

# **AC 2008-1104: IMPLEMENTING A CIVIL ENGINEERING PROGRAM AT THE NATIONAL MILITARY ACADEMY OF AFGHANISTAN**

## **Stephen Ressler, United States Military Academy**

Colonel Stephen Ressler is Professor and Head of the Department of Civil and Mechanical Engineering at the U.S. Military Academy (USMA) at West Point. He earned a B.S. degree from USMA in 1979, a Master of Science in Civil Engineering degree from Lehigh University in 1989, and a Ph.D. from Lehigh in 1991. An active duty Army officer, he has served in a variety of military engineering assignments around the world. He has been a member of the USMA faculty for 16 years, teaching courses in engineering mechanics, structural engineering, construction, and professional practice.

## **Richard Gash, United States Military Academy**

Major Richard Gash, P.E. is an instructor in the Department of Civil and Mechanical Engineering at the U.S. Military Academy (USMA), West Point. He graduated from the USMA in 1996, earning a Bachelor of Science Degree in Civil Engineering. He has since earned Master of Science Degrees in Geophysics from the University of Missouri, Rolla and Earthquake Engineering from the University of California, Los Angeles. As an active duty Army officer he has served in a variety of military assignments around the world including Iraq and Afghanistan. During the summer of 2007 he served as a member of the Combined Security Transition Command's Implementation and Support team at the National Military Academy of Afghanistan.

## **Christopher Conley, United States Military Academy**

Chris Conley is an Associate Professor in the Department of Civil and Mechanical Engineering at the U.S. Military Academy. He earned a B.S. degree in Civil Engineering from the University of Massachusetts (1978), and M.S. and Ph.D. degrees in Civil Engineering from Cornell University (1980, 1983). He has served as a Member of Technical Staff at Sandia National Laboratories, a Senior Research Associate at Cornell University, and an Assistant Professor at the University of Massachusetts Lowell. In his 13 years on the USMA faculty he has taught a variety of courses in the civil and mechanical engineering programs, and has collaborated on research with Army laboratory personnel.

## **Scott Hamilton, United States Military Academy**

Lieutenant Colonel Scott Hamilton is currently the Senior Advisor and Team Chief at the National Military Academy of Afghanistan in Kabul Afghanistan. He earned a B.S. degree from USMA, and Master of Science degrees in Civil Engineering and Engineering Management from Stanford University in 1994. An active duty Army officer, he has served in a variety of military engineering assignments around the world and is a registered professional Engineer in California. He has been an Assistant Professor in the Department of Civil and Mechanical Engineering at the U.S. Military Academy (USMA), West Point for 7.5 years, teaching courses in engineering mechanics, structural analysis and Home Brewing.

## **Farid Momand, Kabul University**

Farid Ahmad Momand holds a Bachelor of Science degree in Civil Engineering from Kabul University in Kabul, Afghanistan. He has served as an Assistant Professor (Pohialay) at Kabul University for two years, an adjunct instructor at the National Military Academy of Afghanistan for one semester, and a practicing structural engineer for 14 months at United Infrastructure Projects, a private company. He is currently enrolled in the master's degree program in civil engineering at Ohio University, under the auspices of the Afghan Merit Scholars Program.

## **Qaium Fekrat, Kabul University**

Abdul Qaium Fekrat holds a Bachelor of Science degree in Mechanical Engineering from Kabul

University in Kabul, Afghanistan. He has served as an Assistant Professor (Pohialay) at Kabul University for two years, an adjunct instructor at the National Military Academy of Afghanistan for one semester, and a practicing mechanical engineer for two years in the International Organization for Migration and at United Infrastructure Projects, a private company. He is currently enrolled in the master's degree program in mechanical engineering at Ohio University, under the auspices of the Afghan Merit Scholars Program.

**Aziz Gulistani, Kabul University**

Aziz Ahmad Gulistani holds a Bachelor of Science degree in Civil Engineering from Kabul University in Kabul, Afghanistan. He has served as an Assistant Professor (Pohialay) at Kabul University for one year, an adjunct instructor at the National Military Academy of Afghanistan for one semester, and a practicing design engineer for eighteen months at 18 months at the Amu Construction Company. He is currently enrolled in the master's degree program in civil engineering at Ohio University, under the auspices of the Afghan Merit Scholars Program.

## **Implementing a Civil Engineering Program at the National Military Academy of Afghanistan**

This paper describes the ongoing implementation of a civil engineering program at the newly created National Military Academy of Afghanistan (NMAA) in Kabul. We begin with a brief summary of our respective roles in the project and the current status of program development. We present an interim assessment of the project in the following areas:

- Faculty Qualifications and Training
- Curriculum Development Process
- Course Design Process
- Course Implementation
- Student Learning Outcomes

We conclude with an overview of future plans for this project and a summary of the challenges the institution must overcome in order to succeed.

### **Background**

The authors have participated in the development of NMAA in a variety of roles. Conley and Ressler deployed to Afghanistan on military orders from January to April 2007, with the mission to design the NMAA civil engineering program. Upon arrival in Afghanistan, their first major task was to hire four faculty members who would teach the first two courses in the new program, starting in March 2007. Fekrat, Gulistani, and Momand were three of these initial faculty hires. All three are Afghan assistant professors at Kabul University, hired as adjunct instructors at the NMAA. It was necessary to hire adjuncts for this first year of the new program, because there were no military officers in the Afghan National Army with adequate background to teach college-level engineering.

Working in collaboration with the Dean of Engineering Faculty at Kabul University, Conley, Ressler, Fekrat, and Momand developed the 16-course civil engineering curriculum shown in Figure 1 below. In this graphic, the first column shows the eight academic semesters constituting the four-year NMAA curriculum. The courses offered in each semester are listed across each corresponding row. The dark horizontal bands preceding each pair of semesters represent military training periods. These periods would correspond to summers at a U.S. institution; however, at the NMAA they actually occur in the February-March timeframe, as Afghan educational institutions use the Islamic calendar as the basis for their school year. The courses highlighted in yellow represent the 16-course civil engineering major. All remaining courses constitute a common core curriculum taken by all NMAA cadets. CE301 (Introduction to Engineering Mechanics and Design) and CE302 (Construction Management) serve as a two-course core engineering sequence taken by all cadets, as well as being part of the civil engineering major. The core curriculum includes nine courses that also serve as prerequisites for the civil engineering major—Pre-Calculus, Calculus I and II, Statistics, Chemistry, Physics I and II, Information Technology, and Information Systems.

CADET BASIC TRAINING							
1	Foreign Language	Afghan, Regional, & Islamic Culture	Composition	Information Technology	Pre-Calculus & Modeling	Ethics, Moral Theory & Islam	Intro to the Military Profession
2	Foreign Language	World History	Composition	Chemistry	Calculus I	Psychology	Introduction to Warfighting
CADET ADVANCED TRAINING							
3	Foreign Language	Military Geography	Economics	Physics I	Calculus II	Small-Unit Tactics	
4	Foreign Language	Information Systems	Government	Physics II	Statistics	Small-Unit Tactics	
BRANCH ORIENTATION TRAINING							
5	Foreign Language	Intro to Engineering Mechanics and Design (CE 301)	International Relations	Military Leadership	Engineering Mathematics	Civil Engineering Fundamentals (CE 303)	Small Unit Leadership
6	Foreign Language	Construction Management (CE 302)	Constitution and Law	Thermodynamics & Fluid Mechanics (CE 304)	Mechanics of Materials (CE 305)	Environmental Engineering (CE307)	Combined Arms Operations
BRANCH SPECIFIC TRAINING							
7	Hydrology and Hydraulic Design (CE 401)	Transportation Engineering (CE 402)	Structural Analysis (CE 403)	Technical Communication (CE405)	Geotechnical Engineering (CE306)	Military History	Tactical Leadership
8	Dynamics (CE404)	Design of Steel Structures (CE 406)	Design of Reinforced Concrete Structures (CE 407)	CE Design Project (CE409)	Military History	Branch Training	
COMMISSION							

Figure 1. The NMAA Curriculum with Civil Engineering Major

In January 2007, when Conley and Ressler deployed, NMAA had just completed its second full academic year, and the rising class of 84 third-year (junior) cadets was preparing to begin Semester 5. During this first semester of engineering instruction from March to August 2007:

- Fekrat, Gulistani, and another Kabul University colleague taught CE301 to the entire class of 84 cadets. The content of CE301 includes statics, basic-level mechanics of materials, and an introduction to the engineering design process.
- Momand taught CE303 (Civil Engineering Fundamentals) to the 18 cadets enrolled in the civil engineering major. Enrollment in the major was based on the cadets' preferences and academic merit—only the strongest students in the class were admitted into the single 18-man section. The content of CE303 includes an overview of the civil engineering sub-disciplines (e.g., transportation, hydrology, geotechnical engineering), civil engineering site design, CADD, and surveying.

Gash deployed to NMAA from June to August 2007, along with two faculty members from the U.S. Air Force Academy, to continue mentoring the Afghan faculty and to design the Semester 6 courses. Hamilton also deployed in June 2007, to serve for a full year as Chief of the Military Academy Support Team in Kabul. In this capacity, he is responsible for oversight of all NMAA programs—academic, military, and physical—as well as facilities, personnel, administration, and logistics. His role in the development of this paper was the design and implementation of a student feedback process—the first formal assessment system at NMAA—and the associated data collection.

The historical development of NMAA and the design of its civil engineering curriculum are described in greater detail in Reference 1.

## Assessment of Faculty Qualifications and Training

Table 1 shows a summary of the three Afghan professors' professional qualifications at the time of their hiring as NMAA adjuncts in January 2007. Fekrat, Gulistani, and Momand earned their bachelor's degrees from Kabul University in the 2005-2006 timeframe. In assessing these credentials, it is important to recognize that, at the time, the Kabul University degree program was five years long and included 53 courses and one semester of professional experience—easily the equivalent of a bachelor's degree plus a master's degree in the U.S. The course content in this degree program was quite comprehensive; however, it lacked a substantive laboratory component, because the university's lab facilities had been destroyed during Afghanistan's civil war from 1992-1996. Nonetheless, this program was then (and remains now) the best degree program available in Afghanistan.

Fekrat, Gulistani, and Momand also have strong English language skills. They are largely self-taught, because formal English language instruction was forbidden under the Taliban regime.

Given their academic preparation, teaching experience, and professional work experience, Fekrat, Gulistani, and Momand represented the best qualified faculty that NMAA could ever have expected to employ.

Name	Degree	Institution	Teaching Experience	Professional Work Experience
Fekrat	B.S., Mechanical Engineering	Kabul University	2 years - Assistant Professor, Kabul University	2 years – Mechanical Engineer, International Organization for Migration and United Infrastructure Projects*
Gulistani	B.S., Civil Engineering	Kabul University	1 year - Assistant Professor, Kabul University	18 months – Monitor and Design Engineer, Amu Construction Company*
Momand	B.S., Civil Engineering	Kabul University	2 years - Assistant Professor, Kabul University	14 months – Structural Engineer, United Infrastructure Projects*

\* Private company

Table 1. Faculty qualifications of NMAA's adjunct instructors

To remediate the Afghans' lack of experience with laboratory instruction, Conley conducted training on the use of total station surveying equipment, which would be employed in CE303. Subsequently Gash trained the CE301 instructors on the uniaxial tension testing machine, which had just been installed in the newly constructed Civil Engineering Testing Laboratory. To prepare the Afghans for their roles in developing courses and delivering classroom instruction, Ressler conducted a one-day faculty development workshop, using materials adapted from the American Society of Civil Engineers (ASCE) Excellence in Civil Engineering Education (ExCEED) Teaching Workshop.<sup>3</sup> The NMAA workshop emphasized techniques for organizing classroom instruction, to include the use of learning objectives and board notes.<sup>4</sup>

The Afghan adjunct instructors' strong qualifications and professional aspirations proved to be a liability for the NMAA when, after only one semester of teaching, all three men were selected

for graduate fellowships in the U.S., under the auspices of the Afghan Merit Scholars Program.<sup>2</sup> Although well-qualified replacements were eventually hired, the loss of three trained instructors caused some problems with continuity in the civil engineering program. We conclude that NMAA's heavy reliance on adjunct instructors is a "double-edged sword." In the short term, the adjuncts have provided the academy with a coherent, relevant curriculum and the capacity to offer *bona fide* college-level engineering instruction to cadets; however, lack of faculty continuity hinders the NMAA Civil Engineering Department's long-term development of curriculum management, faculty development, and assessment capabilities. Given Afghanistan's meager supply of educated engineers and the low salary levels being offered by the Afghan Ministry of Defense, the current prospects for hiring permanent faculty at NMAA are poor—and they are not likely to improve until the NMAA's own graduates can be assigned as Academy instructors in a few years.

### Assessment of the Curriculum Design Process

In developing the 16-course NMAA civil engineering curriculum, Conley, Ressler, Fekrat, and Momand worked collaboratively with a wide variety of experts and stakeholders—the Heads of the NMAA Math Department and Basic Sciences Department, engineers from the U.S. Army Corps of Engineers Afghanistan Engineer District and the United Nations Office for Project Services, representatives of the installation management agency of the Afghan Ministry of Defense, and officials from the Afghan Ministry of Higher Education. Gash and Hamilton have continued this process with the more recently hired adjunct instructors. To date, the collaboration has been successful. The U.S. mentors have contributed expertise in curricular design, pedagogy, and western engineering design and construction methods; the Afghans have contributed insights about Afghanistan's education system, infrastructure needs, and current construction practices. The authors unanimously judge the curriculum to be appropriately rigorous, comprehensive, and relevant to the needs of the Afghan National Army. A more objective assessment of the program outcomes will not be possible until the program's first graduates enter professional service in 2009.

### Assessment of the Course Design Process

As of this writing, a first iteration of course development has been completed for all of the Semester 5 and Semester 6 civil engineering courses indicated in Figure 1 above. For each course, this process involved the Afghan instructors and U.S. mentors working collaboratively to select a textbook and then to create the following:

- Course syllabus, which lists lesson titles, lab exercises, and course grading policies
- Course study guide, including learning objectives, an orientation, and a reading assignment for each lesson in the course
- Homework assignments, laboratory exercises, and design projects
- In some cases, instructor "board notes" for each individual lesson in the course

As noted in Reference 1, English-language textbooks are being used for all courses in the NMAA civil engineering program. All course materials for the two core engineering courses, CE301 and CE302, have been written in English and then translated into Dari, the official language of the NMAA and one of the two principal languages spoken in Afghanistan.

Our observations about the course development process are as follows:

- The course study guide format has proved to be effective and is now standardized for use in all NMAA civil engineering courses.
- The Afghans are unanimous in their praise for “board notes” as a tool for both lesson organization and the delivery of classroom instruction.
- Initially, the translation of core course material from English into Dari was performed by the NMAA’s staff translators. These translations proved to be problematic, as the staff translators lacked any knowledge of engineering terminology. After reviewing several products of dubious quality, the Afghan adjunct instructors decided to perform all of the translations themselves. Although this slowed the course development process considerably, it greatly improved the final quality of the products. Furthermore, the Afghans noted that performing the translations required intensive engagement with the course material, which better prepared them to teach this material once the semester began.
- Upon arrival in Afghanistan, the U.S. mentors were surprised to learn that unlicensed (i.e., “pirated”) versions of industry-standard CADD and structural analysis software packages were being sold for under five dollars per copy in the bazaars of Kabul. They specified that only legitimate, licensed software be used in NMAA’s computer labs. This decision, though the only ethically acceptable option, greatly increased the challenges associated with integrating computer applications into the NMAA curriculum. State-of-the-art CADD products could not be used, because their site licenses were prohibitively expensive; and the site license for our computational software package could not be activated because of internet connectivity problems. Conley responded to these difficulties by introducing Google SketchUp into CE303 as an alternative to CADD. Although we used the professional version, rather than the free version, the educational site license was available for a very reasonable price.

#### Assessment of Course Implementation

CE301 and CE303 were successfully implemented during the semester that started in March 2007 and ended in August 2007. All planned lessons, labs, and examinations were conducted as planned. The course design project in CE301 was not completed in several sections because of military training events that caused the cancellation of several classes. The first iteration of Semester 6 courses was completed in January 2008; however, as of this writing, the authors have received no feedback on these courses from the NMAA.

Our key observations concerning course implementation are as follows:

- Due to delayed deliveries of equipment, the planned uniaxial tension test lab exercise in CE301 was conducted as a demonstration, rather than a true hands-on lab experience.

Nonetheless, the instructors reported that the demonstration had a significant positive impact on the students' understanding and interest.

- The use of Google SketchUp as an alternative to CADD in CE303 proved to be entirely adequate in this introductory course.
- Although the course content of CE303 was not especially difficult, the students struggled with the use of English-language course materials. Even though they were able to converse reasonably well in English, their ability to read, comprehend, and learn technical information in English proved to be far more limited. It remains to be seen whether this situation will improve as their language proficiency increases over time.
- Throughout the March-August 2007 semester, we observed many aspects of the NMAA academic culture that do not yet reflect an appropriate university-level standard, resulting in less than optimal implementation of the civil engineering curriculum. These included a variety of distractions during evening study hours, frequent cancellation of classes due to military training events, inadequate course administration (e.g., failure to prepare syllabi in many courses), and students' unwillingness to do homework. Some of the non-engineering majors in CE301 complained that the course was too difficult and that they should not be required to take engineering at all. To some extent, these problems reflect the academy leaders' lack of experience in academic governance and students' inadequate preparation for college-level study. We expect that this situation will improve over time, as Afghanistan's primary and secondary school systems continue to improve, and as U.S. mentors continue to assist the NMAA leadership with raising and enforcing standards.

Upon completion of the March-August 2007 semester, Hamilton designed and implemented the first student feedback system in NMAA's three-year history. He developed an assessment instrument consisting of 18 questions, using a 5-point Likert response scale ranging from 1=strongly disagree to 5=strongly agree. The instrument was administered to all 18 students in CE303 and to a sample (40 of 84 students) in CE301 at the conclusion of the course. The results are summarized in Figures 2 and 3 below.



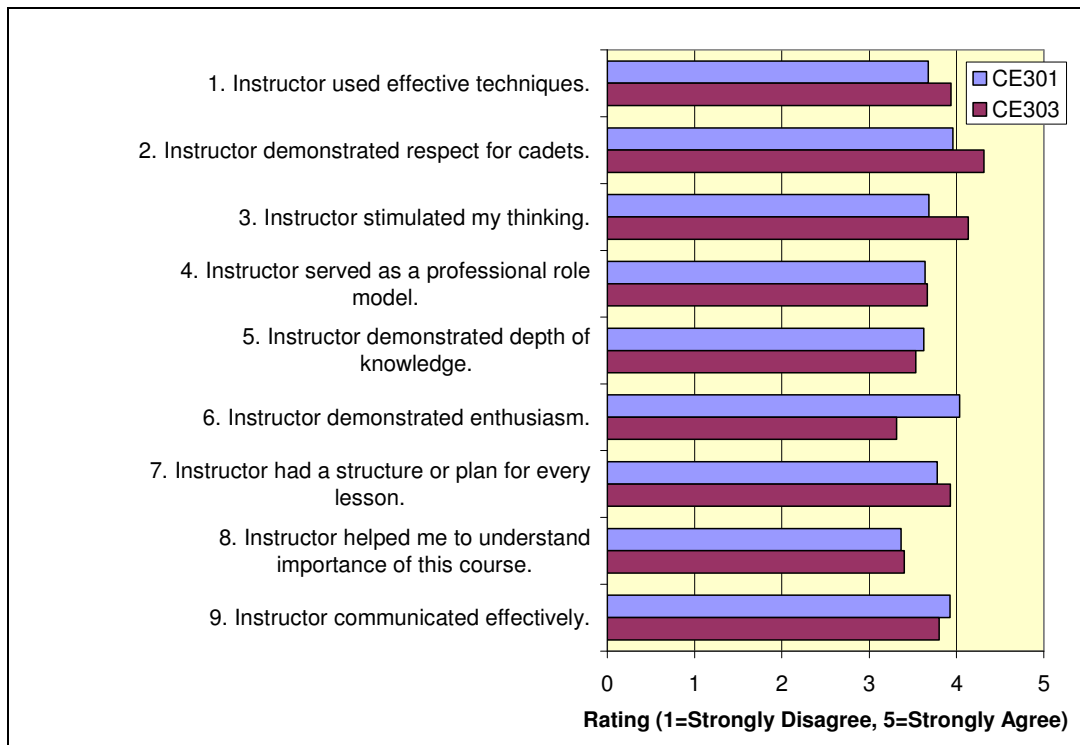


Figure 2. Cadets' responses to course-end survey in CE301 (18 students) and CE303 (40 students)—Questions 1-9.

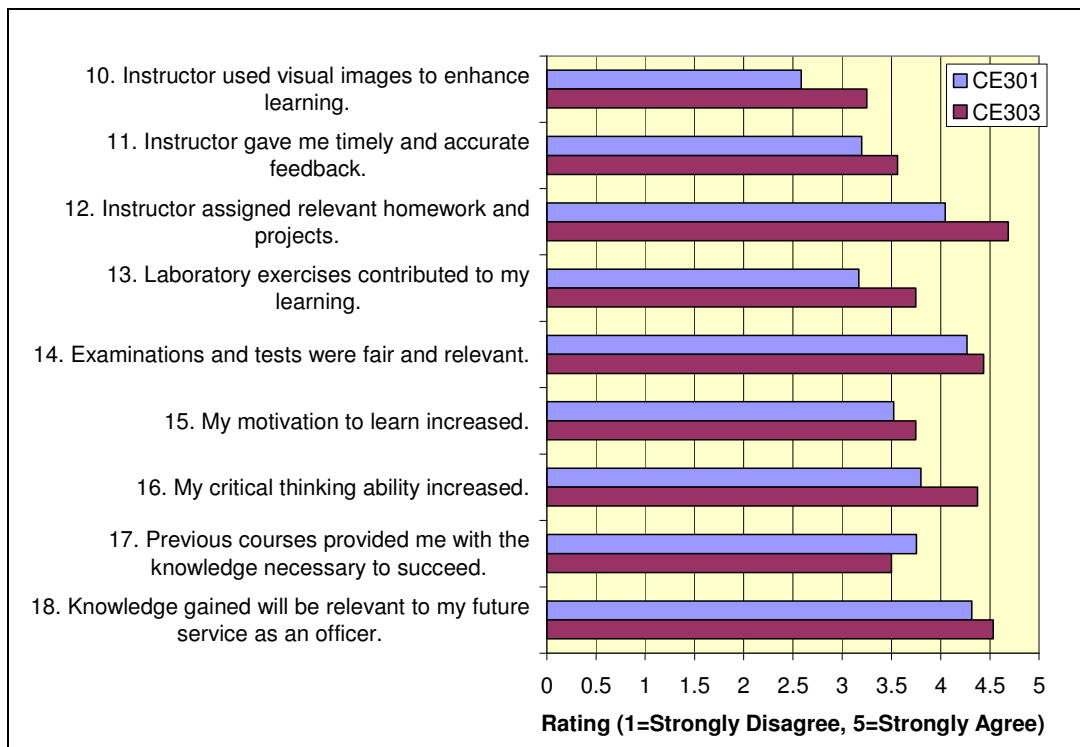


Figure 3. Cadets' responses to course-end survey in CE301 (18 students) and CE303 (40 students)—Questions 10-18.

These graphs suggest that, on the whole, the students were satisfied with the instruction they received in both courses, though the level of satisfaction was not particularly strong. On most of the survey questions, CE303 was rated slightly higher than CE301, reflecting the fact that CE301 is a core course taken (unwillingly, in some cases) by all cadets, while CE303 is taken only by civil engineering majors. Among the more noteworthy responses to individual questions are:

- The cadets' strong perception that the knowledge they gained from both courses will be relevant to their future service as officers in the Afghan National Army (Question 18).
- The cadets' relatively positive assessments of the homework and exams in both courses (Questions 12 and 14, respectively).

### Assessment of Student Learning

All cadets enrolled in CE301 and CE303 received passing grades for the course. Their performance on the first exam was almost universally poor, but they improved considerably as the semester progressed and they became better accustomed to the subject matter and the expectations of their instructors.

The non-engineering majors in CE301 gained reasonable proficiency in calculating reactions, analyzing trusses, constructing shear and moment diagrams, and the basic concept of engineering design, to include application of the factor of safety. They demonstrated reasonably strong computer skills and great enthusiasm for the use of information technology, as all were able to develop credible bridge designs using the West Point Bridge Designer software. Their proficiency in the course's more advanced statics and mechanics of materials topics was significantly lower. The instructors attribute the cadets' difficulties primarily to poor preparation in math and basic science.

In CE303 the cadets were better prepared, because only the most academically capable cadets were permitted to major in civil engineering. Nonetheless, these cadets also performed poorly on the first exam in CE303, largely because the exam questions were written in English and the cadets' English comprehension proved to be lower than expected. Their performance improved considerably on the second exam and reached a respectably high level on the final exam. Primarily as a result of a demanding course project, these cadets also developed reasonably strong proficiency in the use of total station surveying equipment and Google SketchUp software. These positive results notwithstanding, the use of English-language instructional materials in the civil engineering program remains a significant challenge for both cadets and faculty.

Overall, the first semester of engineering study at the NMAA must be judged a qualified success. The NMAA Dean has expressed satisfaction with the educational outcomes, which exceeded his expectations for this first semester of program implementation. The cadets' satisfactory performance demonstrated that engineering instruction at NMAA is indeed feasible. Their steady improvement over the course of the semester suggests that there is significant potential for higher levels of performance in the future. Cadets' preparation for college-level study, particularly in math and the basic sciences, remains problematic. This situation will likely improve over the long term, as Afghanistan rebuilds its primary and secondary education systems. More substantial short-term gains can be made through improvements to the NMAA core math, physics, and chemistry courses.

## Prospects for the Future

As of February 2008, two USMA civil engineering faculty members are in Kabul mentoring a new team of Afghan adjuncts in developing the Semester 7 courses. A USMA physics instructor spent three months at NMAA in the fall of 2007 to devote some much-needed attention to the two core physics courses and their integration with the civil engineering program. U.S. Air Force Academy physics and math professors will continue working with the core physics and math courses during the spring of 2008. An additional round of USMA faculty deployments this summer will facilitate the development and implementation of the Semester 8 civil engineering courses, thus completing the first edition of the NMAA engineering curriculum. But even as the academy's first graduates enter service in the Afghan National Army, significant challenges will remain for the institution.

NMAA's greatest long-term challenge is to enhance the academic qualifications and longevity of its faculty. There are major barriers to the attainment of this end. Most NMAA faculty members are military officers drawn from the Afghan National Army. Though most are conscientious and hard-working, few are fully qualified or adequately prepared to teach at the college level. There are currently no functioning graduate degree programs in Afghanistan, so providing additional education for existing faculty members would be very difficult at best. Civilian instructors can be hired to enhance faculty quality; however, the current salary levels being offered by the Afghan Ministry of Defense are too low to attract well-qualified candidates in professional disciplines like engineering and computer science. The hiring of civilian adjunct professors remains the only feasible method of providing the necessary expertise in these areas. Yet the heavy reliance on adjuncts creates discontinuity within the faculty and severely hinders program management. In our view, this situation is not likely to improve until (1) Afghan scholars currently attending graduate programs outside of Afghanistan complete their degree programs and return to the country, and (2) NMAA's own graduates are able to earn graduate degrees and begin serving as faculty members.

A second great challenge will be to build functional systems for strategic planning, academic assessment, and curriculum management, such that NMAA's programs can continue to progress toward accreditation. Measures must also be taken to strengthen the NMAA's academic culture. The pursuit of academic excellence must become part of the fabric of the institution. Impediments to academic excellence—poor study conditions, disruptions to the academic calendar, inadequate academic administration—must be eliminated wherever possible.

We are confident that these challenges can be met, provided that the Afghans continue to get the support—in the form of funding, expertise, mentorship, and encouragement—that they so desperately need and so richly deserve.

## References

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2. “Announcements - Afghan Merit Scholars at Ohio University,” accessed at [http://www.afghanequalityalliances.net/index.php?module=cms&action=page&id=gen12Srv35Nme0\\_84](http://www.afghanequalityalliances.net/index.php?module=cms&action=page&id=gen12Srv35Nme0_84), January 14, 2007.