



## **Developing Best Practices for an Undergraduate STEM Summer Research Program in a Government Institution through a Higher Education Partnership**

### **Jessica Drennan MSW, Centers for Disease Control**

Jessica Drennan received a B.A. in Communication Arts from the College of Mount St. Joseph in Cincinnati, OH and a M.S.W. from Washington University in St. Louis, MO. She is currently an ORISE Evaluation fellow at Centers for Disease Control and Prevention in Atlanta, Ga. From 2011 to 2012, she was the Internal Program Evaluator and Evaluation Committee chair with the LEADER Consortium, a National Science Foundation ADVANCE Program in Dayton, Ohio. From 2010 to 2011, she was a Senior Research and Evaluation assistant with the Healthy & Active Communities Initiative at the George Warren Brown School of Social Work at Washington University in St. Louis, MO. From 2009 to 2012, she was a project coordinator at the Institute of Applied Research, St. Louis, MO. She received the Ameren UE Outstanding Practicum Student Award from Washington University and is a Maury Herbert Scholarship recipient at Washington University. She is a member of American Evaluation Association.

### **Dr. Mary Y. Lanzerotti, Air Force Institute of Technology**

Dr. Mary Y. Lanzerotti is an associate professor of Computer Engineering in the Department of Electrical and Computer Engineering at the Air Force Institute of Technology in Dayton. She is editor-in-chief of IEEE Solid-State Circuits Magazine and an elected member of the IEEE Press Editorial Board. She has worked at Pacific Lutheran University, Harvard University Summer School, and IBM. She received an A.B. and graduated summa cum laude from Harvard University, an M. Phil. from the University of Cambridge in the United Kingdom, and a Ph.D. from Cornell University—all in Physics. She holds permanent certifications as a Teacher of Mathematics, Teacher of Physical Science, and Teacher of Physics in the State of New Jersey for Grades P-12.

### **Ms. Maggie Varga, Southwestern Ohio Council for Higher Education**

Maggie Varga received a B.A. in Economics and Finance from University of Dayton, Dayton, OH, and an M.B.A. in business administration from the University of Dayton. She has been the director of Program Innovation at Southwestern Ohio for Council on Higher Education (SOCHE) in Dayton since October 2011. Prior to joining SOCHE in 2011, Varga was interim coordinator at Rivers Institute at the University of Dayton. From 2009 to 2011, she was a graduate assistant at the University of Dayton Rivers Institute where she coordinated student civic engagement program to develop and lead orientation programs and the annual River Summit.

### **Dr. Sean J Creighton, Southwestern Ohio Council for Higher Education**

Dr. Sean Creighton is the executive director of SOCHE, a regional consortium of colleges and universities dedicated to educating, employing, and engaging citizens. In 2012, SOCHE received the Dayton Business Journal Non-Profit Business of the Year Award. Dr. Creighton is an elected member of the Board of Education for the Yellow Springs Public Schools and serves on advisory committees for several local and national organizations. He has published and presented extensively on the impact of higher education, collaboration and civic engagement, and has conducted research for the Kettering Foundation on the economic and civic missions of regionally based colleges and universities. Dr. Creighton has degrees from Marist College and New York University, and earned his Ph.D. from Antioch University. He lives in the charming village of Yellow Springs, with his wife, Leslee, and his five fun children—Liam, Maya, Quinn, Audrey, and Juliette.

### **Dr. Derrick Langley, Air Force Institute of Technology**



Dr. Derrick Langley is an assistant professor of Electrical Engineering at the Air Force Institute of Technology (AFIT), Wright-Patterson Air Force Base (AFB), Ohio. He received his B.S. in Electrical Engineering from the University of Central Florida in 2003, his M.S. in Electrical Engineering from Wright State University in 2007, and his Ph.D. in Electrical Engineering from AFIT, Wright-Patterson AFB in 2012. His current research interests are metamaterials, microelectronics, microelectromechanical systems and nanotechnology.

**Mrs. Diana Lynn Cahill, Air Force Institute of Technology**

Diana Cahill earned her M.Ed. in Curriculum and Instruction at Wright State University. She earned her B.A. in English at Youngstown State University. She has an Ohio Teaching License for High School English. Cahill is currently a Civilian Student Coordinator with the Air Force Institute of Technology at Wright-Patterson Air Force Base.

# **Developing Best Practices for an Undergraduate STEM Summer Research Program in a Government Institution through a Higher Education Partnership**

## **Abstract**

This paper introduces a novel and unique paradigm to upgrade a long-standing summer research program at a government institution to include components that are now standard at civilian programs, such as National Science Foundation (NSF) Research Experiences for Undergraduates (REU) programs. Critical to the success of this new paradigm is a campus-community partnership. This partnership makes it possible for the first time to assess the summer program at the government institution due to government regulations.

The AFIT Summer Research Program hosts approximately 50 student contractors each summer; making the program four to five times larger than a typical NSF REU program, and over 10% are female. All students who participate in the AFIT Summer Research Program are required to be U.S. citizens, and are employed under a contractor through the Southwestern Ohio Council for Higher Education (SOCHE). SOCHE has employed nearly 1,000 STEM students over the past 25 years in both summer programs and year-long programs. During this time, a formal assessment tool was not distributed to students to measure the impact of the research experience on student learning because federal regulations [AFI38-501] do not permit Air Force employees at AFIT to legally survey the students since the students work in contractor status (Air Force employees are not legally permitted to survey contractors in any form; neither paper surveys or email surveys are permitted). Due to AFIT policies and procedures surrounding contractors, the AFIT Summer Research Program lacks components of standard comparable NSF-funded REU programs summer research programs at other institutions. These regulations include not being legally permitted to buy refreshments for informal student cohort meetings, not having a dedicated program coordinator, not offering group meetings to discuss resumes, careers, graduate school, or offer a poster conference. While it is typical at other NSF-funded REU programs to have a program coordinator, each student in the AFIT Summer Research Program is directed through his or her own AFIT Faculty Advisor and has a unique experience. Another unique aspect of the AFIT summer program is that all students are required to work the same core hours between 0900 and 1500 each day.

The new paradigm that we present in this paper is novel and unique because we were able to figure out a way forward to assess students' experiences in 2012 and use this information to gain support and resources to upgrade future summer student research experiences, starting in 2013. Representatives from SOCHE, AFIT, and NSF-funded ADVANCE program entitled the LEADER Consortium (Launching Equity in the Academy across the Dayton Entrepreneurial Region) met in 2011 and 2012 and came up with this new approach. It was a tremendous effort. We feel the project greatly benefits the students and is a first significant step forward to standardizing the student experiences in the AFIT Summer Research Program and incorporating components that are standard at NSF REU programs. An essential part of this solution is that

SOCHE conducts the surveys of the students by email and makes the results available to AFIT and to the LEADER Consortium. SOCHE's assessment tool is a baseline survey conducted when the program was in session (response rate: 54.2%) and a post survey following the program (response rate: 39.6%). Females responded in greater proportion to both surveys: Of respondents to the first survey, 20% were female; of respondents to the second survey, over 36% were female.

We are very excited to obtain this solution for assessing the program, which is legal and obeys federal regulations, because SOCHE is the employer and can legally survey the students. Several updates to the program have occurred since the assessment. First, AFIT hired a Civilian Student Coordinator who will oversee all students in 2013 and will implement the recommendations provided by the students in 2012 (for student cohorts and an orientation). Second, AFIT faculty members have offered to organize a student poster conference and student presentations. Third, SOCHE has offered to bring in local experts to give resume feedback and to pay for refreshments for the students (which is legal for SOCHE) at informal gatherings of student cohorts.

In summary, we present a unique successful partnership. The campus-community partnership produced student feedback results for the first time. Recommendations based on these results will introduce components of standard STEM programs to the AFIT Summer Research Program, which the AFIT program is lacking. The existence of this partnership is critical to be able to move forward legally to upgrade a long-standing summer research program.

The views expressed in this document are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

## Introduction

This paper introduces a novel and unique way forward to upgrade a long-standing summer research program at a government institution to include components that are now standard at civilian programs, such as National Science Foundation (NSF) Research Experiences for Undergraduates (REU) programs. Critical to the success of this new paradigm is a campus-community partnership. This partnership makes it possible for the first time to upgrade the summer program at the government institution because of government regulations.

First, this paper presents a new higher education partnership launched in 2012 intended to transform the undergraduate Summer Research Program at the Air Force Institute of Technology (AFIT). A partnership among AFIT, the LEADER Consortium (Launching Equity in the Academy across the Dayton Entrepreneurial Region), and the Southwestern Ohio Council for Higher Education (SOCHE) was established to assess the students' experiences and to inform future experiences based upon the results of surveys conducted during the 2012 Program.<sup>1, 2, 3</sup>

In this paper, we present the first steps in an institutional transformation project to adapt standard STEM models of undergraduate research programs to the Summer Research Program at AFIT. AFIT is partnering with SOCHE to provide students in the fields of Science, Technology, Engineering, and Mathematics (STEM) with a better experience and improve the existing program. In the effort to find solutions to improve the existing summer research program at a government institution, one goal is to provide a better summer research experience for students.

The new paradigm that we present in this paper is novel and unique because we were able to figure out a way forward to assess students' experiences in 2012 and use this information to gain support and resources to upgrade future summer student research experiences, starting in 2013. Representatives from SOCHE, AFIT, and NSF-funded ADVANCE program entitled the LEADER Consortium (Launching Equity in the Academy across the Dayton Entrepreneurial Region) met in 2011 and 2012 and came up with this new approach. It was a tremendous effort.

In conducting this project, we use the term *research* according to the definitions provided by the National Science Foundation<sup>4</sup> and Lopatto.<sup>5</sup> The National Science Foundation states that: "Research means a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge."<sup>4</sup> In Chapter 2 of *Science in Solution: The Impact of Undergraduate Research on Student Learning*, David Lopatto<sup>5</sup> reviews the definition of the term 'research' and specifically '*scientific research*'. Lopatto writes that at colleges and universities, the most common form of research is the 'scholarship of discovery' described by Ernest Boyer.<sup>6</sup> In *Scholarship Reconsidered: Priorities of the Professoriate*, Ernest Boyer describes 'the scholarship of discovery' (1990) as "[contributing] not only to the stock of human knowledge but also to the intellectual climate of a college or university. Not just the outcomes, but the process, and especially the passion, give meaning to the effort. The advancement of knowledge can generate an almost palpable excitement in the life of an educational institution."<sup>6</sup> As Lopatto writes, "this widens the NSF definition to include the effect that research has on the institution and on the people who undertake it."<sup>5</sup> In this paper, we refer to the goals of undergraduate research defined by David Lopatto as "student development and knowledge production."<sup>5</sup>

AFIT currently lacks many components of standard STEM research programs. We now present a summary of a typical standard STEM summer program, such as those at institutions funded through programs such as the National Science Foundation Research Experience for Undergraduates which we are using as models to which we aspire to upgrade the AFIT program. A standard STEM summer program briefly consists of the following broad steps:

- First Component: Students are recruited,
- Second Component: Students form cohorts,
- Third Component: Students participate in research
- Fourth Component: Students develop presentations,
- Fifth Component: Students work on resumes, and
- Sixth Component: Students prepare poster sessions.<sup>5,7,8</sup>

As of summer 2012, the AFIT Summer Research Program lacked all components except the first component (recruiting) and the third component (research).

Practical strategies for building sustainable programs will be used in this project and are described in the literature, for example, in *Science in Solution: The Impact of Undergraduate Research on Student Learning*, by David Lopatto;<sup>5</sup> *Broadening Participation in Undergraduate Research*, edited by Mary K. Boyd and Jodi L. Wesemann;<sup>7</sup> and *Characteristics of Excellence in Undergraduate Research* edited by Nancy Hensel,<sup>8</sup> all published by the Council of Undergraduate Research.

This project seeks to adapt standard STEM models of undergraduate research programs to improve the experiences of the students at the Summer Research Program at AFIT, where government regulations place some restrictions on who can participate in the research program and on who is able to collect data.

The outline of our paper is as follows:

- First, we discuss the motivation and goal for the project which is to present a new paradigm for a campus-community partnership and transform the Summer Research Program at a government institution;
- Next we discuss the partnership of the government institution, SOCHE, and the LEADER Consortium which provided assessment and evaluation<sup>1,2</sup>. We then discuss the approach and methodology for the assessment of 2012 Summer Research Program;
- We discuss the results and findings of SOCHE's assessment of the 2012 Program;
- Finally, we conclude with recommendations for the 2013 Summer Research Program.

## **Motivation**

This project in workforce development is motivated by the results and findings of a series of reports published by the National Academy during the past decade entitled *Rising Above the Gathering Storm*<sup>9,10,11</sup> and *Examination of the U.S. Air Force's Science, Technology, Engineering, and Mathematics Workforce Needs in the Future and Its Strategy to Meet Those Needs*.<sup>12</sup> In particular, the report entitled, *Examination of the U.S. Air Force's Science, Technology, Engineering, and Mathematics Workforce Needs in the Future and Its Strategy to*

*Meet Those Needs*, is the product of a Committee formed by the National Research Council in response to a request by the Air Force Deputy Chief of Staff for Manpower and Personnel and the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering. This report<sup>12</sup> describes that:

“[technical] capabilities have always been critical to the missions and roles of the U.S. Air Force in military operations, and these capabilities are rooted in science, technology, engineering, and mathematics... For a variety of reasons, concerns have arisen over the future of both the military and civilian contingents of the Air Force’s STEM workforce. Emerging mission areas, particularly in the space and cyber domains, are expanding the need for new technical skills and expertise... A growing percentage of science and engineering graduates in the United States are foreign citizens and thus ineligible for the security clearances that many jobs in the Air Force and in the aerospace industry require. The existing STEM workforce is aging, with many individuals nearing retirement. Women and minorities are underrepresented in most S&E educational pursuits at a time when they constitute the majority of college students and therefore the majority of the future workforce. The market for STEM-educated U.S. citizens is becoming much more competitive.”<sup>12</sup>

The motivation for our project stems from Recommendation 6-6a<sup>12</sup> which states that the “Air Force should periodically access the capability of AFIT to help meet projected future requirements for STEM-degreed personnel by providing selected officers and civilians with educational opportunities leading to the award of a STEM degree. In addition, the STEM personnel decision support model should include a sufficient number of military and civilian AFIT student positions to enable use of these AFIT opportunities.”<sup>12</sup> Recommendation 6-6a was developed in response to Finding 6-6<sup>12</sup> that states that “[the] Air Force Institute of Technology currently offers a number of degree, certificate, and short-course programs (and could potentially offer additional programs) that would increase the number of STEM-degreed officers available to meet Air Force STEM needs. In particular, the AFIT resident school offers graduate STEM education programs that address problems of unique importance to the Air Force; comparable programs are not available at civilian institutions.”<sup>12</sup>

Our project, in response to Recommendation 6-6a,<sup>12</sup> exposes a pool of STEM undergraduate students to research opportunities and future educational opportunities at AFIT. This exposure thereby increases the number of civilian students who are participating directly in exciting and dynamic research opportunities at the forefront of basic scientific knowledge and also have the potential to contribute to the development of advanced technology of interest to the Department of Defense. This pool of STEM-educated students has the opportunity through the Summer Research Program to develop unique capabilities and current skills that are aligned with the workforce needs of the Air Force.

## **Partners**

The LEADER Consortium is funded by an ADVANCE Institutional Transformation Award from the NSF Award #0810989<sup>1,2</sup> since 2008 and is a partnership of four institutions of higher education in the Dayton region: the Air Force Institute of Technology, Central State University,

University of Dayton, and Wright State University. The LEADER Consortium was selected for an Award in Cohort 4 of the National Science Foundation's ADVANCE Institutional Transformation Program.

AFIT<sup>13</sup> is a government institution and engineering graduate school with 900 graduate students. AFIT's mission is to advance air, space, and cyberspace power for the Nation, its partners, and our armed forces by providing relevant defense-focused technical graduate and continuing education, research, and consultation. In the 2011 AFIT Annual Report, Dean Marlin Thomas writes that "The Air Force Institute of Technology's longstanding commitment to excellence in research-based graduate education provides an outstanding return on investment to the Air Force and Department of Defense. Our graduates apply their enhanced skills throughout the military and civilian careers."<sup>13</sup> In 2011, the Carnegie Foundation identified AFIT as a doctoral/research institution for the first time in recognition of the doctoral education productivity with strong research activity in Science, Technology, Engineering, and Mathematics disciplines. Students participating in the AFIT Summer Research Program work with faculty in six departments: Aeronautics and Astronautics, Electrical and Computer Engineering, Engineering Physics, Mathematics and Statistics, Operational Sciences, and Systems and Engineering Management. These departments contain five centers: the Center for Cyberspace Research, Center for Directed Energy, Center for Operational Analysis, Center for Technical Intelligence Studies and Research, and Advanced Navigation Technology Center.

The Southwestern Ohio Council for Higher Education, or SOCHE, is a 501c3 non-profit organization.<sup>14</sup> Formed in 1967, SOCHE is a regional consortium of 20 colleges and universities in southwest Ohio. SOCHE's mission is to be "the collaborative infrastructure for higher education, helping colleges and universities transform their communities and economies through the education, employment, and engagement of more than 120,000 students in southwest Ohio."<sup>14</sup> SOCHE's vision is "educated, employed, and engaged citizens." In addition to providing internships, the organization manages a comprehensive portfolio of programs and initiatives to support higher education in the region.

To encourage knowledge sharing and best practices, SOCHE administers 17 Councils and Committees comprised of representatives from member institutions. Councils and Committees meet quarterly providing representatives with the opportunity to serve as a resource for one another, identify common challenges, and broaden awareness of the resources, services, and activities in higher education in the region. They also drive much of the content for SOCHE's professional development programs throughout the year including two major conferences which feature national education leaders and showcase regional and statewide expertise. SOCHE also supports inter-university learning policies that enable cross-registration for students. The SOCHE Wright-Patt Office serves as clearinghouse on higher education for civilian and military personnel and their families interested in attending college.

SOCHE supports internships in the region through a number of initiatives and programs. In 2012, SOCHE created and led the "20 by 20 Challenge" forging key strategic partnerships with Dayton Chamber of Commerce, Dayton Development Coalition, and updayton to promote and achieve 20,000 internships in the region by 2020.



SOCHE supports internships directly through *SOCHEIntern*<sup>15</sup> which provides experiential learning opportunities for students through the year-round Student Research Program with the Air Force Research Laboratories (AFRL) and AFIT, the Summer Internship Program with AFIT, and through placement at area businesses.

### **AFIT Summer Research Program**

The AFIT Summer Research Program hosts approximately 50 student contractors each summer; the program is four to five times larger than a typical NSF REU program. All students are required to be U.S. citizens, and over 10% are female, which are STEM populations of great need. The students are employed by the Southwestern Ohio Council for Higher Education (SOCHE), which employed nearly 1,000 STEM students in the past 25 years. During this time, a formal assessment tool was not distributed to students to measure the impact of the research experience on student learning because federal regulations [AF38-501] do not permit Air Force employees at AFIT to legally survey the students since the students work in contractor status (Air Force employees are not legally permitted to survey contractors in any form; neither paper surveys or email surveys are permitted).

Although the AFIT Summer Research Program involves four to five times as many students in a typical NSF-funded REU program, the AFIT Summer Research Program lacks components of standard STEM summer research programs because AFIT is not legally permitted to buy food/snacks for contractors for informal student cohort meetings, did not have a program coordinator, and did not offer group meetings to discuss resumes, careers, graduate school, or offer a poster conference because each student contractor's activities are directly by his or her single Faculty Advisor. Students are required to work the core hours between 0900 and 1500 each day or as directed by the Faculty Advisor; thus, each student's experience is unique.

An essential part of this solution is that SOCHE conducts the surveys of the students by email and makes the results available to AFIT and to the LEADER Consortium. SOCHE's assessment tool is a pre survey conducted when the program was in session (response rate: 54.2%) and a post survey following the program (response rate: 39.6%). Females responded in greater proportion to both surveys (Of the respondents to the first survey, 20% were female; of the respondents to the second survey, over 36% were female).

SOCHE has committed to partner with AFIT in an effort to find solutions to improve the existing AFIT Summer Research Program. SOCHE supports this program directly through *SOCHEIntern*.<sup>15</sup> We are very excited to obtain this solution, which is legal and obeys federal regulations, because SOCHE is the employer and can legally survey the students. Each spring, SOCHE provides a list of undergraduates recruited from local schools and around the country. Students who apply to the AFIT Summer Research Program are U.S. citizens and are provided with "an opportunity to develop scientific and engineering skills and competence through participation in cutting-edge research projects in a graduate educational environment."<sup>15</sup> In the application process, students select from internships in Engineering (Aeronautical, Astronautical, Electrical & Computer, Mechanical, Nuclear, Systems) and Science (Computer Science, Materials Science, Mathematics, Operations Research, and Physics).<sup>15</sup> Eligible students include undergraduate students and recent science and engineering graduates who are beginning graduate

studies in the fall following participation in the Summer Research Program.<sup>15</sup> To apply, students submit three references, a resume, and an unofficial transcript. The selection criteria includes: “a transcript indicating academic field and level of achievement, resume, professional references, and a match between student interests and available projects.”<sup>15</sup>

### **Approach and Methodology**

In 2012, SOCHE surveyed 48 students in the 2012 Summer Research Program. Students were given the opportunity to complete a baseline survey and a post-survey based on their experience in the program. The baseline survey and post-survey were sent by email to all participating students in the 2012 Program. The baseline survey was sent to students in June, 2012, and the post-survey was sent to students as part of the out-processing process following the student completion of the program; students completed the program at different times at the conclusion of the summer in August, 2012 through September, 2012. Data for both surveys was collected using Constant Contact. The response rates were 54.2% for the baseline survey and 39.6% for the post-survey.

### **Results and Findings: Student Citizenship, Student Institutions, Student Majors, and Student Gender Distribution**

All students who participated in the 2012 AFIT Summer Research Program are required to be U.S. citizens. In the 2012 Summer Research Program, both undergraduates and graduate students participated in the Program: Sophomores (2), Juniors (5), Seniors (17), and Graduate Students (2). The participating students are from colleges and universities in Ohio (18), Indiana (4), Illinois (1), Tennessee (1), and Virginia (1). All of the student respondents are majoring in STEM fields: Computer Engineering (6), Electrical Engineering (7), Mechanical Engineering (5), Mathematics (5), Physics (1), and Engineering Physics (1). Over 10% of the participating students are female.

### **Results and Findings: Reasons that Students Apply to the Summer Research Program**

SOCHE asked students to describe the reasons that they apply to the AFIT Summer Research Program. The majority of the students (12) responded that they applied to “gain engineering experience.” Four students responded that they wanted to “work in a research environment.” Three students indicated that they applied to AFIT for the “salary;” an additional three students applied “to make decisions about [their] career.”

### **Results and Findings: Student Awareness of SMART Scholarships**

SMART Scholarships<sup>16</sup> are Scholarships for Science, Mathematics, and Research for Transformation and are part of the National Defense Education Program. They are administered by the American Society for Engineering Education and are a premier scholarship program supporting the education of America’s future scientists and engineers. The SMART Scholarship for Service Program is an opportunity for students pursuing an undergraduate or graduate degree in Science, Technology, Engineering, and Mathematics disciplines to receive a full scholarship and be employed upon degree completion. Participants in SMART receive full tuition, a stipend

between \$25K and \$38K, paid summer internships, a health insurance allowance, a book allowance, mentoring, and employment placement after graduation.

Currently, the AFIT Summer Research Program does not offer formal opportunities to students regarding scholarships and fellowships for their undergraduate and graduate education in STEM. In 2012, SOCHE assessed student awareness of these opportunities. Of the students in the program who participated in the survey, 20 (77%) responded that they did not know about SMART Scholarships previously, and 5 (19%) responded that they were aware of SMART Scholarships prior to the program (one did not respond). Following the program, over 25% of the student respondents indicated that they would apply for SMART Scholarships, which we feel is a positive impact of their exposure to this opportunity during the summer.

### **Results and Findings: Student Interest in Feedback on Their Resume/CV**

Currently, the AFIT Summer Research Program does not offer the opportunity to students to receive feedback on their resume or CV, which is a component of some summer research programs. In 2012, SOCHE assessed student interest in receiving feedback. Of the participating students who responded to the survey, 19 students (73%) initially requested feedback on their resume/CV (one did not respond). Following the program, over 51% of the students requested feedback on their resume/CV, which we feel is a positive response from the students.

### **Results and Findings: Prior Research Experience of Students**

In 2012, SOCHE assessed the prior research experience of students participating in the Summer Research Program. Thirty-six percent of students who participated in the Summer Research Program and who participated in the survey reported that they did not have any prior research experience.

The students were working primarily in the Departments of Electrical and Computer Engineering (10) and Aeronautics and Astronautics (5). One student worked in the Department of Engineering Physics, four worked in Operational Sciences, two worked in Systems and Engineering Management (one student did not respond).

A few students identified themselves as working in one of the Centers that are within one of the six departments: two students worked in the Center for Directed Energy, two in the Center for Cyberspace Research, and one in the Advanced Navigation Technology Center.

### **Results and Findings: Student Goals**

SOCHE assessed student goals in the baseline survey and asked students to describe what the students hoped to accomplish during the summer. The majority (7) of the student respondents indicated that they wanted “to gain skills and knowledge.” An additional five students responded that they wanted to “gain confidence in research.” Three students responded that they wanted “to work in engineering.”

The number of students who feel that the summer internship is preparation for a research career is extremely high: over 90% of student respondents in the baseline survey, and over 71% of the student respondents in the post-survey.

In both the baseline survey and post-survey, SOCHE asked the students about their future plans in order to collect information regarding student interest in continuing within the STEM pipeline.<sup>17,18,19</sup> In both surveys, SOCHE asked the students to indicate whether they: (1) plan to graduate with a STEM degree; (2) are uncertain about their major; (3) plan to attend graduate school in STEM; (4) plan to attain a Ph.D. in a STEM field; and (5) feel confident in their research knowledge. 100% of students responded that they plan to graduate with a STEM degree in both the baseline survey and post-survey. Moreover, the results show that none of the students are uncertain about their major. Over 60% of the students plan to attend graduate school in STEM and feel confident in their research knowledge.

Following participation in the 2012 Summer Research Program, there was an increase in the percentage of students who responded that they plan to attain a Ph.D. in a STEM field from over 15% to nearly 30%.

### **Results and Findings: Student Interest in Engagements with other Students**

Currently, the AFIT Summer Research Program does not offer formal opportunities to participating students to engage with other students in activities such as weekly meetings. SOCHE asked the students in the 2012 AFIT Summer Research Program about whether they would be interested in engaging with other students as part of their summer experience.

Over 62% of student respondents in the baseline survey and over 42% of student respondents in the post-survey indicated that they were interested in social engagements and activities.

### **Results and Findings: Student Accomplishments in the 2012 Summer Research Program**

In the post-survey following the 2012 Summer Research Program, the students were asked to list their accomplishments. A large majority of the students (13) wrote that they worked on “programming”. Four students wrote that they “performed experiments,” and two students published a paper. One student wrote an abstract (for a publication), one student wrote a conference paper, and one student submitted a grant proposal.

### **Results and Findings: Feedback from Students About What was Most Helpful; Feedback from Students About What Could be Improved**

SOCHE asked students to identify what was most helpful in the Summer Research Program and about what could be improved in the Program. Examples of comments regarding what was most helpful include: “I learned how to interact in a professional work environment,” “I was able to learn a great deal from everyone I met,” “The people were all very helpful and understanding.” Students were encouraged to write additional comments about the program. Three wrote:

- “I had a great time during my internship and am very happy to have had the opportunity to gain insight into the realm of engineering as a career. Also, I learned a lot from working in a team.”
- “Overall, it is a great program! I am happy to have had the opportunity to get a glimpse into AFIT and to perform research mostly independently.”
- “I really liked that I was able to work in a group with other interns. We were able to bounce ideas off of each other and difficult tasks were made easy by breaking it up between us. In addition to my research, I enjoyed working on the Air Force Base and feeling like the work that I did could help with the defense and security of our nation.”

We were excited to learn that seven students responded that nothing needed to be improved in the program. Two other students responded that interactions with other interns would be helpful, and two additional students responded that a pay raise would be helpful. One other student indicated that the program could be more organized. Another student wrote that the program could offer flexibility with work hours. One student wrote that the program could be improved with more communication between SOCHE, AFIT, and the students. Two students wrote with a suggestion that a mentor would have been helpful:

- “It would have been nice to have been able to have a ‘mentor’ to learn from. I was on my own for the majority of the time here and was unsure of what to do at times.”

Another student was participating for the first time, and responded that he/she was glad to have participated, in the following comment:

- “It was my first intern experience. It was scary and difficult, but now that I look back on it, I am glad to have gone through it.”

Twenty-five percent of the students participating in the program responded that they plan to apply to participate in the 2013 AFIT Summer Research Program.

## **Discussion**

The data collected from the baseline survey and post-survey were discussed extensively by the partnership to identify areas in which the students feel that their summer research experiences can be improved in the future. We grouped the student responses into main areas of improvement that students feel would have improved their summer research experience.

Based on the 2012 survey results and findings presented in the previous sections, we identify the following four broad needs expressed by the students:

- (1) A desire expressed by students for mentors with increased organization and communication among SOCHE, AFIT, and the students;
- (2) A desire expressed by students for increased interactions with other students;
- (3) A desire expressed by students to improve their CV/resume at the beginning of the program and interest expressed by students in applying for the SMART Scholarship;
- (4) A desire expressed by students to gain engineering experience, skills, and confidence in research.

## Recommendations for 2013 Summer Research Program

In this section, we now discuss how we are going to address the four needs expressed by the students. To address the needs expressed by the students, we plan to introduce typical components of a standard STEM program to AFIT (these components were listed in the introduction).

First, to increase communication among SOCHE, AFIT, and the summer interns, we *plan a joint orientation process with SOCHE and AFIT Project Leaders/Mentors*. We plan to build student cohorts, engage in discussions to build student cohorts with a summer student seminar, and incorporate opportunities for presentations during the program and at the end of the summer.

Second, in 2013, to increase interactions among the students, our team will *develop student cohorts*. The AFIT Civilian Student Coordinator, Mrs. Cahill, has written a Civilian Student Survival Guide to share with students to improve the summer student experience. With addition of some general student social activities, and placing students in research teams working in similar areas so they can assist each other, we hope to foster a sense of shared mission. This will also be facilitated by the seminar.

Third, we will *develop a regular seminar* at which the cohort will meet and alternate in presenting their research results and activities. The seminar will be deliberately structured informally to enable a sense of camaraderie to develop among the students. We will also arrange for outside presentations of general interest, such as on job-hunting, resume-writing, information about scholarships and fellowships, and the process to apply to graduate school.

Fourth, one of the more valuable skills that students can learn from open-ended projects is the opportunity to *develop presentation and communication skills*. We will provide this opportunity informally at the weekly seminar and require the students to present at least once during the summer. The goal will be for the students to have the experience of communicating their work to an audience of other students, faculty, and researchers. At the end of the summer, we will *organize a small conference to present the students' work to the AFIT community so that students can present the engineering experiences they have gained* (such as shown in Table 6) The students will each make up a poster, expressing the goal of the project, what they did, and their results. This experience in written communication will be a valuable exercise for students intending to go into academia, government, or industry, where presentation skills are very important. A certificate of participation in the Summer Research Program will be provided to each student who prepares a poster. A poster competition will be held to select the best student posters, and the selected students will be given *Best Poster Certificates*.

We are excited because AFIT hired a Civilian Student Coordinator who will oversee all students in 2013 and will implement the recommendations provided by the students in 2012 (for student cohorts and an orientation). AFIT faculty have offered to organize a student poster conference and student presentations. SOCHE has offered to bring in local experts to give resume feedback and to pay for food and snacks for the students (which is legal for SOCHE) at informal gatherings of student cohorts.

In preparing these four components for the 2013 Summer Research Program, we will refer to the extensive existing literature, such as published “practical strategies for building sustainable programs” described in Mary K. Boyd and Jodi L. Wesemann’s book “Broadening Participation in Undergraduate Research” and David Lopatto’s book “Science in Solution: The Impact of Undergraduate Research on Student Learning,” and Characteristics of Excellence in Undergraduate Research” edited by Nancy Hensel.

## Summary

In summary, many challenges exist at a government institution to introduce standard STEM program components to a long-standing summer research program. In this paper, we are excited to present a unique campus-community partnership that successfully introduced a new paradigm to the AFIT Summer Research Program. With this paradigm, together we found a way forward to upgrade the AFIT Summer Research Program based on student recommendations. As a result, we are excited to report that starting in Summer 2013, the AFIT Summer Research Program will include standard STEM program components for all students for the first time, to our knowledge.

To achieve this new paradigm, we formed a campus-community partnership to move forward, and we developed legal solutions. This paper presents a new paradigm that upgrades the summer program, describes our results of student surveys that inform recommendations to improve the AFIT Summer Research Program, and will be structured with standard STEM components to provide better research experiences for the students. The three partners look forward to continuing to partner together.

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