Training and Mentoring the Next Generation of Scientists and Engineers to Secure Continuity and Successes of the US DOE's Environmental Remediation Efforts - 13387

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ABSTRACT

The DOE Office of Environmental Management (DOE-EM) oversees one of the largest and most technically challenging cleanup programs in the world. The mission of DOE-EM is to complete the safe cleanup of the environmental legacy from five decades of nuclear weapons development and government-sponsored nuclear energy research. Since 1995, Florida International University's Applied Research Center (FIU-ARC) has supported the DOE-EM mission and provided unique research capabilities to address some of these highly technical and difficult challenges. This partnership has allowed FIU-ARC to create a unique infrastructure that is critical for the training and mentoring of science, technology, engineering, and math (STEM) students and has exposed many STEM students to "hands-on" DOE-EM applied research, supervised by the scientists and engineers at ARC. As a result of this successful partnership between DOE and FIU, DOE requested FIU-ARC to create the DOE-FIU Science and Technology Workforce Development Initiative in 2007. This innovative program was established to create a "***pipeline***" of minority STEM students trained and mentored to enter DOE's environmental cleanup workforce. The program was designed to help address DOE's future workforce needs by partnering with academic, government and private companies (DOE contractors) to mentor future minority scientists and engineers in the research, development, and deployment of new technologies and processes addressing DOE's environmental cleanup challenges. Since its inception in 2007, the program has trained and mentored 78 FIU STEM minority students. Although, the program has been in existence for only five years, a total of 75 internships have been conducted at DOE National Laboratories, DOE sites, DOE Headquarters and field offices, and DOE contractors. Over 85 DOE Fellows have participated in the Waste Management Symposia since 2008 with a total of 68 student posters and 7 oral presentations given at WM. The DOE Fellows participation at WM has resulted in three Best Student Poster Awards (WM09, WM10, and WM11) and one Best Professional Poster Award (WM09). DOE Fellows have also presented their research at ANS DD&R and ANS Robotics Topical meetings. Moreover, several of our DOE Fellows have already obtained employment with DOE-EM, other federal agencies, DOE contractors.

This paper will discuss how DOE Fellows program is training and mentoring FIU STEM students in Department of Energy's Office of Environmental Management technical challenges and research. This training and mentoring has resulted in the development of well trained and

polished young scientists and engineers that will become the future workforce in charge of carrying on DOE-EM's environmental cleanup mission. The paper will showcase FIU's DOE Fellows model and highlight some of the applied research the DOE Fellows have conducted at FIU's Applied Research Center and across the Complex by participating in summer internship assignments. This paper will also present and highlight other Fellowships and internships programs sponsored by National Nuclear Security Agency (NNSA), DOE-EM, NRC, Energy (NE), and other federal agencies targeting workforce development.

INTRODUCTION

Well educated and trained professionals are needed to combat the shortage of a 21st century workforce that will continue the environmental restoration challenges faced by the US and other countries around the world that were involved in the research & development and production of nuclear weapons. In addition, currently 31 countries around the world operate a total of 435 nuclear power plants units (104 in the US alone) and an additional 62 plants are under construction in 14 countries [1]. These commercial nuclear power plants will also face shut down and decommissioning in a not too distance future which will add to the need of a well trained and skilled workforce. Today, the challenges are even greater, as the environmental restoration program in the US is experiencing cuts and many sites across the Complex are reducing the size of their trained and skilled workforce. Budget cuts by the government not only postpone the remediation of highly contaminated facilities across the US which creates an even larger environment treat to future generations, but has the ramification of losing the knowledge base and knowledge transfer needed to train our future workforce.

For example, US Department of Energy's Office of Environmental Management (DOE-EM) is responsible for conducting one of the largest environmental restoration program in the world that involve a workforce of over 30,000 employees composed of federal and private contractors. This workforce is composed in majority by experienced, seasoned professional with an average age of 50+ year old. The challenges of workforce development for the environmental remediation field are evident by recent number reported by DOE-EM. According to a survey conducted by DOE-EM's Human Capital Office in 2008, 43% of its workforce was 50-59 years old and 37% of the workforce was between the ages of 40-49 years old. In contrast, 11% of its workforce was age 60 or older and only 1% of its workforce was 30 years old or younger (see Figure 1). As reflected in Figure 1, 91% of EM workforce is 40 years old or older [2]. Similar trends are reflected in by private contractor and DOE National Laboratory workforce. The aging of a workforce for environmental management is not only an US problem but it is also an issue being faced by other countries with conducting large environmental restoration program such as the United Kingdom.

The workforce development not only affect the environmental restoration industry, but also will be a major issue with the construction of new nuclear reactors as more and more countries consider nuclear energy as part of their energy security strategy. New construction of nuclear power plants will require a trained and skilled workforce, which compounds the aging workforce issue and increases the demand for skilled workers. As identified above, currently 62 new

commercial nuclear plants are under construction in 14 countries around the world. For example according to the Nuclear Energy Institute, by 2015, the electric power industry will have to replace nearly 100,000 skilled workers – more than 25,000 of them in the nuclear industry [3].

THE DOE FELLOWS PROGRAM MODEL

The aim of the DOE Fellows Program is to create a "***pipeline***" of well trained and mentored STEM Florida International University students. The program has been design on an "apprenticeship" model where selected students perform "hands-on" research under the supervision of staff and faculty. Since its inception in 2007, this program has been able to train and mentor FIU minority students on DOE-EM related applied research. FIU-ARC has full-time researchers dedicated to EM's environmental restoration mission. This infrastructure makes an ideal environment for the mentoring and training of students. This training is augmented by exposing DOE Fellows to internships experiences at DOE facilities across the country. Also, the students participating in this program participate and showcase their research at annual conferences such as the Waste Management Symposia and American Nuclear Society Annual conferences. Students are selected via a well established recruitment and selection process. An application package is available at the DOE Fellows website (http://fellows.fiu.edu) and a DOE Fellows selection committee is assemble with representation from US DOE, FIU College of Engineering, FIU College of Arts & Sciences, and FIU's Applied Research Center scientists. Typically, about 10-15 students enter the program each year. The students selected are composed of undergraduate and graduate FIU student. Graduate students (master's and doctoral) conduct applied research are ARC or DOE national laboratories which become the basis for their thesis or dissertation. The program also works closely with DOE and DOE contractors in identifying and facilitating employment opportunities to the DOE Fellows.

DESCRIPTION OF THE PROGRAM

The DOE-FIU Science and Technology Workforce Development Program established by the US Department of Energy and Florida International University in 2007. Since its inception in 2007, the DOE-FIU Science and Technology Workforce Development Program (also known as the DOE Fellows program) has formally recruited, selected and inducted a total of 78 students. The next section details the various activates within the program that leads to the successful recruitment, selection, and training of top FIU STEM minority students.

Recruitment Efforts

Formal recruitment efforts of FIU minority STEM students are conducted in the April/May (Spring Semester) and September/October (Fall Semester) timeframes each year since the program's inception. Recruitment efforts included the development of a dedicated program web site (http://fellows.fiu.edu), in-class room presentations, recruitment tables at the College of Engineering and the College of Arts and Sciences, booths at FIU Job Fairs, information sessions, and presentations at student societies such as the Society of Hispanic Professional Engineers, the Society of Women Engineers, and the Society of Black Engineers.

Students are required to turn in application packages that included a complete application, three letters of recommendation from FIU faculty, an updated resume, and unofficial FIU transcripts. A DOE Fellows selection committee was formed with the participation of DOE's EM personnel (including DOE-EM HR), FIU faculty members, and ARC scientists. Applications are reviewed by the committee and selected students were called for formal interviews. Over 600 applications have been received since program inception in 2007 and total of 78 students have been selected and inducted as DOE Fellows.

DOE Fellows Induction Ceremony

FIU students that are recruited and selected for this program are formally inducted as DOE Fellows. The selected students are vested with this name at a special ceremony conducted at FIU each Fall semester (during the month of November). The DOE Fellows Induction Ceremony is an event that is attended by DOE Officials (HQ), DOE National Laboratory officials, FIU administration, faculty, staff, students and, of course, our DOE Fellows. A total of six formal induction ceremonies have been conducted since 2007. These ceremonies have included the participation of several DOE officials including: Assistant Secretary for Environmental Management (Mr. Jim Rispolli in 2008 and Dr. Ines Triay in 2010), Dr. Paul Deason (Deputy Director Savannah River National Lab) in 2010, Mrs. Tracy Mustin (Principal Assistant Secretary for Environmental Management) in 2011, and Mrs. Alice Williams (Associate Principal Deputy Assistant Secretary for Environmental Management) in 2012 (see Figure 1 below).

Fig. 1 DOE-EM's Representatives, DOE Fellows Class of 2012 and Dr. Lagos at 2012 Induction Ceremony

DOE Fellows Conducting "Hands-On" Research for DOE-EM

Since the program started in 2007, all DOE Fellows inducted into the program have been engaged in DOE-EM applied research activities being conducted at FIU-ARC. The DOE Fellows

are integral part of the applied research activities and work side-by-side with ARC scientists and engineers in the development of research portfolio under the DOE-FIU Cooperative Agreement. The DOE Fellows are actively engage in decontamination & decommissioning (D&D) projects, soil and groundwater and high level waste research. For example, the DOE Fellows are involved in soil and groundwater EM projects being conducted by ARC scientists in collaboration with Oak Ridge National Laboratory (i.e. developing computer models for fate and transport of mercury contamination) and Pacific Northwest National Laboratory (i.e. investigating uranium sequestration issues due to polyphosphate injection). DOE Fellows have also participated in D&D activities including the evaluation of D&D technologies (i.e. evaluation of a robotic platform capable of spraying fixatives inside hot cell facilities), and are actively involved and supporting in-situ decommissioning (ISD) efforts along with Savannah River Site scientists and engineers. DOE Fellows are also supporting the design and development of D&D Knowledge Management Information Tool (KM-IT) for DOE-EM and directly supporting the Energy Facility Contractors Group (EFCOG) in the development of lessons learned and best practices documents. In fact, since the DOE Fellows have engaged in the development of these documents in 2010, a total of 9 best practices and lessons learned documents have been developed and officially posted on the EFCOG and KM-IT websites. Also, DOE Fellows have collaborated with our researchers in the development of innovative technologies for the detection and measurement of high level waste at Hanford's Tank Farm (i.e. ARC's Solid-Liquid Interface Monitor technology) and designing, developing, and prototyping a "pipe" crawler mechanism for Hanford's Tank Farm. DOE Fellows also conduct environmental restoration research as part of their summer internship assignments where they get the opportunity to work with DOE scientists and engineers at DOE sites, DOE national labs, DOE-HQ, and/or DOE contractors. For example DOE Fellows, Mr. Amaury Betancourt, collaborated with a team of scientists at the Savannah River Site (SRS) during a summer internship in 2011 to evaluate the effects of an innovative mercury remediation strategy on a real ecosystem. During his 10-week internship at SRS, Mr. Betancourt assisted SRS scientist Dr. Brian B. Looney in taking samples of the sediments and water to determine the distribution of tin along Tims Branch (see Figure 2).

Fig. 2 DOE Fellow, Amaury Betancourt with mentor Dr. Brian Looney at SRNL during summer 2011

DOE Fellows Internships

Since 2007, our DOE Fellows have participated in a total of 75 internship assignments at DOE sites (Hanford, Moab, Savannah River, Idaho), DOE-HQ (Forrestal and Germantown offices), DOE National Laboratories (PNNL, ORNL, LLNL, and SRNL) and DOE contractors (NuVision Engineering, Columbia-Energy Environmental Services, Sullivan International Consulting). The DOE Fellows program director works closely with DOE-HQ, national labs and DOE contractors to secure 10-week long internship assignments for the Fellows. Approximately 10 – 15 Fellows participate in summer internship each year (see Figure 2 below). The Fellows are exposed to real life DOE-EM environmental restoration challenges during their summer assignments. This experience allows them to become familiar with DOE-EM mission and understand the magnitude of the various environmental issues faced by the DOE Complex. At the end of the internship, the Fellows typically present their research to the hosting organization and they are tasked with developing a summer internship technical reports as part of their summer internship assignments. This summer internship technical reports are submitted to DOE-HQ as a deliverable for this program. These reports are also posted on the DOE Fellows website (http://fellows.fiu.edu). The Fellows also present their summer internship research at the Waste Management Symposia and the annual DOE Fellows Poster Exhibition and Competition held in Miami.

Fig. 2 Summer 2012 DOE Fellows Summer Interns with Mentors at Oak Ridge National Laboratory

Table 1 below details the number of DOE Fellows that participated in summer 2012 internships [4], the location of the summer internship, the Fellows summer mentor, and the title of the summer internship technical report developed at the end of the summer internship.

Table 1 DOE Fellows Summer 2012 Internships

DOE Fellow	DOE Site/ National Lab/ Contractor	Location	Mentor	Technical Report Title
Janty Ghazi	DOE-HQ EM-23 (Tank Farm Program)	Washington, DC	James Poppiti	Hydrogen in Pipes and Ancillary Vessels (HPAV)
Claudia Cardona	DOE-HQ EM-12 (Soil/Groundwater Remediation	Washington, DC	Kurt Gerdes	Database of Groundwater Pump-and-Treat Systems
Joshua Midence	Savannah River Site	Aiken, NC	Alex Cozzi	Saltstone Processing of Low-Level Waste at Savannah River Site
Eric Inclan	Oak Ridge National Laboratory	Oak Ridge, TN	Dr. Prashant Jain	Development of Pre-processing Software for Lattice Boltzmann Fluid Dynamics Solver
Jaime Mudrich	Oak Ridge National Laboratory	Oak Ridge, TN	Dr. Prashant Jain	Development of a Parallel, 3D, Lattice Boltzmann Method CFD Solver for Simulation of

				Turbulent Reactor Flow
Heidi Henderson	Oak Ridge National Laboratory	Oak Ridge, TN	Dr. Eric Pierce	Analysis of Oak Ridge National Laboratory Outfall 211 Contributing Drainage Areas
Revathy Venkataraman	Y-12 National Security Complex	Oak Ridge, TN	Emma Jones/ Jessica Metcalf	Y-12 EMBOS Medical Lab Interface Batch Loader
Ximena Prugue	Washington River Protection Solutions, Hanford Site	Richland, WA	Leo Thompson	Development of Mechanical Systems for Dry Retrieval of Single Shell Tank Waste at Hanford
Robert Lapierre	Pacific Northwest National Laboratory	Richland, WA	Dr. Dawn Wellman	Single Pass Flow-Through Testing of Metals
Lillian Marrero	Sullivan International Consulting	Chicago, IL	Jennifer Knoepfle	An Evaluation of Volatile Organic Compound Contamination at Two Superfund Sites
Elicek Delgado	Sullivan International Consulting	Chicago, IL	Jennifer Knoepfle	Metal Remediation of the Zinc Site

Waste Management Symposia Participation and other Conferences

Over 85 DOE Fellows have participated in the Waste Management (WM) Symposia since 2008. Most of the Fellows present their DOE-EM research during WM's Student Poster Exhibition (69 poster presented since 2008), but a total of 8 Fellows have presented professional posters and/or oral presentation during the conference. The DOE Fellows participation at WM has resulted in three Best Student Poster Awards (WM09, WM10, and WM11) and one Best Professional Poster Award (WM09). The students also participate as Student Assistant during the conference and provide assistant to sessions co-chairs during oral presentations. In addition, DOE Fellows have participated as panel members on Panel Sessions "Graduating Students and New Engineers – Wants and Needs – Are Companies Even Listening" and Young Professional Panel. The Fellows also have a unique opportunity to meet and network with companies and professional in the environmental remediation field. For example, as shown on Figure 3, during WM12 the DOE Fellows had the opportunity to meet and greet Mr. David Huizenga (Senior Advisor DOE Office of Environmental Management). The DOE Fellows have also presented their DOE-EM research at ANS DD&R (2010 and 2012 meetings) and ANS Robotics Topical meetings in 2011.

Fig. 3 Mr. David Huizenga and DOE Fellows at WM2012

The "Pipeline" is Working

As described above, the main aim of this program is to develop a "pipeline" of minority STEM young scientist and engineers that will enter the STEM workforce. Since its inception in 2007, this program has been able to train and mentor a total of 78 FIU STEM minority students on DOE-EM related applied research. FIU-ARC has full-time researchers dedicated to EM's environmental restoration mission. This infrastructure makes an ideal place for the mentoring and training of students. This training and mentoring has provided the professional development and skills needed by the students to obtained employment at DOE, other federal agencies and private industry. All the DOE Fellows that have graduated FIU and completed the DOE Fellows program have obtained employment in STEM related fields. Some of the DOE Fellows that have joined the workforce include:

- **One (1)** DOE Fellows selected to DOE EM's Professional Development Corps Program
- **Three (3)** DOE Fellows participated in Summer Career Experience Program (SCEP)
- **Three (3)** DOE Fellows hired into DOE-EM and currently working at DOE-HQ in Washington, DC
- **One (1)** DOE Fellow hired at Oak Ridge National Laboratory
- **Seven (7)** DOE Fellows hired by other federal and state agencies including, Department of Defense (1) , Department of Commerce (1), Internal Revenue Service (1 Fellow), Department of Health & Humans Services (1), Florida Department of Environmental Protection (1 Fellow), NASA (2 Fellows)
- **Three (3)** DOE Fellows hired by DOE contractors – AREVA (1 Fellow), Waste Control Specialists (1 Fellow) , and Bechtel (1 Fellow)
- **Fifteen (15)** DOE Fellows obtained employment at Boeing Company (3 Fellows), Florida Power & Light (2 Fellows), General Electric (1 Fellow), Lockheed Martin (1 Fellow), Mount Sinai Medical Center (2 Fellow), Johnson & Johnson (1 Fellow), PriceSmart Inc. (1 Fellow), Bouygues Civil Works Florida (1 Fellow), Crane Aerospace and Electronics (1 Fellow), HP Foundation (1 Fellow), PSI Miami (1 Fellow)

Other Fellows that have completed Bachelors degrees at FIU have left the program and continued their graduate education by pursuing STEM degrees at other institution such as MIT, Michigan, Purdue, Stanford, Virginia Tech, UT, USF, and other institutions.

OTHER FELLOWSHIP/INTERNSHIPS PROGRAMS

In addition to the DOE Fellows Program supported by DOE-EM, other offices at DOE and other federal agencies support various types of scholarship and fellowship program every year. These programs are sponsored by National Nuclear Security Agency (NNSA), DOE Nuclear Energy, Nuclear Regulatory Commission (NRC), and other federal agencies targeting STEM workforce development. For example, NNSA offers HBCU STEM Fellowship Program, and NNSA Graduate Programs that offer internships and job experience for graduate students. DOE's Nuclear Energy also provides fellowships programs under the Nuclear Energy University Program which offer research experience to college students from participating institutions. DOE Office of Science support summer internship at DOE national laboratories under program such as Higher Education Research Experiences (HERE) and Science Undergraduate Laboratory Internships (SULI). These programs directly support students at various universities across by providing fellowship and/or scholarships directly to the students.

CONCLUSION

STEM workforce development programs such as the DOE-FIU Science and Technology Workforce Development Program, and other programs at DOE's Office of Science, Nuclear Energy and NNSA aim to develop talent STEM students in an effort to secure our future workforce. Specifically, the DOE-FIU Science and Technology Workforce Development Program created between US DOE-EM and Florida International University's Applied Research Center located in Miami, Florida, has created a "pipeline" of STEM minority students ready to enter the DOE-EM's workforce. Since its inception, the program has inducted 78 DOE Fellows. Under this program, 75 internships have been conducted across the DOE Complex and 85 presentations have been given at the Waste Management Symposia and other related conferences. The DOE-FIU program has been able to provide hands on DOE-EM research to 78 students and exposed this student to real life environmental restoration challenges being faced by DOE-EM. A large number of DOE Fellows have started their STEM career by obtaining employment at DOE-EM, other federal agencies and private industry.

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