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## Rebuilding Kabul University Engineering Program

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### Abstract

An Engineering Partnership which is part of the Strengthening Higher Education Program (SHEP) of the Ministry of Higher Education (MoHE), sponsored by the World Bank between Kabul University (KU) and Kansas State University (KSU) is rebuilding the Engineering Program. This paper provides a historical backdrop against which the rebuilding project is described. The several aspects of the rebuilding project are described along with a report of progress. The paper concludes with observations about the nature of engineering education and some recommendations about changes that are required to achieve the expected outcomes of the rebuilding project.

### Historical Backdrop

The Faculty of Engineering was established in the 1960's and 70's by a consortium of US Universities with USAID sponsorship. The project was a "turn-key" project that provided a building, laboratories, and US based education for the new Afghan Faculty members. Faculty members from the participating US Universities established and taught classes and performed other aspects of the project while sending off candidates for faculty positions for degrees in the US universities. When the Afghan faculty members returned they took over the operation of the program. The Faculty of Engineering had a Research Institute based on a not-for-profit non-governmental organization (NGO) so that the members of the faculty were able to undertake sponsored research and service projects. The result was a first rate Engineering Program that was highly regarded within Afghanistan and the region that prepared graduates with world class skills and capabilities.

During the Russian occupation the Faculty of Engineering was regarded as a decadent Western institution and was closed. Members of the faculty fled the country or lost their lives. Many members of the faculty and graduates of the program made their way to the US or Europe and took up successful Engineering careers. Some are supporting the present rebuilding effort in a variety of ways.

During the civil war the engineering building was used by the military and laboratory equipment was scrapped and sold for funds to support the war effort. Even the plumbing and electrical wiring was stripped out of the building. During the Taliban administration the engineering program was restarted, but with little resources. Following the fall of the Taliban a number of international agencies have provided some assistance for rebuilding the engineering program including some renovation of the building and the contribution of some equipment. In 2005 the World Bank established the SHEP program with the Ministry of Higher Education. The SHEP program established a number of Partnerships between Afghan Educational programs and western educational institutions. One of these was the Engineering Partnership between KU and KSU. A team of KSU engineers and architects made an assessment visit in November of 2006 from which they prepared the project proposal that was signed by both institutions in April 2007.

### **The KU/KSU Engineering Partnership**

The standard for engineering education in the US and some other countries is accreditation by the Accrediting Board for Engineering and Technology (ABET). The guiding principle and ultimate outcome of the partnership is accreditation of the KU programs to ABET standards. The partnership agreement is for ten years with the first three years funded. One of the measures of the quality of engineering education of graduates and the primary step in obtaining a Professional Engineering (PE) license in the US is passing the Fundamentals of Engineering (FE) examination. The ability of KU graduates to pass the FE exam is a primary metric of the partnership. The Engineering Partnership is an integrated and iterative approach to improve the overall quality of the Faculty of Engineering. This approach emphasizes improved and updated infrastructure and physical resources (laboratories, information technology, and library resources) as well as enhanced faculty skills and competencies. Specific goals include:

- A. Rehabilitate the physical infrastructure
- B. Equip laboratories, offices, libraries, and classrooms
- C. Raise the quality of the faculty
- D. Reform the curriculum
- E. Improve teaching
- F. Increase access to information technology and library resources
- G. Raise the level of English proficiency
- H. Improve management
- I. Establish relationships with external constituencies

Resources for pursuing these goals come from three sources: The Partnership funds, the SHEP Block Grant Funds, and other resources and funds from other donors and agencies. The Partnership administration seeks to achieve these outcomes by seeking additional funding from outside sources and by orchestrating the use of all funding to obtain the maximum outcomes. The Partnership funds are primarily devoted to meeting the costs of operating the project and to the costs of graduate education (MS degrees) for some faculty members at KSU. The Partnership team seeks funding from the SHEP Block Grant for:

- Building repair and renovation
- Laboratory Equipment
- Computers and IT infrastructure
- Textbooks

- Furniture – office, classroom and laboratory
- Library and teaching materials

Other resources have contributed to the graduate education of additional faculty members, to laboratory development through donated equipment, to operating funds and supplemental salaries through sponsored projects, and to utilizing general University developments of library and student records management systems and internet infrastructure.

## **Progress on Reaching the Goals**

The Engineering Partnership is in the second year of the three year funding and the ten year overall project, so this is very much a work-in-progress report. We will discuss briefly the nine specific goals of the project:

### **A. Rehabilitate the Physical Infrastructure**

At the time of the assessment visit in November, 2006, projects had recently been completed to replace the roof, to install electrical wiring, to install a hot-water based heating system, and to renovate the large lecture hall and the library. During the following winter it was discovered that the roof leaked as badly as before it was replaced, the electrical wiring is inadequate for the anticipated laboratory equipment, the heating system leaks and many of the radiators are broken, and the benches in the auditorium are breaking loose from the floor. During the first year the Partnership team supported efforts by the University Administration to require the contractors to remedy these deficiencies. The roof repair was successfully completed by the contractor, but the other efforts were not successful. The Partnership was able to work together with the American Society of Civil Engineers and the Society of Afghan Engineers on a capacity building project that resulted in funding to renovate two large classrooms. That project resulted in rooms that are prototypes for further renovation of the teaching space of the building. The students initiated a project to improve the landscape that resulted in the installation of sidewalks that are a great improvement. With the roof repair completed the Partnership team requested from the SHEP office that the general design and renovation of the engineering building be initiated and were informed that there are not adequate funds in the Block Grant during this phase of the project to accomplish that work. The Partnership contracted with a team of faculty members to complete a design for the renovation. That work has been completed. Each laboratory space is being given a touch-up and furniture is being acquired as part of the laboratory development plans.

### **B. Equip Laboratories, Offices, Libraries, and Classrooms**

Equipping facilities is accomplished by providing specifications for the required equipment to SHEP for procurement. It has taken a long time to work out with SHEP just how this is to be done and there are constant changes in requirements. We have spent a good deal of time getting this together. There are about 18 Laboratories we have proposed to equip over the ten years of the partnership:

1. Computation Instruction Laboratory
2. Computer Service Laboratory
3. Engineering Chemistry Laboratory
4. Engineering Physics Laboratory
5. Civil Engineering (CE) Laboratories
  - a. Construction Materials Testing Laboratory

- b. Solid Mechanics Laboratory – with ME
- c. Surveying Laboratory
- d. Hydrology – Fluid Mechanics Laboratory - with ME
6. Electrical Engineering (EE) Laboratories
  - a. Circuits and Electronics Laboratory
  - b. Digital and Computer Systems Laboratory
  - c. Electric Machines Laboratory
  - d. Automatic Controls Laboratory – with ME
7. Mechanical Engineering (ME) Laboratories
  - a. Instrumentation and Measurements Laboratory
  - b. Automatic Controls Laboratory – with EE
  - c. Solid Mechanics Laboratory – with CE
  - d. Automated Manufacturing Laboratory
  - e. Internal Combustion Engine Laboratory
  - f. HVAC Laboratory
  - g. Hydrology – Fluid Mechanics Laboratory - with CE
8. Architecture Studios (at least three levels)
9. Model Building Shop

Thus far the equipment for the Computation Instruction, Computer Service, Engineering Chemistry, Construction Materials Testing, Solid Mechanics, Surveying, and Hydrology – Fluid Mechanics Laboratories have been specified and are in various stages of acquisition or implementation. We expect to complete the specifications for the Circuits and Electronics, Digital and Computer Systems, Electric Machines, Automatic Controls, Instrumentation and Measurements Laboratories and the Architecture Studios and Model Building Shop by the end of the first phase of the Partnership. The specifications for the Engineering Physics, Automated Manufacturing, Internal Combustion Engine, and HVAC Laboratories will be completed in the second phase of the Partnership. Laboratories are being designed to support both Teaching and Research and Service functions.

The present arrangement of office space is inadequate even for the present size of the faculty. With significant increase in the number of faculty members additional office space will be required. A plan has been developed in connection with the design for the renovation of the building to improve the quality and quantity of faculty offices, including administrative offices for the College and the Departments.

The Faculty of Engineering has a modest library with about 8,000 reference books. The goal for the engineering library is to establish an electronic/on-line library with engineering and scientific research and reference documents and a small collection of course reference texts. Several years ago the U.S. Civilian Research & Development Foundation established the Iraq Virtual Science Library. The Partnership team and Kabul University administration is working with the same agency to develop an Afghan Virtual Science Library which, if realized, will provide not only the desired Engineering on-line library for Kabul University, but the same service for all academic institutions in Afghanistan. The USAID organization has sponsored the development of an on-line library management system for all of the educational libraries in Kabul by the University of Arizona. The Partnership team has worked with USAID and the University of Arizona to include the Faculty of Engineering as a participating library in the system. The Library management system provides an on-line cataloging facility and automated book checkout and accounting. The Partnership is in the process of entering the books in the Engineering Library into the database and organizing the books on the shelves according to the

US Library of Congress Cataloging system. We anticipate having both parts of the Engineering Library complete by the end of the first phase of the Partnership. The Partnership has established a wireless internet node in the Engineering Library and we will specify computers for patron use in the next equipment order to SHEP.

Classroom furniture in the Faculty of Engineering is in desperate condition with the exception of 100 small drafting tables provided by Japan International Cooperation Agency (JICA). These tables have proved very durable and are excellent not only for drafting, but also as general classroom furniture. We have requested that JICA provide an additional 650 tables and chairs to furnish all of the classrooms. We have had no response from JICA. If they do not respond we will include acquisition of similar furniture in the building renovation project.

### **C. Raise the Quality of the Faculty**

Raising the quality of the faculty is accomplished in several ways in the Partnership including mentoring, on-line courses, special training courses and graduate education. Mentoring will be mentioned in connection with the reform of the curricula. The focus of this report will be on graduate education, though there are a number of on-line and special training activities going on.

In 2003 there were 38 members of the Engineering Faculty including three newly-hired. That year Japan began sponsoring faculty members for graduate study and three members of the faculty went to Japan to begin their studies. Since then five have completed MS degrees and returned and eleven are presently studying for MS or PhD degrees in Japan. One faculty member has completed an MS degree at Purdue University and presently there are 20 members of the faculty pursuing MS degrees at Ohio University and Kansas State University. In the summer of 2009 four members of the faculty are scheduled to begin a year of study at the University of Colorado and five graduates from the College (three of whom are members of the faculty) will begin MS degree programs at US Universities sponsored by the Fulbright Program. The total number of members of the faculty has grown to 62 with the expectation of adding twelve more this year.

### **D. Reform the Curricula**

The curricula being used in the Faculty of Engineering at the beginning of the Partnership was unchanged from that used in the late 1970s. Most of the textbooks were from that time as well. During the assessment visit in 2006 the KSU team proposed a workshop to develop updated curricula at the start of the project. Several agencies had conducted curricula workshops during the few years prior to the start of the project, but no changes in the curricula were made and the leaders of the faculty felt that another workshop would be a waste of time and effort. They proposed that the KSU team prepare curricula proposals based on the workshops and present engineering education standards and bring them for modification and approval. The result was new four-year curricula for the Engineering programs and a new five-year curriculum for Architecture. The curricula have been designed to meet the particular needs of Afghanistan and have been reviewed by the Faculty of Engineering Advisory Board (a group of Governmental and Industrial Leaders) that meets regularly to provide advice and assistance to the College.

### **E. Improve Teaching**

Improving teaching is the overall objective of the Engineering Partnership. In 2008 the process of implementing the new curricula was begun and will continue through the next four years. All

courses in the new curricula are mentored by an experienced member of the KSU Partnership Team. Syllabi are prepared for each new course with specific course outcomes, homework, quiz, and examination expectations. The style of education under the old curricula was formal lectures with little or no homework or graded assignments during the semester with success or failure of the course dependent on the final examination with students given two or three chances to pass the exam. In the new curricula the final exam constitutes no more than 40% of the final grade and any second or third chances only affect the score on the final exam. Recitation, studio, or laboratory work is included in all courses and frequent homework assignments are collected and graded.

One of the greatest detriments to the quality of teaching is the absence of members of the faculty from the College. Faculty salaries are desperately inadequate, but members of the faculty have skills that are in high demand in government agencies and industry. As a consequence, most hold full time outside jobs in addition to their full time faculty positions. The outside jobs are demanding and pay well and since there are no personal consequences for not being present in the faculty many spend a minimum amount of time at the University and make little preparation for their classes. In the implementation of the new curricula faculty members are required to be prepared and available to the students outside of class hours. Significant progress is being made on a plan to return the members of the faculty to their University jobs full time.

In the US the Fundamentals of Engineering (FE) examination is the established standard to measure the quality of an Engineering Education. We are using this examination as a metric of our progress in improving teaching and in assessing the preparation of members of the faculty to enter graduate study. The examination is in two parts: a morning examination that measures competency in general engineering subjects and an afternoon examination that measures degree specific competencies. An average score of 70% for the two exams is considered passing. In the US about 85% of graduating engineers are able to pass the examination. In December 2007 we gave the FE examination to five faculty members that were candidates for graduate study at KSU. The averages of their scores were 38% and 46% for an overall average of 42%. In August 2008 we gave the FE exam to nine applicants for graduate school at KSU. The averages of their scores were 62%, and 45.6% for an overall average of 53.6%. Only one faculty member out of fourteen had a score of greater than 70%. The significant improvement in the morning exam scores is encouraging but the overall performance indicates that we have much work to do. We will be giving the FE exam to all graduating engineering students beginning in 2009 to measure the progress of the Partnership in raising the quality of the education of the students.

## **F. Increase Access to Information Technology and Library Resources**

At the beginning of the Partnership Project a group of faculty members and students had connected a few computers together in a local area network, but there was no connection to the Internet. The ITCK was connected through a satellite link to the Internet and operated a laboratory with about 30 computers. Use of the computers was (and still is) restricted to faculty members. Some wired extensions of the Internet were operational to buildings close to the ITCK, but Engineering was too far for a wired connection. A fiber-optic system was being installed to provide Internet access to the entire campus, but it would be six to eight months before that would be operational. A company we had befriended was upgrading their satellite based Internet system and donated their old system to us until the University fiber-optic system was operational. The system was installed and within a few days we were issuing passwords to engineering students and members of the faculty. Within a few weeks we had issued passwords to almost all of the engineering students. We operated that system until the University fiber-

optic system became stable and then switched to that. In the meantime we began extending the internet wiring into the faculty offices and the library. We installed three wireless nodes in the building: in the computer laboratory, the library, and the administrative offices. There are presently about 30 computers wired on the system in addition to a similar number of laptops using the wireless connections.

This spring we will be installing over 100 more computers in the faculty offices and two computer laboratories. We have also acquired six laptop computers and three projectors that members of the faculty can use for teaching. There are two computer courses in the first year of the new curricula and several members of the faculty have begun to add computer applications in courses in the old curricula. One of the greatest deficiencies members of the faculty who have entered graduate school have reported is their lack of computer experience. Almost all courses in the new curricula include computer applications.

Plans for increasing access to library resources are outlined above.

### **G. Raise Level of English Proficiency**

It is the objective of the Faculty of Engineering to get to the point where English is the language for all instruction. To reach that objective we will need to improve the English language skills of both the faculty and the students. All of the members of the engineering faculty are able to carry on basic conversations in English and to read English text books. None are able to properly lecture in English and their written English is generally poor. In December of 2007 five members of the Faculty took the TOEFL exam as part of their applications for graduate school. The average score was 399. In August 2008 eight members of the faculty took the TOEFL and their average score was 511. The improvement is heartening, but demonstrates that there is still much to be done. The Partnership is providing on-going English courses for the members of the faculty. Members of the faculty that are enrolled in graduate study at Ohio University and at KSU must participate in English Language courses until they are proficient in speaking, listening, reading and writing. Standardized tests similar to the TOEFL are used to determine the progress of the students.

Besides the Engineering Partnership, Kansas State University also has an English Partnership with Kabul University. The Engineering Partnership is working closely with the English Partnership to improve the English proficiency of the students. In 2008 we attempted to lecture some of the courses in the new curricula in English, but the skill level of the students was not sufficient to do that. The textbooks are in English, the assignments and examinations are in English, but instructors had to translate exam questions for the students and many could not respond in English.

### **H. Improve Management**

Improving management is being addressed in both formal and informal ways. Two experienced senior faculty members from KSU live and work in Kabul during the academic year. They provide leadership mentoring for the Dean, Department Heads and the various committees of the College. Each Department Head also has a personal mentor on the Partnership team that uses internet communications and periodic visits to assist in management issues. During January 2009 five senior members of the faculty attended a week-long Leadership Retreat at KSU that focused on ways to make the Partnership and the local administration more effective in improving teaching in the College.

## **I. Establish Relationships with External Constituencies**

The Faculty of Engineering at Kabul University is a pearl of great value to the Afghan Nation and there are many agencies that have a stake in the outcome of the rebuilding project. Establishing working relationships with these constituents is accomplished in both formal and informal ways. Informally, the College and Partnership leadership attend a multitude of meetings and activities and make visits to and host visits from a multitude of governmental and industrial representatives. Formally, we have established the Faculty of Engineering Advisory Board with representatives from among our constituents. Forty-four highly placed members of governmental and industrial institutions are on our list of invitees and we held three very successful meetings in 2008. The Board has provided valuable input and support to the College and the Partnership.

One of the most difficult issues facing the College and the Partnership is the result of the very low salaries paid to members of the faculty and staff. Members of the faculty have skills that are highly valued in business and government and many of them have taken full time outside jobs in addition to their positions as members of the faculty. Their outside jobs frequently pay more than five times their salary as a member of the faculty. These outside jobs are demanding and members of the faculty have little time to devote to their teaching duties. All of the members of the faculty regret this situation and would immediately devote their full time to their teaching duties if they could obtain sufficient income to sustain their families.

One of the essential characteristics of an engineering faculty member is that he not only disseminates knowledge to his students, but he also participates in the generation of new knowledge. This is the way members of the faculty remain current in their specialized knowledge and able to prepare graduates with the knowledge and skills required to practice Engineering. Faculty members participate in the generation of new knowledge through engagement in research activities. It is essential that the members of the faculty have the opportunity and incentive to engage in research.

Universities from around the world normally have operating budgets derived from four sources:

- budgets from the government
- tuition from students
- charitable donations
- income from research and sponsored projects

In many US public Universities the funds from these four sources are approximately equal. Kabul University has only the budget from the Afghan government and that is woefully inadequate. One possibility for providing adequate income for the members of the faculty so that they could devote all of their energies to their faculty work is to obtain additional funds from these other sources. The Afghan Constitution stipulates that University education will be free to the students, so tuition could not be charged without a change in the constitution. The present regulations of the Afghan government requires that if any funds come into the University from any of these other activities that the funds be deposited in the National General fund and it requires an act of the Parliament to release the funds back to the University. Many US Universities form not-for-profit non-governmental organizations to manage their charitable fund raising and research and sponsored projects activities. We have found a mechanism through the Engineering Partnership for the Faculty of Engineering to form such an organization. This

organization provides a means for members of the faculty to develop and engage in research and sponsored projects and to retain all of the revenue to be used to supplement salaries and develop and maintain the research facilities of the College.

### **Lessons Learned and Recommendations:**

The discussion in this section of the paper is based on two years experience in the KU/KSU Engineering Partnership living and working in Kabul and a lifetime of leadership in Engineering Education in the US. Some issues are associated with practices and policies that apply to the broader University and National culture and we address them only in the context of Engineering Education. We make certain recommendations that we believe would be good for Engineering Education at Kabul University without attempting to evaluate whether they would be equally beneficial to other disciplines or other Universities though we recognize that it may not be possible or practical to implement them only in the Engineering Faculty at KU.

Under lessons learned we observe that it is much more difficult to get things done at KU than it is at institutions like KSU. For example, purchasing textbooks and laboratory equipment has taken several times as long in the Partnership as similar purchases at a US University. Some of the difficulties are associated with the large number of agencies involved (the Partnership, Kabul University, SHEP, the MoHE, the World Bank, and the Afghan Government) and the bureaucracies and procedures they follow to transact purchase recommendations. The other complication in purchasing is to get suitable bids. The companies that provide the texts and equipment we require generally have not done business in Afghanistan for years and they do not monitor the bid advertisements and even when we specifically send them bid documents they are unwilling to bid because of requirement to assist with installation and service of their products. With the present security situation they are unwilling to commit to a purchase that could end up requiring them to send a representative into Afghanistan. The boiler-plate on laboratory bid requests is almost 100 pages. Another example is getting visas for travel for members of the faculty to go to the US. When KSU colleagues travel to Afghanistan they fill out a one page document, get one signature and send it off to the Afghan embassy and within a few days they are ready to go. To get a visa for an Afghan faculty member to travel to KSU we (they) are required to present several documents to be signed and stamped by the Dean, the Chancellor, the MoHE and the Minister of the Economy. Then we have to negotiate with the US Embassy whether the visa will be processed in Kabul or in Pakistan, then we submit an additional packet of forms, participate in an interview and wait for up to three or four months and we are not assured the visa will come even then. This is the process if you have an excellent relationship with a high level member of the Embassy staff.

We have also observed that it takes great patience and persistence to implement any change (the curricula, for example) within the University. It has required the full-time effort of an experienced KSU faculty member to mentor the implementation of the courses in the first year of the new curricula. Change is very difficult and the changes we require are very large and both the members of the faculty and the students take a great deal of assistance to make the changes. The knowledge an engineering student must acquire has several aspects: He must have a deep understanding of fundamental concepts, an understanding of how to apply those concepts in the solution of problems and skill in using the tools to implement the solutions. Further, the knowledge must be integrated, what is learned in any course builds on the knowledge from many earlier courses. The acquisition of this kind of knowledge can only be acquired by instruction that includes not only lectures and recitations, but also laboratories and studios. The courses must include many assignments, quizzes and examinations spread over the duration of

the courses. Further, the content of courses must be integrates so that they properly build on one another, but also so that lower level courses actually accomplish the required educational objectives so that the higher level courses can count on the students being properly prepared. The present scheme of courses consisting of formal lectures and a final examination is just not acceptable. Furthermore, the present situation where many of the members of the faculty are largely engaged in outside employment and spend minimal time delivering real engineering education is not tolerable.

The notion that a university education can be free is misguided. In order to acquire the kind of education required for the practice of engineering, students must be fully engaged and must make major personal sacrifices. The payment of tuition and fees represents an investment by the student in his future and establishes a very different dynamic relationship between the members of the faculty and the students. Students making such an investment will expect, even demand that instructors deliver quality education and will not tolerate faculty members that come unprepared and do not devote the required effort to deliver the knowledge the students require. Faculty members also recognize that the students are making sacrifices and they feel compelled to make whatever sacrifices are required of them to deliver the education to the students. The la sa fair attitude observed in both the faculty and students grows out of the notion that an engineering education can be obtained for free. The argument that the students can not afford to pay fees is simply not true. It may be necessary to provide tuition loans for some, maybe most students, but when they graduate with the improved education that will result they will have a much greater value (salary) that they will very quickly be able to repay the loans and will then have the improved salary for the remainder of their lives. What we are doing now is cheating the students from the education they desire and limiting their capacity to earn for their entire lives. It is common in US universities for engineering students to pay much more in tuition and fees than students in other disciplines based on much greater earning capacity when they complete their degrees. A related factor is that engineering faculty members are paid much higher salaries than other members of the faculty. Because of the much higher salaries of practicing engineers in business it is not possible to attract the quality of faculty required for engineering education without this salary differential. Kabul University must be highly selective and competitive in hiring and retaining members of its engineering faculty.

Engineering is a profession based on high ethical standards of its members. The University and the Faculty of Engineering must adhere to the highest standards of integrity. The rules and regulations of operation must be strict and uniformly enforced to establish and maintain the confidence of our constituents and our graduates.