ASEE International Forum
Seattle Sheraton / Seattle, WA
June 14, 2015

Paper ID #14257

Succeeding in a Trans-Continental Academic Partnership - Renewable Energy Desktop Learning Gasification Module

Jacqueline K Burgher, Washington State University

Jacqueline Burgher is a graduate student at Washington State University in the Chemical Engineering Department. She received her bachelor's degree from Anderson University, worked in industry, received an MBA from Anderson University and is currently working with Prof. Bernard J. Van Wie on fabricating, optimizing, and implementing a miniaturized gasification system for use in the engineering classroom.

Prof. Bernard J. Van Wie, Washington State University

Prof. Bernard J. Van Wie received his B.S., M.S. and Ph.D., and did his postdoctoral work at the University of Oklahoma where he also taught as a visiting lecturer. He has been on the Washington State University faculty for 32 years and for the past 18 years has focused on innovative pedagogy research and technical research in biotechnology. His 2007-2008 Fulbright exchange to Nigeria set the stage for him to receive the Marian Smith Award given annually to the most innovative teacher at Washington State University.

Succeeding in a Trans-Continental Academic Partnership – Renewable Energy Desktop Learning Gasification Module

Abstract

Increasingly researchers are attempting to build international research collaborations. Challenges exist in establishing and maintaining such interactions to make them successful. In this paper we present an assessment of experiences gained from an international collaboration between Washington State University, and the National Research Institute for Chemical Technology and Ahmadu Bello University, in Zaria, Nigeria which grew from a relationship initiated during a Fulbright Exchange. This discussion focuses on two aspects in establishing successful international research partnerships: first, an administrative component examining how to establish, launch and maintain international relationships that fosters successful trans-continental research efforts and second, a practical application focusing on research exchange centered on developing and implementing a biogasification system for use in the classroom with a team of undergraduate students from each respective location. These two components are natural progressions, and takeaways for successful research collaboration include a solid understanding of differences in cultures and values, a mutual understanding between each group to undertake pieces of the project within the capabilities of their own facilities as well as recognition and adaptability when technological constraints hinder project progression.

In addressing energy demands for the future it is critical to decrease emissions from fossil fuels while harnessing energy from renewable resources. These concerns reach across political and geographical borders, and, when considering the establishing of knowhow and practice in developing nations, researchers and practitioners need to address the special needs of capacity building and infrastructure and resource limitations. Beyond that one must be cognizant of how to create a link with engineers and scientists to begin with and then go beyond that to maintain the collaboration while considering issues related to tact, communication, and understanding the influence of culture on research and interaction practice [1].

In this paper we consider a USAID/NSF PEER program aimed at enhancing the understanding of biomass conversion technology and meeting the challenges of implementation in a developing nation. This project focuses on a global problem, energy demand, and utilizes an existing collaboration to develop a miniaturized hands-on learning module for implementation in the classroom and train future engineers from both sites while exposing them to international collaborations to develop their problem-solving skills. The module is being designed to overcome process implementation barriers in resource limited environments like Nigeria.

Discussions for writing and submitting the USAID-PEER proposal that supports this work were initiated by Washington State University (WSU) with Ahmadu Bello University (ABU) in Zaria, Nigeria, and called on existing collaborations for developing miniaturized fluid mechanics and heat transfer modules. The project description involves a team of undergraduates from both sites

working on different components for the development of a miniaturized biomass to biofuels system via gasification.

To describe how to build and implement a successful international collaboration, this paper is structured as follows: first, a section describing how to initiate and foster successful international relationships and engage in trans-continental research and second, a practical application of how to do this on an individual project, taking the USAID-PEER project as an empirical example.

Part I: Initiating and fostering international relationships

Achieving success in initiating cross-cultural international collaborations, especially with developing nations, requires an alternative kind and of commitment different from taking on a similar endeavor in one's own culture. To be successful researchers must make a decision to go to another country personally, and ultimately to be truly successful at building critical relationships they must go a step further, that of total immersion in another culture. We can read books about a country or culture, however, it is another matter to experience and learn to manage differences in cultural norms, customs, food and the way food is eaten, greetings, ethics and values, beliefs, and then integrate that experience in relating to the international partner to form healthy international relationships with successful professional outcomes.

To engage in such a process takes risk, sacrifice and professional commitment in pursuing opportunities such as a Fulbright exchange. Run through the US Department of State a Fulbright offers the opportunity to work through a US embassy in a country of interest to identify universities with colleague who have similar interest and with viable programs. Many such programs do not have websites, or if they do have them they are mediocre in quality and may not even list the program of interest, and even if they do so it's highly likely they will neither list the faculty nor their research interests. Obviously, the risk is in that a researcher likely will not immediately find the niche for which he or she is looking. To effectively counter the void in readily accessible information one can work through the Cultural Affairs Office of the US embassy who frequently sends delegations to institutions that are key to the educational, research and economic development of a nation.

An example pertinent to the case for establishing collaboration in renewable energy research is that of a co-author's experience (Van Wie) in pursuit of a meaningful Fulbright exchange in Nigeria (the Fulbright program is also knowns as the Council for International Exchange of Scholars). First, one must realize the Fulbright applications are due a year in advance (August 1st) and that a researcher can work with the Fulbright program office to identify prospective international partners before completing the application. This is necessary because a letter of invitation is needed with the application. However, it's important to know that the Fulbright program does have some flexibility. For those who may have missed this early deadline there is a note on the Fulbright page that says if you missed the deadline, there still may be opportunities and that an inquiry should be made; this was the case in this instance. A discussion with the

Fulbright office led to consideration of several African countries until a suitable institution with a strong chemical engineering program and biofuels interest was determined. Since Nigeria has a substantial petroleum-based industry it was considered, and also because it has the second largest number of Fulbright openings (4 faculty and 4 student positions) and the second largest number of institutions participating in the Fulbright program in Africa.

A suitable position was identified by working with the US embassy in Abuja, which quickly located a university of interest, Ahmadu University (ABU), with one of the top flight chemical engineering programs in Nigeria, with a typical cadre of about 70 graduate MS and PhD students and 35 academic staff faculty, several of whom are engaged in biomass conversion efforts. Two points-of-contact were provided and after contact within 24 hours two invitations to join the two different universities as a Fulbright lecturer/researcher were offered. Subsequent discussions about the research areas at the two institutions, and cultures in the two areas led to the decision to join the faculty at ABU in northern Nigeria. Of course undergirding this was a supportive family with a hunger to go together to Africa after weighing the risks and benefits of distant travel and life in a new culture. As an aside the risk was worth it and one of the author's sons is now married to a Nigerian and they have blessed the family with a new grandson.

One of the key points made in the Fulbright orientation is that scholars need to be flexible – that the original proposed work approved by the Fulbright program may not be available once the Scholar arrives and they need to be patient, flexible and persistent in making the Fulbright exchange meaningful in any reasonable way possible. Needless to say, while ABU has a strong graduate research program in biofuels, the partnership for the work at hand was not realized until a few years later, though the contacts and exposure began immediately after arrival. The current Nigerian partner became chair of chemical engineering a day after arrival as a Fulbright scholar and the co-PI, then a graduate student/lecturer, assisted with acclimation to computer facilities, bartering at the market and exposure to automobile sales people. However, immediate research connections proceeded down a different path that lead to a World Bank supported effort to expand use of hands-on learning equipment for teaching fluid mechanics and heat transfer to a number of Nigerian institutions as well as with a biosensor emphasis for detecting cyanide in cassava, a staple food in the culture. These efforts afforded the maintaining of critical relationships and trust with the researchers at the original Fulbright institution.

We must also offer advice about maintaining the relationship and confidence in contractual work among countries with vastly differing procedural norms. While both US and international institutions seek to operate with integrity, the pace and efficiency in which things are done are varied. In the US we have grown to expect a "sharp-sharp" response to any need. Contrary to this a developing nation may be dealing with regular ½-day power outages, internet connectivity issues, frequent political and labor-related disruptions to semester work schedules, and a bureaucracy that can take months and even years for documents to be signed, approvals to be given, and moneys to be transferred. There really is no way to understand this until a person

resides on-ground in the partner country, knows the hearts of the people are genuine, and that things really do get done, though at an entirely different pace.

Then when interacting with the people of another culture we must consider cultural issues. Staple foods in Africa often consist of some type of soup with a small lump of meat, liver or cow skin that is eaten by scooping it with a mashed starch like pounded yam and all this is eaten with your hand, your ***right hand*** and never your left and in northern Nigeria the right hand is washed with a bit of soap only using the thumb on the same right hand to wash the hand itself while pouring fresh water over it. The special greetings of all those with whom you interact are a blessing, though they are also expected. Dress consisting of long pants for men and dresses for women is generally the norm and all women should have their head covered, at least in some areas of Africa. While not heeding these norms is forgivable to westerners, knowing them and living by them helps to open the doors to precious relationships.

Back to the biofuels project, it was a few years later after returning to the US that the Fulbrighter was made aware by an NSF program officer of the USAID/NSF Partnerships in for Enhanced Engagement in Research (PEER) program. Because a key element of the Fulbright was teaching using hands-on learning stations for fluid and heat transfer classes a follow-up effort was explored seeking opportunity for hands-on learning enhancement both in Nigeria and Ghana. Unexpectedly, it was the former chair and graduate student mentioned, now PhD holder, were interested, however, not in expanding fluid mechanics and heat transfer hands-on learning stations, but in applying the concept to learning about biomass conversion. A successful application was made to the PEER program to support the Nigerian side through the National Research Institute for Chemical Technology (NARICT), in Zaria, Nigeria where the Nigerian-side PI and co-PI now reside, and soon after NSF provided a supplement to the grant used to justify the PEER to extend the existing hands-on learning concept to biomass conversion. Hence, the well-articulated Fulbright orientation advice about flexibility, patience and persistence was heeded and eventually one of the partnerships originally intended was realized.

Once, the project was established of course, there was the need for assimilating team members. Much of this will be spoken of in the next section, however, it was critical that a key PhD graduate (co-author Burgher) be involved from the PEER's inception to her realize critical aspects in developing an international partnership. While Burgher and Van Wie were in Washington, DC with a contingent there as part of an IGERT training program they visited a key NSF program officer, he himself from Africa, who was serving in the Division of Undergraduate Education and also as a link to NSF's Office of International Science and Engineering program. This bridging was critical to success of the project to both show commitment and availability of personnel and to help the graduate student begin to understand the nature of building an international collaboration. In addition aspects of the project involve recruitment of undergraduates and faculty as NSF's international emphases are intended to create broader exposure of US personnel to how to integrate science and engineering across international borders. As a result we recruited three faculty members and several students to be involved with

us. As part of the program we decided to involve a faculty member teaching a senior design course and negotiations were needed on how to integrate a meaningful biofuels component while maintaining the structure of the course without deviating too much from what is traditionally done and determined as necessary for achieving the goals of the course [2].

Part II: Practical Application and Implementation

Once the collaboration was established and funding was secured, a few main items needed attention before initializing the project. First, we had to recruit three undergraduate team members from the WSU and three undergraduate team members from ABU as project participants. We also wanted to outline and allocate specific tasks for both WSU and ABU in order to achieve program outcomes. In our case, the specific objectives of this project are to: (1) develop technical know-how, and design and construct a miniaturized DLM gasifier; (2) develop expertise among US and Nigerian undergraduate and graduate students, and faculty in establishing biomass conversion technology suited for resource limited environments; (3) provide a hands-on DLM component for biomass conversion classes and assess learning effectiveness at WSU and ABU; (4) provide an international design team experience for students and faculty targeted at sustainable energy through biomass conversion suitable for a developing nation.

It was critical that the fabrication of the DLMs be completed in the US; WSU has facilities including an excellent machine shop, service labs, access to tools and equipment, and a consistent supply of electricity throughout the day. Because of the capabilities of WSU, it was decided to split the development of the module into two sections: modeling and fabrication. Additionally, the gasification project was split according to function; the first part of the design, the reactor with heat source and producer of synthesis gas (syngas) and the second portion of the design, where the syngas is scrubbed to remove pollutants introduced during the reactions.

The designs for the system would be a collaboration between ABU and WSU, the modeling portion of the syngas project would be primarily ABU's task, and the fabrication and optimization of these designs would be the task of WSU. WSU also assumed the role of fabricating and testing the reactor portion of the system, which included developing expertise on how a gasification system should function given the constraints of the system. Safety was a primary concern, with challenges including designing the reactor with a very small amount of input biomass which results in high surface area to volume ratio. This outcome resulted in difficulties designing an insulation system to achieve desired temperatures in the reactor, especially because one of the desired outcomes is creating a system in which students could readily view the reaction in a quartz glass see-through system. Insulation could not be directly placed around the reactor, and adjustments and creative innovations to the system were required.

Splitting the design into two main sections was highly beneficial for the two teams, and it allowed each group to use creative designs and input specific ideas into their section of the project. Additionally, critical discussions about design and troubleshooting problems could not

always occur between teams, so it was helpful because each team could design and troubleshoot their specific aspect of the project while working towards the greater goal of the overall system.

Discussions below include managing aspects of an international project like communication and personal turnover. These issues exist in most research projects, and extra care must be taken with international projects to achieve desired outcomes considering cultural aspects and time zones. A highlight of this project is a final workshop where technology transfer will occur between ABU and WSU. The WSU team consisting of three professors, a graduate student, and three undergraduate students will travel to Africa and bring the fabricated DLMs for a workshop on technical know-how and to meet in person with the team from ABU. This aspect of the project is critical, as it provides continuous motivation for the development of the module as well as continuous incentive for the undergraduate students to participate in an international experience as well as an international project.

Communication between ABU and WSU occurred on a bi-weekly basis with all team members. Present at these meetings were the co-PIs from each site, graduate students, undergraduates as well as any others involved in the project. Presentations were rotated between the teams, with ABU presenting updates one week and WSU presenting updates the next meeting.

The software initially used for meetings was Skype®, but this software did not suit all the needs of the group. We wanted to have a chat as well as access the meeting from anywhere, whereas Skype® limits the number of users. We changed for the first year of the project to Adobe Connect, a software platform that allows use of a webcam, microphone, and enables discussion with a chat window between each group. This software worked well, but we had difficulties at times relying on the internet availability at ABU. In fall 2014 WSU switched to Blackboard, and the group started using Blackboard Connect. The advantage of this software was the ability to record our meetings for later viewing. Connect also equips each user with webcam, microphone, chat window, and unique login to show other users who is in the meeting [3].

Perhaps the most difficult aspect of success in this project was the high turnover of undergraduates on the project. At WSU we had three initial participants, two of which are no longer on the project. At the end of the project, we now have had seven total undergraduates participating in the project, with one more joining the project for the summer. This turnover has caused difficulties with information transfer and added time to the project for training new undergraduates and getting them up to speed with the project.

The technical components of this project have been executed very well; the miniaturized gasification system is now functioning with a radiation shield and additional insulation because of technical challenges with the heat transfer and high surface area to volume ratio in the system. The syngas cleaning system experiments are also mimicking the modeling completed by the ABU team, with models developed with data exchanged between the two sites on gasification reactor conditions and system parameters including materials and dimensions.

The international exchange will occur this summer, 2015, with a group of three undergraduates, one graduate student and three professors for a few days of technical information exchange and to bring useable desktop gasification modules to the ABU team for implementation in the Nigerian classroom. The days include discussions around the concepts, operating and implementation of the gasification modules in the classroom as well as a cultural exchange where ABU introduces the WSU team to African culture and customs.

Conclusions

A successful collaboration developing a miniaturized gasification reactor system for implementation in both WSU and ABU in Zaria, Nigeria has been discussed. Components contributing to success include an existing relationship and Fulbright experience between co-author Van Wie and collaborators in Zaria, Nigeria. This relationship allowed for understanding of cultural values, procedures, and the bureaucratic operations in Africa as well as understanding of design and facilities capacity at ABU. The key success to the project included dividing up the project into modeling and experimentation as well as dividing the project according to function: reactor system and syngas cleanup. These designations allowed each group to independently solve technical challenges while contributing to the overall goal of the project. Finally, a cultural exchange at the end of the project allows for technology transfer of the gasification module and cultural immersion of the WSU team in African culture.

Acknowledgements

We gratefully acknowledge support from NSF through grant numbers DUE 1023121 for support of the work. We gratefully acknowledge Ahmadu Bello University, the National Research Institute for Chemical Technology and Ahmadu Bello University, in Zaria, Nigeria, Prof. Nurudeen Yusef and the entire team at ABU.

References

1. Abdul, B., B.J. Van Wie, J.T. Babauta, P.B. Golter, G.R. Brown, R.B. Bako, A.S. Ahmed, E.G. Shide, F.O. Anafi, and O.O. Olaofe, *Addressing Student Learning Barriers in Developing Nations with a Novel Hands-on Active Pedagogy and Miniaturized Industrial Process Equipment: The Case of Nigeria.* International Journal of Engineering Education, 2011. **27**(1): p. 1-19.
2. Krishnan, S., *Project-based learning with international collaboration for training biomedical engineers.* Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual Conference, 2011. **2011**: p. 6518-21.

3. Wen, K., S. Tan, J. Wang, R. Li, and Y. Gao, *A model based transformation paradigm for cross-language collaborations.* Advanced Engineering Informatics, 2013. **27**(1): p. 27-37.