

## **Enhancing Student Education through International Research Experiences**

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## **Enhancing Student Education through International Research Experiences**

### **Abstract**

Many of the world's most pressing science and engineering challenges are trans-national in nature and many of the leading scientific and engineering resources are located outside the United States. In order to remain at the forefront of science, technology, engineering, and mathematics (STEM), the United States needs to nurture a globally-engaged STEM workforce capable of performing research in an international environment. To help address this need, the National Science Foundation's International Research Experiences for Students (NSF-IRES) program supports the development of globally-engaged U.S. science and engineering students capable of performing in an international research environment. These programs involve students in international research in meaningful ways while teaching them about foreign cultures. Such experiences expose students to the international research community at a critical early stage in their careers.

Through an NSF-IRES grant, the University of Alabama at Birmingham (UAB) has developed an international research experience focused on the theme of sustainable green building design and construction. Two program offerings took place during the summers of 2015 and 2016, supporting eight undergraduate and graduate students each time. A third offering will take place in summer 2017. The 2015 program included two weeks in the Netherlands and two weeks in Egypt while the 2016 program provided two weeks in the United Kingdom and two weeks in Egypt. The students benefited from studying and experiencing sustainability programs in each country and by comparing sustainability efforts in developed countries with those in a developing country. Of primary importance throughout each program was providing the students one-on-one interactions with researchers in each country and allowing them to continue those relationships as they completed research projects back in the U.S.

This paper reviews the process of establishing and developing an international research program and the key elements needed to make it successful. It then discusses the actual research experiences in our program, the work products developed, and the benefits realized by the students. The key topics discussed include program planning, logistics, program execution, assessment, and lessons learned.

### **Program Background**

The University of Alabama at Birmingham (UAB) was awarded a 3-year NSF-IRES grant to conduct an international research program for a cohort of at least six undergraduate and graduate students each year. Each 8-week summer research experience consists of four weeks in an international host country and four weeks at UAB. The four weeks abroad are preceded by two weeks in the U.S. dedicated to orientation, project assignments, project planning, and preparing the students for the international experience. Following the international experience, the students spend a minimum of another two weeks at UAB working on their final research project reports, preparing presentations, and developing manuscripts and posters for presentation at conferences.

The IRES program requires that students conduct high-quality research within an approved research area. Research topics should be selected that will enable students to work in

collaboration with both U.S. and overseas mentors, ideally in ways that complement ongoing research at both the US and international hosts. The IRES program also requires that all projects fall under a unifying research theme, so that it provides a cohort experience for the students. Each student is assigned an individual research project for which he/she is responsible, but each of these individual projects must also address the overarching research theme specified in the grant.

### Program Theme

The program theme selected by UAB was the area of “sustainable green building design and construction.” This theme was selected for several reasons:

- There is a growing emphasis on energy efficiency and the protection of natural resources in the building industry;
- In many developing countries, such as Egypt, there is an acute need for affordable yet resource-efficient housing;
- UAB and the international partners have collaborated on research in this area in the past and have jointly held two International Workshops directly related to this theme;
- The area is broad and encompasses a number of research areas, thus providing a range of potential research topics for students;

### Program Objectives

In order to create a cohesive and meaningful experience for the students and to be able to assess the success of the program, clear research and education objectives were established. Following the NSF program requirements and keeping in mind the research expertise of the US and the international partners, the following objectives were established:

- 1) Provide the students with a hands-on international education experience in the emerging area of sustainable green building design and construction;
- 2) Engage the students in meaningful research under the guidance of U.S. and international mentors;
- 3) Allow students to create a network of international contacts in order to promote future collaborations;
- 4) Expose U.S. students to foreign cultures, improve their communication skills, boost their confidence, and provide them with the tools necessary to adapt to and succeed in a global environment;
- 5) Promote diversity by engaging students from underrepresented groups to pursue careers in science, technology, and engineering.

## **Program Development and Planning**

This section provides an overview of the process used to develop our international research experience.

### **1. Program Management Team**

Assembling a management team early in the process was essential for the success of the program. International programs for students require formal agreements with international host institutions that can take months to arrange. They typically require significant amounts administrative effort to coordinate travel and arrange overseas activities. They require staff with knowledge of University travel and financial policies and the ability to coordinate with foreign institutions on these matters. Finally, they require significant lead times to plan and coordinate program activities, as much as twelve months prior to student travel. According to the needs of this program, our management team included the following members:

- Program Director – provided overall leadership of the program and arranged agreements with international institutions;
- Program Coordinator – advertised the program, met with the students, managed planning activities, and was the main point of contact for the students;
- Financial Assistant – was in charge of budgeting, reimbursements, and student stipends;
- Faculty mentors – four faculty mentors collaborated in this program. Each mentor assisted two students with their research project throughout the program.

### **2. Identifying International Hosts**

Since the key portion of an international research experience takes place at the international host institutions, it is important to choose partners that have established programs of high quality research and histories of collaboration with the U.S. university. The primary international partner for our program is the Housing and Building National Research Center (HBRC) in Cairo, Egypt. It is an independent government research center that focuses on enhancing the performance of the building, housing, and urban development sector in Egypt but also prides itself on being a center of excellence within the Arab region. The scientists and engineers working at the HBRC are PhDs trained in areas related to building design and construction, with some of their primary focus areas being sustainable design, non-conventional building materials, and green building construction. Also attractive to us was the history of collaboration between the HBRC and UAB. The two have worked in the past on joint research projects related to housing and building design, codes and standards, and environmental remediation.

Our original intent was to provide the international research experience exclusively in Egypt; however, when opportunities arose to expand the program to Europe we carefully considered the potential benefits. There are many ongoing sustainability initiatives in Europe and programs to promote sustainability are probably more mature there than anywhere in the world. Providing a research experience in Europe as well as Egypt would give the students a much broader view of what sustainability and sustainable construction mean in different parts of the world. The students would also benefit from experiencing and contrasting sustainability efforts taking place in a developed country with those in a developing country. They would have the opportunity to interact with researchers and mentors from European countries as well as from Egypt. We therefore submitted a proposal to the NSF to modify the original itinerary, which consisted of

four weeks in Egypt, to two weeks in Egypt and two weeks in a European country. The NSF accepted this suggestion and, as a result, the 2015 program provided students two weeks in the Netherlands and two weeks in Egypt. The 2016 program provided students two weeks at Staffordshire University in the United Kingdom and two weeks with the HBRC host in Egypt. UAB already had a well-established working relationship with the Staffordshire University in the UK, making administrative coordination fairly smooth.

### 3. Program Funding

The NSF IRES grant covered all student expenses related to the international research experience, including round trip airfare, accommodations, transportation, and supplies. Our university covered the faculty and staff time required to make this program successful. Developing and managing budgets for the program required careful coordination with the foreign institutions. We found that having a financial assistant in charge of budgets and payments was critical to this effort.

### 4. Selection of Research Projects

Following the selection of the research theme, the management team selected topic areas for the student research projects. Faculty, rather than students, chose the project topic areas to ensure that they meshed well with ongoing research at the international host institutions. The following seven project topics were chosen.

1. Sustainable Affordable Housing
2. Novel and Green Autoclaved Aerated Concrete (AAC) Building Systems
3. Assessment of the Green Building Code Design and Construction Provisions
4. Economic Assessment of the Green Building Code
5. Sustainable Green Concrete Materials
6. Assessing the Energy Efficiency of Green Roofs
7. Development of Low-Cost Construction Materials Utilizing Agricultural Waste

The students were allowed to choose one of the proposed topics or to propose a project closely related to one of them, provided it matched the expertise of the U.S. and international mentors. During the first offering of the program in 2015, the students worked in teams of two on the following projects:

- Assessing the Energy Efficiency of Green Walls
- Building Envelope Systems Around the World
- Strength Performance of Recycled Aggregate Concrete with Class C Fly Ash
- Evaluation of Green Building Codes in Egypt, the Netherlands, and the U.S.

During the second program offering in 2016, the students worked in teams of two on the following research projects:

- Sustainable Affordable Housing Design
- Assessment of the Green Building Code Design and Construction Provisions
- Renewable Energy Sources and Applications
- Green Construction Practices and Technologies

## 5. Program Marketing and Student Recruitment

The program was marketed with the goal of attracting students who would best capitalize on the opportunities provided. We found that it is important to begin advertising and marketing efforts early in order to recruit top students before they commit to summer internships or other local activities. Advertising brochures were developed and circulated to the student body, including undergraduate, M.S., and Ph.D. students. The brochure (Appendix A) was disseminated through the UAB School of Engineering faculty, website, and newspaper. We also asked faculty to recommend students who they felt were likely to be successful in the program and some of those students were contacted individually. We were seeking students with the following characteristics:

- Strong academic history
- Interest in the research theme
- Demonstrated work ethic and maturity
- Good social skills
- Under-represented STEM groups (women and minorities)

The management team met to select the top applicants and sent acceptance letters to the selected students. This letter included a deadline for the students to accept the offer and clearly stated their obligations once accepted. It is recommended that the selection committee also choose alternate candidates in case any of the participants decide to withdraw from the program. Although the program was intended to support six students each year, we have been able to support eight students during each of first two offerings.



*Image 1 – 2015 International Research Experience Students*



*Image 2 – 2016 International Research Experience Students*

## 6. Planning the Itinerary

Each day of the international experience was carefully planned to maximize the limited time available at the international host institutions and to ensure that the student experiences in each country were complementary. We tried to achieve a balance between educational experiences (such as lectures and site visits), cultural experiences, opportunities for the students to work with their research mentors, and off-times for the students to relax and work on their projects. Collaboration with the foreign institutions was essential in developing the itinerary of day-to-day activities and it was typically an iterative process. We also found that a detailed itinerary helped the students to understand program expectations and budget their time while abroad.

## 7. Pre- Program Activities – Preparing the Students

Prior to the departure, the students attended orientation meetings to prepare them for the program and for travel abroad. These meetings were especially important for students who had not traveled abroad before. Topics covered included:

- a) Passport and visa requirements
- b) Registering for international travel at the university
- c) Emergency contact information
- d) Cultural differences and expectations for behavior in each country
- e) Suggestions for packing
- f) Student stipends
- g) Pre-program surveys of expectations
- h) Itinerary while in the host countries

## 8. Initiation of Research Projects

The students began work on their research projects prior to traveling abroad. They were assigned U.S. faculty mentors who helped them develop literature reviews and research plans. The literature reviews and research plans were then sent to the foreign mentors for review and comment. We found it was also important during this time to communicate clearly to the students the expectations regarding their research and work products. In this case, final work products included a report summarizing their research findings, a summary of their personal experiences, a final presentation, and a poster. We found that providing the students with

standard outlines for their final reports and presentations (Appendix B) helped them to organize their thoughts and their approaches to the research.

### 9. Program Planning Timeline

The total pre-trip planning time required for each program was approximately 10 months. An additional two months were allocated following the trip for the completion of the research projects, presentations to faculty, and program assessment. Total planning and execution time totaled about 12 months per offering. A brief summary of the planning timeline is provided below.

**Table 1 - Program Planning Activities**

<b>Month</b>	<b>Activities at American Host Institution</b>	<b>Activities at International Host Institution</b>
August	<ul style="list-style-type: none"> <li>Develop advertising materials</li> </ul>	<ul style="list-style-type: none"> <li>Confirm international partner(s) and conduct first conference call</li> </ul>
September	<ul style="list-style-type: none"> <li>Distribute advertising material and application form to students</li> </ul>	<ul style="list-style-type: none"> <li>Discuss potential research theme and project topics</li> </ul>
October	<ul style="list-style-type: none"> <li>Create a database to collect all student applications</li> </ul>	<ul style="list-style-type: none"> <li>Agree on a research theme. Draft research topics</li> </ul>
November	<ul style="list-style-type: none"> <li>Draft a budget and discuss with partner institutions</li> </ul>	<ul style="list-style-type: none"> <li>Finalize research project topics</li> <li>Identify research mentors</li> <li>Negotiate preliminary budgets</li> </ul>
December	<ul style="list-style-type: none"> <li>Application deadline for students</li> </ul>	<ul style="list-style-type: none"> <li>Finalize research mentors</li> <li>Arrange student accommodations, laboratory tours, industry tours, etc.</li> </ul>
January	<ul style="list-style-type: none"> <li>Review applicants and select participants</li> <li>Ask selected participants to send their passport and visa information</li> </ul>	<ul style="list-style-type: none"> <li>Agree on a number of students participating, keeping in mind the budget</li> </ul>
February	<ul style="list-style-type: none"> <li>Host a meeting with all accepted students</li> <li>Review flights, transportation, accommodation, student visa etc.</li> </ul>	<ul style="list-style-type: none"> <li>Develop draft itinerary of research activities for each day</li> </ul>
March	<ul style="list-style-type: none"> <li>Students submit all necessary forms (emergency contact information, medical insurance, special needs etc.)</li> <li>Assign research project to each student or student team</li> </ul>	<ul style="list-style-type: none"> <li>Finalize itinerary</li> </ul>
April	<ul style="list-style-type: none"> <li>Students begin working on their research project with an assigned mentor from the US institution</li> <li>Hold orientation meeting with students</li> <li>Deposit stipend on students account</li> </ul>	<ul style="list-style-type: none"> <li>Plan student reception at airport and arrange transportation to host site</li> </ul>
May	<ul style="list-style-type: none"> <li>Students travel abroad</li> <li>INTERNATIONAL RESEARCH EXPERIENCE</li> </ul>	<ul style="list-style-type: none"> <li>During the whole month the international institutions provide continuous feedback regarding the progress of the program</li> </ul>
June	<ul style="list-style-type: none"> <li>Students return to US university, continue contact with foreign mentors</li> <li>Meeting with students to guide them on finishing their research projects</li> <li>Send survey and questionnaire to students</li> </ul>	<ul style="list-style-type: none"> <li>Mentors continue correspondence with students on projects</li> <li>Send survey and questionnaire to international institution for program feedback</li> </ul>
July	<ul style="list-style-type: none"> <li>Assist students with their final research project reports</li> <li>Help students develop conference abstracts</li> </ul>	<ul style="list-style-type: none"> <li>Mentors continue to communicate with students and provide assistance with their final research project report</li> </ul>
August	<ul style="list-style-type: none"> <li>Host a final ceremony where the students present their research projects and talk about their experience</li> </ul>	
September	<ul style="list-style-type: none"> <li>Prepare annual report for funding agency</li> </ul>	

## **International Research Experiences**

The students traveled with the Program Coordinator and one faculty mentor. Upon arrival at each host institution the students participated in a welcome ceremony and an orientation tour during which they visited institution facilities, research laboratories, housing, and dining halls. The students also took a walking tour of the surrounding areas with guidance on things such as shopping for food and sundries and handling laundry. Depending on the country, the orientation also included a guide to local transportation.

### 2015 Program

During the first program offering in 2015, the students were involved in collaborative research projects with direct mentoring by faculty from the U.S. and Egypt, and received guidance from experts on sustainability in the Netherlands (Images 3 and 4). The students spent the first two weeks of the program in the Netherlands, during which they visited sustainability projects and met with experts working in the sustainability field. Some of the activities that took place during these two weeks included:

- A bike tour of Amsterdam and visit to Westergasfabriek to learn about the clean-up of a heavily polluted industrial site and its transformation into a vibrant cultural center
- A tour of North Amsterdam, including a visit to De Ceuvel, the urban gardens, and student container housing
- A tour of the University of Amsterdam to learn about their program in Science for Energy and Sustainability
- Sightseeing by bike in Gouda to study sustainable food production and buildings constructed from natural materials in the area
- A walking tour of water containment structures and a comparison to similar structures on the Alabama Gulf Coast
- A tour of green roof sites
- A lecture at the Technical University campus and a tour of the library recently constructed using sustainable architecture
- A discussion with Technical University faculty about sustainable agriculture practices and local markets for produce

The Netherlands portion of the trip was treated primarily as an educational experience and an opportunity for the students to gather information and ideas for their research. They met with experts on sustainability and/or visited sustainability projects nearly every day and saw first-hand how sustainability is being implemented in Dutch society. It also provided a good example of how sustainability is being promoted in a relatively affluent society, a baseline against which they could compare sustainability programs in Egypt.



*Image 3 - The students in the Netherlands (2015)*



*Image 4 - The students in Egypt (2015)*

After two weeks the students traveled from the Netherlands to Egypt. The two weeks in Egypt, hosted by the HBRC, included educational experiences related to the implementation of sustainable design and construction in the country as well as time for the students to work directly with their research mentors. Educational experiences included lectures on sustainability topics and visits to sites where sustainable building design principles were being tested or implemented. Research opportunities generally consisted of time for the students to meet with their mentors to review work performed to date and next steps. The mentors were expert faculty

who conduct research in areas of sustainable building design and construction. The mentors helped the students to refine their research plans and provided information from Egyptian research relevant to their topics. Frequently the mentors would give the students assignments to complete for the next day, when the results would be reviewed and next steps discussed. For some students this time was spent in a laboratory setting, for others it was in the form of face-to-face discussions in an office environment. The students incorporated research being performed in Egypt into their own projects and investigated how technologies and construction methods being developed in Egypt could be applied in the U.S.

Other activities that took place during the two weeks at the HBRC in Egypt included:

- Attending an International Workshop titled “Sustainable Infrastructure in Egypt: Air and Water”
- A visit to the American University in Cairo (AUC) in which the students toured laboratories and facilities, and met with faculty and students.
- A visit to the site of a “green” building under construction
- A tour of the research laboratories of the HBRC partner institution in Cairo
- Multiple meetings with industry experts and managers of sustainability projects
- A visit to a site used by the HBRC host institution to construct demonstration buildings using innovative building techniques and materials

### 2016 Program

The second program offering took place in the summer of 2016 and included 2-week stays in Egypt and the United Kingdom. This time the students had research mentors in both Egypt and the UK and were able to work on their projects with direct mentoring in both countries. (Images 5 and 6).

The program in Egypt hosted by the HBRC was similar to the 2015 program, combining education experiences with opportunities to work with mentors on their research projects. The students attended lectures and had open discussions with research faculty on a variety of topics related to the program theme, including:

- Innovative Construction Systems
- Special Concretes
- Initiatives to manage and recycle construction waste in New Cairo
- Energy efficient buildings in hot climates
- Bridges: Testing and evaluation
- The Green Pyramid Rating System
- Energy efficient buildings using photovoltaic technologies
- Green construction techniques using rammed earth structures and stabilized earth blocks
- Incorporating construction waste into building design

The students also toured research labs and sites where the HBRC tests innovative technologies and building systems. Students met with their HBRC research mentors at regular intervals, sometimes in laboratory settings and sometimes in an office setting, to review work to date and receive suggestions for next steps. Students exchanged contact information with key researchers at the Egyptian institution so that contact could be maintained after they returned to the U.S.



*Image 5 - The students at the HBRC host institution in Cairo (2016)*

After two weeks the students traveled to the United Kingdom where they were hosted by Staffordshire University, our partner institution in Stoke-on-Trent. During the students' stay in the U.K., they were assigned mentors from the partner institution to continue working on their research projects. They were able to meet with their mentors at regular intervals to discuss progress and incorporate ongoing research from the UK.

Along with these working sessions, there were regular education experiences related to the sustainability theme:

- Lectures and discussions regarding topics related to sustainability in the United Kingdom
- Visits to research labs. The students toured the Renewable Energy Lab, Campus Renewable Energy projects, and the Science Center
- Tours of two cities in the U.K. to learn about their sustainability initiatives
- Tours of projects taking place at the Staffordshire University to improve their campus in terms of sustainability



*Image 6 – Students in the United Kingdom (2016)*

### **Post-International Activities**

Following their return to the U.S., the students spent the next two weeks at UAB completing work on their projects and deliverables. The students had several meetings with their U.S. mentors and continued to communicate with their mentors from the foreign institutions via email. The students sent their draft final reports to their overseas mentors for review and comment.

The UAB faculty mentors then reviewed the final reports and presentations. Student were required to address all questions and suggested revisions prior to receiving final grades. The School hosted a concluding event at which each student presented their report and talked about their personal experiences. Other students, faculty, staff, family, and friends attended this event.

The students were also encouraged to develop conference abstracts and papers on their experience with the assistance of their mentors. Following the 2015 program, one student team authored a paper that was accepted for presentation at the International Sustainable Concrete conference in Washington, D.C. From the 2016 program, four student abstracts have been accepted for conference presentations and are now in the paper review process.

### **Evaluating Program Effectiveness**

To assess the program's effectiveness, we established performance measures for each of the stated objectives as shown in Table 2. In addition to these assessment instruments, we surveyed the international partners for their feelings on how well the program functioned and where improvements could be made. We also surveyed the students at the conclusion of each program to assess their perceptions of how well the program met the stated objectives.

*Table 2 – Assessment Measures and Findings*

<b>Objective</b>	<b>Assessment Measures</b>	<b>Findings</b>
<p>1. Provide the students with a hands-on international education experience in the emerging area of sustainable green building design and construction.</p>	<ul style="list-style-type: none"> <li>• The number of educational activities (lectures and site visits) related to the theme in each country</li> <li>• Incorporation of information learned in each country into final reports</li> </ul>	<ul style="list-style-type: none"> <li>• The students had a least 12 educational experiences in each country related to the program theme</li> <li>• Students were able to compare and contrast sustainability efforts in developed countries with those in developing countries</li> <li>• The students incorporated information learned in each country into their research reports</li> </ul>
<p>2. Engage the students in meaningful research under the guidance of U.S. and international mentors.</p>	<ul style="list-style-type: none"> <li>• Faculty and mentor assessment of final reports and presentations</li> <li>• Number of papers and posters accepted for presentation at conferences and/or publication</li> <li>• Number of undergraduate students who enter graduate school and/or research positions after graduation</li> </ul>	<ul style="list-style-type: none"> <li>• U.S. faculty and mentors gave positive reviews to the student reports and presentations. Though some reports required significant revisions, this process too was a learning experience for the students and familiarized them with the rigor required in professional research.</li> <li>• 2015: one team had a paper accepted for presentation at the International Sustainable Concrete Conference in Washington, DC.</li> <li>• 2016: four student paper abstracts were accepted for presentation at conferences and are currently in the paper review phase</li> <li>• One member of the 2015 cohort and 2 members of the 2016 cohort have enrolled or are planning to enroll in graduate school</li> </ul>
<p>3. Allow students to create a network of international contacts in order to promote future collaborations.</p>	<ul style="list-style-type: none"> <li>• Hours of direct interaction with mentors and international experts</li> <li>• Percent of students who maintained contact with their mentors after the international experience</li> </ul>	<ul style="list-style-type: none"> <li>• The students averaged approximately 8 hours of face-to-face interactions with research mentors in each country. Additional interaction occurred through email</li> <li>• 2015: 40% of students continued contact with their international mentors after the international experience</li> <li>• 2016: 80% of students continued contact with their international mentors after the international experience</li> </ul>

<b>Objective</b>	<b>Assessment Measures</b>	<b>Findings</b>
<p>4. Expose U.S. students to foreign cultures, improve their communication skills, boost their confidence, and provide them with the tools necessary to adapt to and succeed in a global environment.</p>	<ul style="list-style-type: none"> <li>• Number of cultural experiences in each country</li> <li>• Assessment of student presentations given during international experience</li> <li>• Assessment of final presentations</li> </ul>	<ul style="list-style-type: none"> <li>• The students averaged at least 8 cultural experiences in each country. These included visits to historic sites, meals with technical experts and faculty, interactions with local students, university tours, city tours, and shopping trips.</li> <li>• International mentors provided positive feedback on student presentations in the UK</li> <li>• Students stated that, while intimidating, the opportunity to present to international mentors and faculty was an empowering experience</li> <li>• Student response to the program has been overwhelmingly positive. Interviews and surveys found that students felt they had gained confidence to interact with foreign researchers and to present findings in an international environment.</li> </ul>
<p>5. Promote diversity by engaging students from underrepresented groups to pursue careers in science, technology, and engineering.</p>	<ul style="list-style-type: none"> <li>• Number of women and minority students who participated in the program</li> </ul>	<ul style="list-style-type: none"> <li>• 2015: of the eight student participants, seven were women and two were minorities</li> <li>• 2016: of the eight student participants, two were women and two were minorities</li> </ul>

## **Assessment Results**

Summaries of the assessment results are provided in Table 2. Overall, the program has been very successful in achieving its stated objectives. Among the significant results and achievements of this program are:

- All students have successfully completed research projects and presented their findings in professional reports and presentations to faculty and mentors. The students have been able to incorporate educational experiences across two countries into successful projects related to sustainable building design and construction.
- The students reported increased confidence in interacting with people from different cultures and presenting to an international audience. Feedback on student presentations from the international partner in the UK was positive.
- The students learned the key aspects needed to have a successful international research project, including project planning, execution, review, and revision. One student team has presented their project at an international conference and four other teams have had their abstracts accepted for presentation at professional conferences.
- The students had the chance to meet with a wide variety of experts in the field of sustainability and the majority have continued correspondence with at least one international contact after the conclusion of the program.
- The program has successfully recruited woman and minority students. Over half of all participants have been women and a quarter have been minority students.

We have also used the assessments and survey instruments to improve the program after each offering. Improvements have included:

- Allotting more time in the program itinerary for students to interact directly with mentors. This was requested by students after the first program offering.
- Requiring the students to do more project preparation prior to the international travel experience. This additional preparation allowed the students to be more productive while overseas and meeting with their mentors.
- Conveying expectations for deliverables more clearly and providing detailed outlines for final reports.
- Providing an opportunity for the students to present their research to an international audience.

## **Dissemination of Results**

We have disseminated program results through a variety of media, including:

- Conference publications
- Conference presentations
- Our School of Engineering website
- Our program website

- A final presentation event hosted by the Department of Civil, Construction and Environmental Engineering where all the students had the opportunity to talk about their experience as well as to present their research findings
- A promotional video

### **Conclusion**

Overall, the international research experience for students has been a success for UAB as well as for our overseas partners. The students have gained valuable research experience in the area sustainable green building design and construction at the same time that they have acquired a global perspective by being exposed to engineering innovations and practices in different countries and cultures.

Presently, UAB is planning for the third offering during the summer of 2017. For this year's program, the theme area will continue to be Sustainable Green Building Design and Construction. The international travel experience will again have the students spend two weeks at the main host institution in Cairo, Egypt (the HBRC) followed by two weeks at host institutions in Germany. UAB has well-established relationships with two different host institutions in Germany and the program management team believes that this will be a great addition to the international experience. At the end of the three offerings a final report will be developed summarizing the data collected over the three years. Our institution hopes to be able to continue developing and expanding this program in the future.

### **Acknowledgement**

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APPENDIX A  
ADVERTISING BROCHURES (2015 & 2016)



NSF INTERNATIONAL  
RESEARCH EXPERIENCE FOR  
STUDENTS IN THE  
**NETHERLANDS AND EGYPT**

**Summer 2015** : April 26<sup>th</sup> – May 10<sup>th</sup> Amsterdam  
May 11<sup>th</sup> – May 25<sup>th</sup> Egypt

**Creating a Culture of Sustainability –  
Sustainable Green Building Design and Construction**

The International Research Experiences for Students program supports development of globally-engaged U.S. science and engineering students capable of performing in an international research environment at the forefront of science and engineering. IRES projects involve students in meaningful ways in ongoing research programs or in research projects specifically designed for the IRES program. **This NSF program will cover all the expenses related to the International Research Experience, including round trip airfare, accommodation, transportation and supplies**

**NSF  
International  
Research  
Experience for  
Students**

The International Research Experiences for Students (IRES) program supports development of globally-engaged U.S. science and engineering students capable of performing in an international research environment at the forefront of science and engineering. IRES projects involve students in meaningful ways in ongoing research programs or in research projects specifically designed for the IRES program.

*This NSF program will cover all the expenses related to the International Research Experience, including round trip airfare, accommodation, transportation and supplies*



**SUSTAINABLE GREEN BUILDING  
DESIGN AND CONSTRUCTION**

Objectives

- Provide U.S. students with an international collaborative research training experience and education in the area of sustainable green building design and construction
- Expand the students' professional network in order to promote future collaborations
- Expose U.S. students to European and Middle Eastern culture, improve their communication skills, boost their confidence, and provide them with the tools necessary to adapt to and succeed in a global environment

Research Projects

1. Sustainable Affordable Housing
2. Novel and Green Autoclaved Aerated Concrete (AAC) Building System
3. Assessment of the Green Building Code Design and Construction Provisions
4. Economical Assessment of the Green Building Code
5. Sustainable Green Concrete Material
6. Assessing the Energy Efficiency of Green Roofs
7. Development of Low-Cost Construction Materials Utilizing Agricultural Waste

**SUMMER 2016**

May 2<sup>nd</sup> – May 16<sup>th</sup> **Egypt**  
May 16<sup>th</sup> – May 25<sup>th</sup> **United Kingdom**

APPENDIX B  
SUMMARY OF REQUIREMENTS FOR STUDENT WORK PRODUCTS

**A. Summary of your personal experience (1-2 pages)**

*Times New Roman (12) Single Space*

- Brief Description of your research, including project title(s), team and mentors
- Brief Summary describing activities in both countries in chronological order (by week)
- What have you learned from this experience? (Technologically, culturally etc.)
- Comparison between developed and developing countries (Egypt and the U.K.). To what extent has the comparison been useful to your research and experience?
- Contacts made in both countries
- Feedback about positive experiences, issues and suggested improvements

**B. Final Report (20-25 pages)- including:**

*Times New Roman (12) Double Space*

- Abstract (1 page max)
  - ❖ State main objectives
  - ❖ Describe methods
  - ❖ Summarize the most important results
  - ❖ State major conclusions and significance
- Introduction (1-2 pages)
  - ❖ Describe the problem investigated
  - ❖ Summarize relevant research to provide context, key terms and concepts
  - ❖ Review relevant research to provide rationale
  - ❖ Briefly describe the research
- Research Objectives (1 page max)
- Literature review (3-5 pages)
- Discussion (10 pages max) including tables and figures
  - ❖ State major findings of study
  - ❖ Explain meaning of the findings and why the findings are important
  - ❖ Relate the findings to those of similar studies
  - ❖ Consider alternative explanations of the findings
  - ❖ State relevance of findings
  - ❖ Potential applications of your research
  - ❖ Brief discussion of the economics involved (cost/benefit, ROI)
  - ❖ Acknowledge study's limitations

- ❖ Discuss where your technology/application would have the greatest benefits and why
- Recommendation for further research (1 page)
- Conclusion (1-2 pages)
- References

**C. PowerPoint Presentation** (*10min, 15 slides max*)

- The students will present to the faculty and staff from the School of Engineering and other external invitees
- The students that worked in teams would only need one PowerPoint Presentation per team
- Use the template that has already been provided during the International Experience

**D. Posters for Sustainable Smart Cities Symposium 2016** (*Fall 2016*)

- Develop poster summarizing the international research experience (Template would be provided)

APPENDIX C  
PHOTO GALLERY INTERNATIONAL EXPERIENCE 2015 AND 2016



*Figure 1:* The students at the HBRC, the host institution in Cairo, Egypt



*Figures 2 & 3: Students touring the host institution (HBRC) Research Labs in Cairo*



*Figure 4: The students visiting the American University in Cairo (AUC)*



*Figure 5: Students working on their research project with their mentor (Egypt) at the HBRC*



*Figure 6: Students participating in the NSF International Workshop “Sustainable Infrastructure in Egypt: Air and Water” held at the HBRC*



*Figure 7: Students visiting test site for a compressed earth block building*



*Figures 8 and 9: Students participating in an NSF International Workshop in Alexandria, Egypt*



*Figure 10: The students touring the Renewable Energy Lab at Staffordshire University in UK*



*Figure 11: Students visiting the GreenPad Center at Staffordshire University in UK*



Figure 12: Tour of neighborhoods that have been revitalized in a more sustainable manner in UK



Figure 13: Students working with their U.K. mentors on their research project at Staffordshire University