as evidenced by numerous conversations with students with whom the instructor has developed good relationships; such concerns are a significant factor in the lack of retention. The other institutions in the PEEC collaborative have policies that allow for student stipends, and while there is no proof it is nonetheless plausible that this fact explains the differentially greater success of the other PEEC institutions in recruiting and retaining students in the program.

To some extent this concern has been mitigated in the past though offering contractual work to some of the students for 5-20 hours/week. The work has often taken the form of tutor/mentor training, assistance with outreach activities, and the development of course materials. Such work does provide additional income while also providing a work environment that facilitates their student development as engineers. Nonetheless, it would be significantly better to offer scholarships or stipends, so that the student could spend this time studying rather than being obligated to perform service tasks for the college. While this form of financial aid has been heretofore disallowed, perhaps there is some way to make it allowed in the future. Perhaps the contract work could be reformulated in such a way as to allow the student to spend the paid time on their coursework, if this is allowed within ethical and legal guidelines.

ii) The lack of tutoring services is problematic for students. The small student numbers often result in class sizes of one, so working with other students on homework is not an option, and furthermore the coursework is sufficiently advanced mathematically that no real tutoring services exist on campus. There may be no way around this as long as student enrollment is low, and the SBC pre-engineering instructor therefore is required to offer substantial assistance outside of class, which has been done consistently thus far.

iii) SBC supports professional development in multiple ways. The college encourages and provides funds for the attendance of conferences and workshops related to engineering education, STEM

education, and a variety of other topics. Travel to meet with other PEEC instructors is also encouraged and supported.

Obstacles

Primary obstacles are as follows:

i) Students do not receive adequate preparation in primary schools. None of the students entering the program were close to being adequately prepared for the rigors of the program, despite many of them having very good grades in STEM related classes. While intensive coaching and remediation can bridge the gap somewhat, it is unclear whether 2 or 3 years is enough time to both bridge the incoming gap and also get students properly through the coursework.

ii) Community support is low. Like many college programs, some community members embrace the program as an unmitigated good, while others regard it (with some justification) as a brain-drain that gives the best and brightest young people paths to leave the local community. Mitigating this latter concern could perhaps be accomplished through creating a successful history of service learning projects in the community, though a prerequisite is to have students enrolled in the program.

iii) Relationships with primary schools are weak. Most of the most capable high school graduates do not attend SBC, instead being recruited by other institutions. Working to strengthen the relationship between SBC and local schools could help to educate the community on the strength of the educational programs here, including the Pre-Engineering program. There is no quick solution to this, other than lots of ongoing work in relationship building. There are currently no strong examples of this, and it remains an important and imperative goal for future work.

Other Contributions

The program has expanded the course catalog in ways that benefit non-engineering students. Classes such as PreCalculus, Calculus, C++ Programming, and Environmental Statistics have been taken by non-engineering students, and are only possible because of the Pre-Engineering program.

Some of the outreach programs, such as the Summer Engineering Camps and robotics outreach, have undoubtedly had some impact on strengthening positive associations between students and STEM education, though this is difficult to quantify.

The engagement of the Pre-Engineering faculty and students with the AISES (American Indian Science and Engineering Society) has promoted important community building, though again this is difficult to quantify.

3. PROGRAM PLANNING

The PEEC-PtiPS funding was renewed for 3 years, with a new and additional focus on research related to the program's successes. It is clear that significant changes are required in the program. One possible modification, currently in the pre-planning stages, could be an alteration to the degree plan that allows for a semester-long first-year engineering/science experience. One possible implementation is an intensive, multi-disciplinary full-time (12 credit hour) course which used evidenced-based practices for building of student resiliency, problem-solving skills, study-habits, time-management, and also on improving content-knowledge deficiencies in subjects such as math, science, computers, and communication. Such a course could also incorporate contextualized multi-disciplinary service-learning projects, which could provide community benefit in addition to enhancing student motivation and self-efficacy. Preliminary planning meetings with other SBC STEM faculty are currently taking place, and it is at least conceivable that such a program could be in place for Fall 2017 students.

SBC enrollment in the program has been minimal, and has shown no indication of increasing substantially in the future. The program needs more students in order to sustain itself after the grant funding is finished. To address this, the Pre-Engineering instructor and some PEEC students will be making multiple recruitment visits to area high-schools during Spring 2017, in the hopes of identifying potential students for Fall 2017. There are also some engineering outreach experiences planned for the summer, including a week-long robotics academy and perhaps a more general summer engineering camp. Another possible activity would be a engineering workshop for area high school teachers, with the idea that a high-school STEM teacher who sees students constantly could serve an important recruitment role.

Regarding transfer of SBC engineering courses to mainstream schools such as NDSU, the NDSU PEEC faculty, Dr. Robert Pieri, has indicated that registration with a course-transfer data-bank would enable our courses to qualify for automatic transfer to NDSU. It is a plan to incorporate this process by the end of the Spring 2017 semester.

There are some resources that could benefit the program. Resources that could be leveraged to engage in a significant amount of outreach and preparatory STEM training in middle and high schools would certainly help in identifying and preparing potential engineering students. Financial incentives in the form of stipends could also help recruit and retain students; while it is true that some percentage of such students would just be "taking advantage" of this system, for other students such support could be critical in providing stability and incentive as they navigate through this rather difficult program. Additionally, the afore-proposed full-time first-year learning experience doesn't fit neatly into pre-existing SBC practices, and thus institutional support for substantial changes of this type would be especially imperative in cultivating an environment that might allow the Pre-Engineering program to evolve into a program that significantly meets the needs of students and the community.