

# **The Minority Engineering Transfer and Articulation (META) Program: Building Stronger Pathways and Developing Student Achievement**

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## **Abstract**

The Minority Engineering Transfer and Articulation program (META) is a 36-month project that took place between 2001 and 2004. The program is a cooperative effort between community colleges, New Mexico State University (NMSU), and five civil engineering industry partners. The goals of the program were to address the need for more civil engineers, to increase the representation of minorities and women within the technological workforce, to boost the transfer rate and numbers of students to bachelor's programs in civil engineering, and to provide a coordinated education pathway from community college pre-engineering programs to bachelor's degree programs in civil engineering. The META program's primary efforts have been focused on recruitment and retention of students by providing 1) a summer bridge component that introduces students to civil engineering and the field's technology applications and that prepares students for success as civil engineering majors, 2) industry-supported opportunities, and 3) year-round advising support on career opportunities. This paper focuses on the challenges we faced in developing and maintaining the META program and presents the positive outcomes, such as strengthened industry and community college relationships, engaging student activities, student internships, and the increase of students entering SMET fields, particularly civil engineering. The paper reflects plans for sustainability by further collaborations with our community college and industry partners.

## **Introduction**

Representing a joint effort of New Mexico State University, Santa Fe Community College (SFCC), Luna Community College (Luna CC), and five regional civil engineering industry partners, the Minority Engineering Transfer and Articulation program (META) was designed to help thoroughly prepare pre-engineering students in community colleges for entry into the civil engineering bachelor's degree program at NMSU. The idea for the program was conceived as a pre-engineering bridge program for the New Mexico Alliance for Minority Participation (New Mexico AMP) community colleges. This idea evolved into the META Program, a National Science Foundation-funded technology-oriented community college to bachelor's degree transfer program that is sponsored by New Mexico AMP. The 36-month program that took place between 2001 and 2004 was designed with several major components: 1) a three-week Summer

Technology Bridge (STB) program for pre-engineering students that included a 2-credit hour Special Topics course that focused on civil engineering and provided academic and financial workshops to help students transition to university life,

- 2) comprehensive student advising to help with transfer and articulation, 3) summer internships and other opportunities offered through the civil engineering industry partners, and
- 4) career preparation workshops and opportunities.

### *Realization of Goals*

The META program was designed to meet the following goals: 1) to address the need for more civil engineers, 2) to increase representation of minorities and women within the technological workforce, 3) to boost the transfer rate and numbers of students to bachelor's programs in civil engineering, and 4) to provide a coordinated educational pathway from community college pre-engineering programs to bachelor's degree programs in civil engineering. The goals of the program were realized as reflected in the majority of the students who opted to enter NMSU or gained a committed intent to do so after they complete their community college programs as well as in the number of students who made the decision to major in civil engineering. We attribute these decisions to the opportunities students were afforded to experience university life on campus for three weeks in addition to the varied opportunities they were provided to explore the discipline of civil engineering, what civil engineers actually do, and the processes of thinking they use in design and problem-solving. Clearly, the META program helped students to collect and acquire information they needed to successfully navigate the pathway or 'bridge' from community college to university life.

## **Background**

### *The Need for Programs that Encourage and Facilitate Student Transfer*

New Mexico, coined "The Land of Enchantment" perhaps as much for its diversity of people types as for its distinguishing diverse terrain, has the highest percentage of underrepresented minorities (42% Hispanic and 9.5% American Indian) in the United States, reflecting a sizable available pool of underrepresented talent in the state<sup>[1]</sup>. New Mexico's population of 1.6 million people is scattered over an area equal to the combined land area of 10 eastern states. Added to the factor of geographic isolation, the state's low income levels and lack of opportunity resulting from other factors, such as language barriers, create the need for programs in the state that enable students to enroll in nearby schools, most often community colleges<sup>[2]</sup>. Nationwide research reveals that the majority of students enrolling for higher education now assemble coursework from two or three campuses by the time they complete their degree programs. In New Mexico, for example, half of the students receiving bachelor's degrees in 1998-1999 and 1999-2000 had transferred from another institution before completing their degree<sup>[3]</sup>. Because of the high rate of transfer of New Mexico students, New Mexico's colleges and universities have steadily improved their working relationships, reflected in the success of programs like New Mexico AMP that partners with a large network of schools and universities.

New Mexico AMP, an NSF-sponsored program, is one of 30 AMP programs nation-wide. New Mexico AMP's goal is to increase the quantity and quality of minority students who complete their B.S. degrees and who are currently underrepresented in science, technology, mathematics, and engineering (STEM) disciplines. Since New Mexico AMP began in 1993, the number of STEM degrees awarded to minorities has doubled from 253 in 1992/93 to 510 in 2003/04. Just as significant is the increase in the percentage of minority students receiving STEM B.S. degrees, rising from 23.7% in 1992/93 to 44.2% in 2003/04.

META benefited from the existing network of New Mexico AMP and offered even more opportunities for transfer students, many of whom were the first in their families to go to college. The program targeted students enrolled in community college or with concurrent high school and community college enrollment, specifically, in the northern part of the state. This target was based on current studies that reveal that nearly half (47%) of all minorities in higher education attend community colleges and, specifically, on the high percentage (48%) of students in New Mexico that attend community college before transferring to university<sup>[4]</sup>. Further, with national attrition rates estimated at over 67% for first-semester two-year college students (nonwhite noted as the highest in attrition)<sup>[5]</sup>, programs like META that target students early and provide them with academic and social integration increase potential for success<sup>[6]</sup>.

#### *Facilitating Transition through Connections*

Liebermann and Hungar highlight the fact that “while the nation’s community colleges serve high numbers of minority and low-income students, disappointingly, few students manage to make the leap to four-year institutions<sup>[7]</sup>. The reasons for this, they purport, lie in the need for more flexible pathways and stronger academic support to compensate for any limitations in students’ readiness for college-level work<sup>[8]</sup>. Therefore, the goals of META were thoughtfully and carefully designed to provide a connected and coordinated educational pathway from community college to university. The summer bridge program provided this pathway with its campus orientations, workshops, networking with faculty, experience of dorm life, and participation in a university course. Further, the program created important connections for students, encouraging development of meaningful relationships with faculty and peers. In addition, the program helped develop self-confidence in those students who were possibly struggling with a fundamental obstacle of low self-esteem perhaps promoted by the lack of role models in their families or lack of confidence in their academic abilities. Workshops and campus tours prepared students for the rigors of university life by introducing them to campus resources that offered support and encouraged success and that reinforced strategies to help students with study skills; critical reading skills, including annotation, summarization, and engagement with the text; time management; money management focusing on obtaining financial aid and avoiding student debt; and issues of social life within the university community.

Rendon points out that two critical phases affect the retention of first-semester students: 1) the phase in which students transition from one setting to another and 2) the “connecting phase” in which students become anchored within the institutional community<sup>[9]</sup>. META provided experiences that helped students through these critical phases by immersing students in the university culture and directing them to specific goals that would reduce the risk of attrition.

## *The Need for More Civil Engineers*

As the oldest engineering profession, society's future depends on the more basic technologies associated with infrastructure and environments needs <sup>[10]</sup>. However, the field of civil engineering is facing "unprecedented challenges" in attracting students to major in the discipline <sup>[11]</sup>. Sack et al assert that the discipline often fails to attract students who are looking for a program of study that "prepares students for a variety of jobs" <sup>[12]</sup>. For example, the authors note that positions which have been traditionally filled by civil engineering graduates are more and more being filled by civil engineering technicians. To attract students to the field, Clough argues that civil engineering students must be trained in new and creative approaches to using technology and that this training must include practical experiences in industry <sup>[13]</sup>. Further, prospective students must be made aware of what it is that civil engineers do. When they understand that civil engineers work on things that most directly affect quality of life, they can begin to connect their own values and passions to the profession as they see that their work can have a direct impact on improving life for others. Oscar Suros, inducted into the Hispanic Engineers hall of Fame in 1998, draws on a model his company uses to familiarize students with the profession of civil engineering and the actual work they do. He encourages companies to provide mentoring and internship programs, advocating that these experiences offer dual benefits: one for the students who receive practical hands-on experience and another for the company who gain a pool of future employees <sup>[14]</sup>.

Drawing on these ideas and models, the META program offered two opportunities: 1) a summer course that introduced students to the background and profession of civil engineering and 2) opportunities with our industry partners, including internships, that allowed students a close-up-and-personal view of the civil engineer. The summer course during the STB focused on what civil engineering is, what civil engineers actually do, and the history and heritage of civil engineering. A course entitled, "Civil Engineering: The Profession, Practice, and Academic Preparation," was the focus each summer with a different design project offered for each course that highlighted some of the challenges locally, namely, the problem of drought in New Mexico, water conservation alternatives, and the problems associated with the colonias, defined as rural neighborhoods and unincorporated subdivisions in or near cities along the U.S./Mexico border characterized by substandard housing and inadequate sewage disposal, roads, and access to clean water that pose health threats to residents. This course, along with the laboratory tours and visits provided hands-on active learning opportunities to explore the new and creative approaches that are being used in civil engineering today. Further, students went on various field trips to local colonias, municipal and on-site water treatment plants, and Elephant Butte dam. These practical experiences immersed students in the discipline and refocused any stereotypes they may have of the civil engineer, introducing students to the new and creative approaches to technologies in the field. Importantly, many students discovered that the field of civil engineering offered them a way to connect with their passion to serve and better society and to use their creativity and artistic abilities. They also begin to recognize that civil engineers are creative problem-solvers who make a difference in our society.

Another way that the META program helped attract students to the field was through industry-supported activities, events, and internships. Students were given opportunities to visit work sites and offices of our civil engineering industry partners and to interact with these engineers. At

one event, students interviewed for internship positions with our industry partners. To prepare for this event, students attended career workshops that focused on strategies of resume writing and interviewing. Before the interviews, each industry representative presented a talk that informed students of their work around the state and what it involved. Through this discussion, students learned about actual problems in New Mexico that are being solved by civil engineers. After this, META students who had been involved concurrently in mentor/student research assistantships through the New Mexico AMP Undergraduate Research Assistantship Program presented oral presentations on their research. Then students interviewed with industry partner representatives for summer internship positions. Several students were selected for internships and interned in Las Cruces and Santa Fe, NM. Each of the selected interns produced a written report about their internship experience. Through these experiences, students were given a new awareness of the complexities, challenges, and realities that civil engineers face in their professions, which pulled many of the students in the direction of entering the discipline as their major.

### **Challenges in Developing and Maintaining the META Program**

In the development stages of META, the primary goals we had in mind were to address the need for better transfer and articulation by offering a summer bridge program and by integrating industry-sponsored technology-oriented work and educational experiences into the curriculum. Although these goals were realized, the program was not without challenges, particularly with community college and industry partnerships that were geographically spread so far apart. The primary challenges were resource-related ones, in addition to the challenge of coming up with design projects for students who lacked the academic training and experience to research and design projects that were challenging yet not too sophisticated for their developmental levels.

#### *Resource-related Challenges*

A bridge program demands a great deal of preparation involving coordination with many entities, including the following:

- admissions and financial aid departments of the admitting university where the program is held;
- staff of the program by whom the students must be screened, accepted, admitted, and compensated;
- university faculty who lead the teaching and direct the field trips and laboratory tours;
- other campus entities that provide campus orientations, tours, and seminars;
- organizations, agencies, individuals that provide tours in labs or field trips
- students and their parents;
- industry partners who provide support of office and on-site tours, presentations, attendance at events with students, consulting and advice;
- community college instructors who recruit the students for the program and who help teach the course.

Because the program becomes very labor-intensive, sufficient resources are required. Needless to say, the program is a costly endeavor, with student stipends, three weeks of room and board for students, and a considerable number of other expenses and budgetary concerns. Although

NSF provided the bulk of the monetary support, we had to depend on our community college and industry partnerships to supply our other resource needs, namely, personnel and in-kind support. These resources were highly beneficial to the program yet not without challenges to organize, coordinate, and attain.

One of the biggest challenges was the time our fairly small staff had to devote to each summer bridge program. Students had to be screened closely and upon selection, those attending community college or a concurrent high school/community college had to be processed through Admissions and formally admitted to the university even though they would be returning to the community college in the fall. This involved close contact with students, parents, and the Admissions Department and required the appropriate documents and procedures of admission. Further, we had to follow correct procedures for processing student stipends, a labor-intensive process, so we had to work closely with the financial aid office that disperses stipends. Most importantly, we had to plan a new curriculum each summer with a different design project focus and coordinate lab tours, campus workshops, and field trips, and various events during the bridge program.

#### *Challenge of Planning Developmentally-appropriate Projects*

For each Summer Technology Bridge program, the accompanying course focused on the basics of civil engineering: what civil engineering is and what civil engineers do, the needs of society that drove development of famous civil engineering projects and the technologies involved, and ethical practices and codes of civil engineering. Then for each course, we focused on a different primary design projects highlighting the colonias the first summer, water resources in New Mexico the second summer, and civil engineering community infrastructure the third summer. The development of course materials since the beginning of the META project has created a viable connection that ties the required coursework to real and relevant technology-oriented applications in civil engineering. However, when it came to identifying the student design projects, we always faced the dilemma of planning challenging projects that were not too sophisticated for the students. Developmentally as engineering students, they lacked the civil engineering background and academic experience to do very high level work. Therefore, their required collaborative design project turned out to be generalized with low level technical analysis and only a fundamental engineering analysis. We allowed the students the freedom to identify solutions that had been researched and used previously in similar situations as models for their chosen project.

Although our Peer Mentors, students who had attended the Bridge program previously, donated a great service by assisting the new students, they, too, did not have the advanced technical background to help with more sophisticated projects or research. The field trips and the course lectures helped to provide a more technical background to their expertise, but for the most part, the students' collaborative projects were designed for students to learn the basic technical and sociological aspects associated with the problems. The experience was also designed to gain practical experience in the engineering design process, teamwork, and oral presentations. For example, in the summer of 2003, the design project was focused on "Water Conservation for Surviving the Drought on the Lower Rio Grande." For their collaborative projects, students explored problems and solutions and selected projects focusing on municipal water conservation,

agricultural water conservation, salt cedar management in New Mexico, and a river restoration project. They studied the problem and its history and identified a solution used in a similar situation and proposed alternatives for addressing the problem based on these models. Even with the challenge of students lacking the necessary background to do very high level work, we recognized early on that the value of this experience went beyond whether or not the collaborative reports lacked the technical focus that is the norm in a higher level civil engineering classroom—most importantly, these students were provided the opportunity to use the engineering design process while collaborating with others on an actual world-of-work civil engineering project.

### *Challenge of Institutional Commitment*

In the original proposal, we partnered with Santa Fe Community College (SFCC) because of our strong working relationship. Our Institutional Coordinator (IC) for New Mexico AMP at SFCC had championed the SMET 101 efforts (an AMP-sponsored “Introduction to Science, Math, Engineering, and Technology” course) in a concurrent high school and community college program, which, it turned out, served as an excellent vehicle for recruitment of students for the META program. He also advertised the META program in his technologies classes at SFCC. For the first two years, these efforts to recruit students already attending SFCC and those enrolled in the concurrent SMET 101 class were successful, providing a majority of the students for the META program in 2001 through 2003. However, he accepted another position at a major New Mexico university, and because of his departure, SFCC has not offered SMET 101 because, like many of our existing partner institutions, SFCC is understaffed and instructors are overloaded with responsibilities. Adding to this challenge is the impact of the significant reduction of AMP funding in Phase III at SFCC and our other partner institutions. This decrease in funding represents a serious challenge to New Mexico, with its low socioeconomic levels, a small population spread over a wide area, and the centralized nature of educational management. Existing AMP funds are spread thin when shared with the large number of independent schools needed to serve this widespread population.

To develop a strategy for continued AMP and META involvement at SFCC, the New Mexico AMP Director and Program Manager met with the administrators at SFCC and with other SFCC staff members numerous times to discuss recruitment strategies for the META program. The meetings included the Chair of Computer and Information Technologies, the Dean of Business Technologies, staff of the Student Services and Career Guidance Office, and various instructors in the SMET areas. Importantly, we worked on continued plans for connected coursework at NMSU and SFCC, and we strengthened ties with administrators, improving the likelihood of continued support at SFCC. However, because of the difficult transitions they were encountering finding replacements for the Chair of Technologies and SMET 101 and technologies instructors, it was clear that we had to shift our focus to another of our partner institutions for recruitment of META students for the final year.

Because of the ties we had at another of our AMP partner institutions in the northern part of the state and their interest in participating in the META program, we invited Luna Community College (Luna CC) to participate in the program for 2004-2005. One of the technologies instructors, who is also serving as Luna CC’s AMP IC joined our team of instructors for the

bridge program for 2004. This instructor widely advertised the META program in the pre-engineering courses at the college, successfully recruiting one-third of the new META students for the final year of the program. As we did the summer before with the SFCC instructor, the Luna CC faculty was hired as a summer bridge instructor. He was compensated for preparing and teaching the summer course and living in the dorm as a chaperone. This proved to be a successful strategy as a majority of the students that were selected were Luna recruits, along with several students from SFCC. Through these very challenging circumstances, institutional relationships and connections were strengthened, resulting in more opportunities for sustainability of AMP and of META in the future.

Working through these challenges made us realize that it is essential to strengthen our ties with the community college administration so they gain a clear perspective of the programs in which their instructors participate. Although we appreciated having a primary “champion” to drive the recruitment at SFCC, we recognize that relying on one person is not wise because if that person leaves, the foundation he/she has built is at risk of weakening, if not collapsing altogether. By considering how best to approach strategies for involving more faculty at the institutions, we realized that we must take into consideration what the administration values most in this participation. We recognized that administration probably attributes highest value to professional development because of the opportunity to transfer skill and knowledge from the program to courses they teach and programs they develop at their institution. For example, the experience of preparing curriculum and teaching in the Bridge program with university faculty is an excellent professional development opportunity that provides instructors fresh pedagogical methods and approaches for teaching their regular classes, an experience that just might reduce the risk of burnout at the community college. Thus, enlisting support of the administration paves the way for more faculty involvement.

### *Challenge of Industry Commitment*

We enlisted the support of five regional civil engineering firms. These firms agreed to help with provision of book scholarships, consulting and advising with curriculum development, summer and part-time internships, company site visits and other experiences, and presentations, staff service on the META program, professional mentorships, and service on the Advisory Board. Although many of these commitments were honored, the economic downturn resulting from 9/11 made it challenging for the companies to honor their commitments in full. Several of the industries had to downsize their staff numbers, resulting in fewer people doing more work. We understood from the beginning that our ability to secure resource from companies would be the most challenging and that in-kind contributions would be the norm. However, we didn't account for this economic crisis resulting from a tragedy like 9/11 that would also impact the in-kind support we needed. Primarily contributing in the way of consulting and advising with projects and curriculum, this became the industry partners' strength in the program. They also provided company on-site visits, presentations at various events, and they met during Fall 2003 to formally interview each student for summer internships. A few of the industry representatives continually offered their support to the students, instructors, and staff, and they consistently championed the efforts. Only one of our partners, the New Mexico Department of Transportation (DOT) provided internships for the students, and these turned out to be excellent experiences. The other industries cited reduced numbers of staff members as the reason for not

honoring their commitments to have student interns, asserting that their reduced level of manpower prohibited them from devoting time to the management and mentoring student interns would require. What we value most about our partnerships with industry is the connections the students made with actual civil engineers who shared their time and lives with them. These engineers shared current opportunities and helped students make vital connections that go further than mere technical or academic knowledge; they helped the students see that civil engineers work on projects that directly affect the quality of life in our society today.

### Positive Outcomes

Even with the challenges that we faced in the program, we consider it a very successful program, evidenced by the number of students who attended and chose to transfer into NMSU in civil engineering, the comments we received from students who have experienced an easier transition into college life because of the bridge experience, and the comments from appreciative parents who were thrilled that their children were more focused and oriented toward a specific goal. Further, the program has strengthened ties with our industry and community college partnerships and provided quality internships and work-related experiences in which our students were involved.

#### *Impact on Students and Faculty*

Beginning on September 1 of 2001 and ending on August 31 of 2004, the META program has impacted the lives of the 32 students supported by the program. Out of the 32 students, 18 entered and remain at NMSU, and out of these 18, 10 students entered and remain in civil engineering and six entered and remain in other SMET disciplines. Six of the students returned to their community college with the intent of transferring to NMSU and two entered another major New Mexico university, one in civil engineering. A profile of the students who participated in the program is summarized in Table 1. The experience of living on campus for three weeks and experiencing campus orientations, academic and financial management workshops, and participation in a college course provided an excellent pathway into university life. Many lives were dramatically impacted, opening up horizons students may not have previously envisioned. From interviews with students and parents, the pathway from high school or community college to university was made more accessible to these students, who felt more anchored, more comfortable, and more connected.

**Table 1. Profile of Students Who Participated in the META Program.**

Gender	Ethnicity	NMSU Enrollment	Other Enrollment
Male – 21 (66%)	Hispanic – 27 (84%)	CE – 10 (31%)*	Univ CE – 1 (3%)*
Female – 11 (33%)	White – 2 (7%)	SMET – 6 (19%)*	Univ Other – 1 (3%)*
	Afr Amer – 1 (3%)	Other – 2 (6%)*	CC – 6 (19%)*
	Amer Ind – 1 (3%)	Total – (56%)	Unknown – 6 (19%)*
	Other – 1 (3%)		

\*Percent of total participants (n=32)

Through the advising component of the META, students have become more aware of transfer requirements, thus reducing the possibility of wasting money and time and of developing skills and knowledge needed for university-level coursework. Students can also more efficiently and effectively navigate the educational pathway between the two degree programs.

Many of our students have become active participants in other New Mexico AMP-sponsored programs, including the Undergraduate Research Assistants (URA) Program, in which students become apprentice researchers on faculty member's research projects, benefiting from practical experience and classroom knowledge and learning to research, write, and report their research. Others have entered the Computer Science, Engineering, and Mathematics Scholarship (CSEMS) program, providing scholarship recipients academic and professional workshops, discipline-specific faculty mentoring, and academic tutoring in Engineering, Engineering Physics, and Computer Science, as well as research opportunities. Many of the META students also participate in the annual New Mexico AMP Undergraduate Student Research conferences at which students in our AMP partnerships convene and present their recent research.

The career workshops in which students participated prepared them for resume writing and interviewing strategies. Then as one of our major events during the year, students had the opportunity to travel to Albuquerque and interview with our industry partners at one of their office sites. Each of the industry partners discussed the work they do and about the problems in New Mexico that are being solved by civil engineers throughout the state. The students interviewed for summer internships with the partners, and some students presented research they have conducted in the URA program. As a result, several of the students obtained summer internships with the New Mexico Department of Transportation. The students' responses to these experiences were positive and developed their awareness of what is expected in an actual world-of-work interview. Each of the post internship reports that the interns wrote reveal that the internship experience directed them to a specific civil engineering specialization for their future career.

Not only students benefited, however. For faculty, new pedagogical methodology was developed, especially for the community college instructors who had the opportunity to partner with university faculty. New curricular connections have begun as one of the faculty for the program developed sidebar lectures that may be used in a community college statistics course. Further, community college and university faculty worked side-by-side in the development of a curriculum on the colonias that is planned to be used as a pilot for a course. These experiences strengthened ties between NMSU and the community colleges, ties that have forged future collaborations and smoother pathways of transfer. Further, the META instructors were given the opportunity to attend professional development workshops and seminar. One such seminar was entitled "Effective College Teaching" that provided tools and strategies for college professors to make their SMET classes more effective. The seminar, presented by Dr. Richard Felder, Hoect Celanese Professor Emeritus of Chemical Engineering at North Carolina State University and faculty development Co-director of the NSF SUCCEED Engineering Education Coalition, was attended by faculty who teach SMET 101 around the state and who are involved with META. Dr. Felder also met with the SMET and META faculty and led a discussion entitled "Articulation and Transfer Strategies for Community Colleges and Universities."

### *Strengthened Industry Ties*

The META Program improved the quality of civil engineering education by the positive response of the industry partners. The partners have provided students with the opportunity to learn more about civil engineering and what civil engineers actually do by conducting presentations, meeting, and interviewing with the students, and providing workplace and site tours. Further, the summer internships provided students opportunities to shadow and be mentored by civil engineers in their workplaces and worksites. Plans are underway for future involvement with New Mexico Department of Transportation and possibly some of the other industries.

### *Strengthened Community College Ties*

As a result of our partnerships with Santa Fe Community College and Luna Community College, more procedures have been set in place to help students navigate the educational pathway between the college and NMSU. Specifically, recruitment strategies, connection of course work around the technology theme at SFCC and NMSU, and coordination of SFCC and NMSU degree and administrative requirements and procedures are better established to help with the transfer and articulation process. Opening up the opportunity of involving Luna CC students in the META program and of Luna faculty to teach in the program has also strengthened ties and paved the way for more collaboration in the future.

### **Plans for Sustainability**

We have begun discussions with the community colleges top administrators and key SMET instructors at SFCC and Luna CC to discuss sustainability of the program to develop further collaborations aimed at increasing the number of community college students transferring to four-year engineering programs. At SFCC, these discussions were specific to civil engineering, and the three-way partnership between SFCC, NMSU, and the New Mexico Department of Transportation (New Mexico DOT) was explored.

Specifically, a 2+2+3 concept was discussed in which SFCC would work with local high schools to develop concurrent enrollment programs that would allow students to apply credits earned in high school to apply to a pre-engineering program at SFCC. Additionally, a two-year pre-engineering program at SFCC would transfer to NMSU, after which students could reasonably expect to spend an additional three years to complete the B.S. degree in civil engineering. Finally, students would have opportunities to intern with the New Mexico DOT, a public agency, which has expressed interest in continuing to cultivate and recruit these students.

In discussions with faculty and administrators at Luna CC, a similar high school to community college to university program concept was discussed. The chief academic officer at Luna CC has extensive experience in developing such programs and is specifically interested in working with NMSU to develop a strong pre-engineering program at Luna CC that would transfer credit to any one of NMSU's engineering programs. Currently, Luna CC faculty are consulting with local area high schools to assess their curriculum and laboratory equipment and are making recommendations for improvement in these areas. These improvements will more carefully

align the high school courses with Luna CC's curriculum, leading to the development of concurrent enrollment programs. The involvement of the New Mexico Mathematics, Science, and Engineering Achievement (New Mexico MESA) Program, a high school preparatory program, was also discussed as an important component of this programs.

As a follow-up to both of these meetings, the META Program Director met with the Dean of the NMSU College of Engineering, who has a strong interest in creating strong articulation agreements and transfer programs with New Mexico's community colleges. These interests are strongly aligned with institutional goals and have the support of the university administration. The Program Director has also met with Department Head of Civil Engineering to discuss these opportunities, and he was very supportive of future work with us.

Further, the faculty member who prepared the sidebar lectures plans to implement his sidebar lectures entitled "Statistical Applications in Civil Engineering," which highlights bridge and culvert design for drainage under bridges. The sidebar lecture includes topics such as design flow, the return period of flow, and probability of failure and will focus on assumptions, log-normal distribution, and will include a statistical presentation of an example for the Santa Fe River. Long-range plans for integration of the sidebar lectures have been discussed with SFCC.

In the spring of 2005, New Mexico AMP plans to submit to National Science Foundation (NSF) a proposal for the Research Experiences for Undergraduates (REU) Program to extend funding for continuation of the summer technology bridge experience.

## **Conclusion**

The positive impact of the META program on students, faculty, and institutions argues for wider application of this model. The positive outcomes derived from the major components of this program, particularly the Summer Technology Bridge program and the partnerships with industry and community college makes this a worthwhile project to continue. META helped remove barriers to transfer for students and offered faculty an alternative to burnout by working with other institutions learning from each other's faculty. Further, the program transformed the stereotype of the community college student and helped ease their progress on the path to the baccalaureate degree, a benefit that will, no doubt, extend into the next generation of those students whose aspirations and expectations were raised.

Perhaps the most valuable offerings of the program to students was the consideration instructors gave to cognition and ways people learn as the framework for the summer bridge course, leading to students' active participation in class activities and assignments. Students were encouraged to use critical thinking techniques and the engineering design process to learn how to question and analyze problems and seek solutions. They were encouraged to engage in the projects by first-hand experiences, including hands-on activities in various NMSU laboratories and on field trips around New Mexico that informed students of the practical nature of civil engineering. Students visited colonias, dams, water treatment plants, and offices of civil engineers and were given collaborative assignments that helped students be participants in their own learning instead of just observers. Further, they were provided a new level of awareness and appreciation for development of their thinking, writing, and oral presentation skills through the assignments. By

focusing the curriculum of the bridge program on the profession of civil engineering, what civil engineers actually do, and the history and heritage of the profession, students were led to understand the importance of the work these professionals do, work that benefits society, that transforms the infrastructures of communities, that offers people more quality in their lives. But most importantly, META contributed by opening the minds of students and providing them a sense of their own possibilities by promoting transfer to a four-year institution, thus opening up options available to these students and offering the skills and confidence to exercise these options.

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