

## **Center for Adaptive Optics Akamai Summer Internship Program**

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### Introduction

It is estimated that over the next ten years, the U.S. will need an additional 1.9 million workers in science, technology, engineering, and math (STEM).<sup>1</sup> Traditionally, the STEM workforce has consisted of mostly white, non-Hispanic men, who made up 70% of the STEM workforce in 1997.<sup>2</sup> In the same year, underrepresented minorities - African-Americans, Hispanics, and American Indians - comprised just over 6% of the general STEM workforce.<sup>2</sup> This reliance on a predominately white, male workforce is troubling in the face of the changing demographics of the U.S. population. The proportion of white students in undergraduate enrollment fell from 80% in 1978 to 70% in 1997. During the same period, the proportion of underrepresented minorities (URM) in undergraduate enrollment increased from 15.7 to 21.7%.<sup>3</sup>

The Advisory Committee to the National Science Foundation Directorate for Education and Human Resources has expressed concern that the facts that the majority of Americans are women, and that the proportion of Americans aged 18-22 who are URM is expected to rise above 40% by the year 2015, have profound implications for STEM education. It concluded that unless STEM education becomes much more inclusive than it has been in the past, the U.S. will be denied the STEM talents of the majority of its population.<sup>4</sup> In order to remain competitive, the U.S. must reinvent STEM education and employment to attract, educate and employ those who have been traditionally underrepresented in STEM.

Approximately 25-30% of all students entering college in the U.S. intend to major in STEM fields.<sup>3</sup> Women are much less likely than men to intend to major in STEM fields.<sup>5</sup> In 1999, women were only 20% of total undergraduate enrollment in engineering programs in the U.S., and were only 19% of full-time first-year engineering undergraduates.<sup>5</sup> In 1998, women received 56% of bachelor degrees overall, but only 37% of STEM bachelor degrees. They earned only 35% of the bachelor's degrees in astronomy, 33% in chemical engineering, and less than 20% in aerospace engineering, electrical engineering, mechanical engineering and physics.<sup>5</sup> Underrepresented minorities received just 12% of the total STEM bachelor degrees awarded.<sup>1</sup>

The participation and retention profiles of white women are different than those of URM males and females. Women are generally more likely to go to college and to graduate than their male peers, but they are far less likely to choose to major in a STEM field. URM males, on the other hand, are just as likely as white males to major in a STEM field if they go to college, but are less likely to attend college and to graduate.<sup>5</sup> In contrast, women from URM are less likely than their male URM counterparts to select a STEM major, but are more likely to do so than white female undergraduates. In 1999, African American women were 34% of African American

engineering enrollment, and Asian, Hispanic and American Indian women were between 23 and 25% of the enrollment of their respective racial/ethnic groups. White women were only 18% of white engineering enrollment in the same year.<sup>5</sup>

The percentage of engineering degrees going to URM has increased steadily from 2.9% in 1973 to 9.2% in 1995. However, 9.2% is still less than half of the combined representation of URM in the US population.<sup>8</sup> While the 2000 Census showed that almost 25% of Americans are African American or Hispanic, only about 10% of engineers are from those ethnic backgrounds. Women constitute half the U.S. population, but are less than 10% of its engineers.<sup>9</sup>

Today the U.S. is the world leader in the global STEM enterprise, but other countries stand ready to challenge this economic strength. One of the main reasons is a shortage of U.S. citizens with the necessary education to fill STEM jobs in the U.S.<sup>2</sup> There is a growing consensus among government, education and industry leaders that if the U.S. is to remain competitive, it is imperative to increase the number of women and URM in STEM. Many major corporations have come to realize that diversity in the workplace enhances creative thinking, improves decision making, increases worker retention, recruitment and productivity, and increases competitiveness in an increasingly diverse consumer market.<sup>8</sup> The engineering community has identified the need to increase the recruitment of women and URM into the engineering profession.<sup>9</sup> This need has been formalized by government institutions such as the Directorate for Education and Human Resources at the National Science Foundation, which lists equal access to STEM fields for URM, women and persons with disabilities as one of its three funding priorities.<sup>2</sup>

### The Role of Two Year Colleges

Almost 50% of all college freshman, and an even greater percentage of women and URM, start their postsecondary education at two-year schools.<sup>10, 11</sup> Two-year colleges are attractive to many students because of their low cost, open admission policies, and flexible schedules. The annual average tuition and fees at a two-year college is only \$1,492, and more than 90% of the U.S. population is less than an hour's drive from a two-year college campus.<sup>11</sup> Since they have smaller class sizes and no research requirement for teachers, two-year colleges can offer students more individual attention than traditional four-year colleges.<sup>11</sup>

Given the large numbers of women and URM whose first attempt at postsecondary education is at a two-year college, these colleges play a vital role in the education of potential entrants into the nation's STEM workforce.<sup>10</sup> In the fall of 1992, two-year colleges accounted for 41% of all undergraduate STEM courses offered for credit, and 34% of all undergraduate STEM course enrollments.<sup>4</sup> Students in STEM at two-year colleges are more likely than their non-STEM peers to be enrolled full-time and have higher academic aspirations than their peers.<sup>1</sup>

One of the more important roles of two-year colleges in STEM education is as a bridge between high school and four-year colleges for students who need additional academic skills or who find two-year colleges an inexpensive means of completing the first two years of their college education.<sup>3, 5, 10</sup> There are no national statistics that specifically address the transfer rates of two-year college students to four-year schools, so there is no way to get an accurate picture.<sup>3, 11</sup>

According to one report, about 30% of traditional-age students enrolled in a two-year college plan to transfer at some point to a four-year institution, and approximately 25% of two-year college students actually transfer to four-year institutions.<sup>10, 11</sup> These transfer students complete their bachelor's degrees at a rate of more than 70%.<sup>10</sup> According to engineering educators, when these transfer students do make the transition from the two-year college to a four-year school, they are successful.<sup>11</sup> Of persons who earned STEM bachelor's degrees in 1995 and 1996, 14% of women and 13% of men had earned associate's degrees.<sup>10</sup> Eighteen percent of physical science students attending four-year schools in 1994 had previously attended a two-year college, and 15% of those earning a bachelor's degree in computer sciences in 1994 had also earned associate degrees.<sup>5</sup> About 14% of 1998 STEM bachelor's degree recipients in 1998 had previously earned an associate's degree.<sup>5</sup>

The two-year college, with its diverse student population, is an integral player in advancing women and URM involvement in STEM.<sup>1</sup> Two-year colleges enroll close to half of all students that are traditionally underrepresented in STEM. Women accounted for 57% of total enrollment in two-year colleges in 1997.<sup>5, 10</sup> Women earned 32% of the total associate's degrees in STEM nationwide in 1998. However, they earned only 15% of those awarded in engineering and engineering technologies.<sup>5</sup> Fifty-four percent of Hispanic undergraduates in 1996 were enrolled in two-year colleges, as were 52% of American Indian undergraduates, 46% of African Americans, 45% of Asians, and 42% of whites in higher education.<sup>3, 5, 10</sup> Over 35% of URM graduating with a bachelor's degree in STEM began their college careers at two-year colleges.<sup>1</sup> Of persons who earned STEM bachelor's degrees in 1995 and 1996, 12% of Asians, 11% of African Americans, 15% of Hispanics, and 20% of American Indians had earned associate's degrees.<sup>10</sup> Two-year colleges also play a significant part in educating minority students who go on to earn STEM doctorates. Almost 12% of all URM who earned doctorates in engineering in 1987 were graduates of two-year institutions.<sup>14</sup>

The need for greater participation by URM and women in STEM careers, coupled with the fact that nearly half of all minority college students attend a two-year college, underscores the importance of establishing two-year college programs for the recruitment and retention of talented URM and women students in STEM fields.<sup>14</sup> Since many of these underrepresented students have their first exposure to higher education STEM at these institutions, two-year colleges possess a special responsibility and influence in moving participants through the pipeline.<sup>1</sup>

### Underrepresented Student Profiles in Hawaii

The national statistics related to URM in STEM focus on African Americans, Hispanics, and American Indians. Hawaii is demographically unique. Hawaii is only 24.5% non-Hispanic white, 7.3% Hispanic, 1.8% African American and 0.1% American Indian, but Hawaii is 39.9% Asian, 7.6% Hawaiian/Pacific Islander, 24.8% Hawaiian/Part-Hawaiian, and 24.8% mixed race.<sup>21</sup> Enrollment and degree data in Hawaii indicates that Native Hawaiians and part-Hawaiians, like other URM, are underrepresented in both higher education overall and in STEM fields in particular.

While Hawaiians/part-Hawaiians are 24.8% of the Hawaii population overall, they were only 14% of total credit enrollment in the University of Hawaii system in fall, 2001.<sup>20</sup> They were only 9% of the enrollment at the University of Hawaii at Manoa, 17% of enrollment at all two-year colleges, and 22% of enrollment at MCC.<sup>20</sup> There are even less Native Hawaiians/part-Hawaiians (HPH) enrolled in STEM fields. At MCC, HPH were 26.8% of students enrolled in career or technical programs in fall, 2002, but only 17.5% in the Electrical and Computer Engineering Technology program.<sup>13</sup> At the University of Hawaii at Manoa in fall, 2002, HPH were only 6.7% of students in information and computer sciences, 2.6% of students in physics and astronomy, and 6.5% of students in engineering.<sup>7</sup>

Hawaii is 50.4% female, and women accounted for 56.7% of total enrollment at the University of Hawaii at Manoa in fall, 2002.<sup>7, 21</sup> Women constituted only 31.8% of enrollment in information and computer sciences, 31.2% in physics and astronomy, and 20.7% in engineering in fall, 2002.<sup>7</sup> Women were 63.8% of total enrollment in fall, 2002 at MCC, and were 64.8% of career and technical education enrollments, but were only 21% of Electric and Computer Engineering Technology students.<sup>13</sup>

### Internships as a Mechanism to Engage Undergraduates in STEM

In recognition of the need to increase the number of STEM workers in the U.S., there has been much focus on educational reform to increase the participation and to decrease the attrition of undergraduates in STEM. Concurrently, improved understanding of the workforce development needs of employers has improved the provision of workplace skills to students during their formal STEM education. Recent changes to accreditation criteria by the Accreditation Board for Engineering and Technology were influenced by feedback from the engineering industry. Many professionals felt that engineering graduates were entering the field with a strong technical background, but that they lacked other important workplace skills, like creative thinking and an ability to communicate ideas. The intent of changing the standards was to encourage development of those job skills, and, as a positive consequence, appeal to a wider demographic of female and URM students.<sup>16</sup>

Educational reform efforts have helped STEM educators recognize that students must become conversant in the methods and processes of research, must be made aware of what scientists and engineers do, learn how to make informed judgments about technical matters, and how to communicate and work in teams to solve complex problems.<sup>4</sup> All undergraduates must acquire basic STEM literacy through direct experience with the methods and processes of inquiry.<sup>4, 17</sup> Undergraduate education, at two-year or four-year institutions, that provides this opportunity gives individual students a basis for further work in STEM fields at some later date, thereby expanding student options rather than closing them off.<sup>4</sup>

Other recommendations for reform of the undergraduate STEM curriculum focus on investigative learning, technology, laboratory experience, and collaborative work. Programs that have provided students an opportunity to engage in hands-on, real-world projects have been successful in increasing female enrollment and retention.<sup>1</sup> Establishing the relevance and social value of these fields is another effective retention strategy. Smith College, Rensselaer

Polytechnic Institute, and a few other colleges are trying to make engineering relevant by engaging students in hands-on assignments and real-world projects.<sup>1, 16</sup>

Real-world experience is key to developing working understanding of STEM. Unfortunately, the hands-on experience so vital to STEM literacy is rarely provided to undergraduates. The 1993 National Survey of Postsecondary Faculty found that only about 20% of freshman and sophomore classes in the biological sciences, physical sciences, and engineering in fall, 1992 had a lab component.<sup>4</sup> Research suggests that participation in lab experiences improves understanding of STEM subjects by a factor of six.<sup>4</sup> Real or simulated research experiences give students the opportunity to experience STEM as those in the workplace experience it. This format can help students realize the importance of certain facts in a way no mere textbook can.<sup>4</sup>

Internship programs, such as the Akamai Internship Program, are a recommended mechanism for engaging diverse populations of students, exposing students to STEM in a real-world context, and making students aware of STEM careers. Working in such an environment helps students grasp what they have seen in the classroom and prepares them for the workplace. Many students are able to use internships as a stepping-stone into later employment at the host firm. The benefits of internships flow both ways, firms that host interns have an advantage in recruitment of STEM graduates.<sup>18</sup> Internships also provide an opportunity for industry and institutions of higher education to form partnerships that improve the overall quality of undergraduate education and ensure the workplace relevance of skill sets provided by STEM education.<sup>3, 4, 18, 19</sup> Targeted outreach to women and URM to participate in these experiences is a recommended mechanism for increasing the number of underrepresented undergraduates in STEM, and has been identified as having a significant impact on the retention of these groups.<sup>18</sup>

There have been a number of projects to increase the numbers of two-year college students going into STEM. The successes of bridge programs that facilitate the transition from two-year to four-year colleges are well documented. There is little in the literature focusing on REU or internships specifically designed for two-year college students. The remainder of this paper will discuss the collaboration between the Center for Adaptive Optics at University of California-Santa Cruz, Maui Community College, the Maui Economic Development Board, and the adaptive optics industry on Maui to provide a full-time, paid summer internship program in optic technologies for underrepresented two-year college students on Maui.

### Building Partnerships for a Successful Internship Program in Adaptive Optics on Maui

Adaptive optics is a method for removing the blurring of images caused by changing distortions within optical systems. The use of adaptive optics allows ground-based telescopes to see as clearly as if they were in space, and these techniques, when used to look at the retina of the human eye, dramatically sharpen images of the retina. Large ground-based telescopes using adaptive optics can exceed the performance of the Hubble Space Telescope and at much lower cost. The world has long recognized Maui, Hawaii as a top vacation destination, but few vacationers realize that Maui is also home to some of the world's most sophisticated adaptive optics technologies.

The Air Force Maui Optical & Supercomputing Site (AMOS) is a Center of Excellence in electro-optical space surveillance and high performance computing. The Maui Space Surveillance System (MSSS) houses the nation's largest optical telescope designed for tracking satellites. It is equipped with an adaptive optics system that can change its shape to remove the atmosphere's distorting effects. Activities at the MSSS include space surveillance, data acquisition for NASA, satellite tracking, and study of the geometry of the Universe. The Maui High Performance Computing Center (MHPCC) supports Department of Defense, government, private industry, and academia with state-of-the-art scalable computing and applications. MHPCC specializes in image and signal processing of data from telescopes, satellites, radar, and other sensors, as well as modeling and simulation of environmental and battlefield scenarios. The technical and administrative facilities of AMOS are located at the Maui Research and Technology Park. The Air Force Research Laboratory, Boeing (prime contractor), Textron, Trex Enterprises, and Oceanit (subcontractors) and the Maui Research and Technology Center are all based at the Park.

The Center for Adaptive Optics is a National Science Foundation-funded Science and Technology Center (STC) headquartered at the University of California, Santa Cruz. The STC Program funds eleven Centers in a variety of disciplines to conduct important basic research and education activities and to encourage technology transfer and innovative approaches to interdisciplinary activities. One goal of STCs is to explore better and more effective ways to educate students in STEM. NSF support as an STC enables academic research teams to involve students, research scientists, and engineers from academic, industry, non-profit organizations, and federal laboratories in partnerships to enhance STEM education and training. STCs receive long-term, stable funding at a level that encourages risk-taking and ensures a solid foundation for attracting quality undergraduate and graduate students into STEM careers, with special emphasis on women and URM. The CfAO concentrates on astronomical and vision science applications of adaptive optics and reaches out to other adaptive optics communities to share technologies. The work at the CfAO in education and human resource development includes a focus on establishing a center-based model for the retention and advancement of underrepresented college students, or potential college students, into either the STEM workforce or the next educational level. In addition to the CfAO Akamai Summer Internship Program on Maui, CfAO offers several educational programs for undergraduates and future faculty.

Maui Community College (MCC) is one of seven community colleges that make up the University of Hawaii Community College system. MCC is recognized by the U.S. Department of Education as an Accredited Postsecondary Minority Institution (66.29% minority enrollment) and as a Native Hawaiian Serving Institution (21.5% Hawaiian/Part-Hawaiian enrollment). MCC received two Advanced Technological Education grants from the NSF to create the Electronic and Computer Engineering Technology (ECET) Program. The ECET Program leads students to a Certificate of Achievement in Electronic Engineering Technology or to an Associate in Science degree in either Computer Engineering Technology or in Electronic Engineering Technology. MCC is also home to the National Center of Excellence for High Performance Computing Technology, one of 22 Advanced Technological Education Centers of Excellence and Large-Scale Dissemination Projects funded by the NSF. The Center is a consortium of community colleges, respected supercomputing centers, and industry partners that develop educational programs in high performance computing technology.

The Maui Economic Development Board, Inc. (MEDB) is a nonprofit corporation chartered to strengthen and diversify Maui County's economy, with a focus on the development of high tech activity. In 2000, MEDB launched the Women in Technology (WIT) Project, a workforce development project funded through a grant from the U.S. Department of Labor. WIT is a pilot and demonstration project to build a highly qualified and well-diversified resident STEM workforce in Hawaii. The primary goal of WIT is to increase the number of women and URM working in emerging technology fields. The WIT Project mission is three-fold: to partner with educators and industry to create a pipeline from education to employment in STEM; to improve the economic quality of life for women by facilitating their success in higher paying technology careers; and to promote the overall economic development of Hawaii's technology industry by building a skilled workforce. WIT Project collaborations with educators and industry have resulted in an increase in the representation of women in the technical workforce at the Maui Research and Technology Park from less than 13% in 1999 to more than 23% in 2003. The successful pilot outcomes of the WIT Project are gaining national recognition, with communities in Alaska, California, and Wisconsin adopting WIT Project best practices.

WIT has been working for several years to bridge the gap between K-12 educators, MCC and the Maui adaptive optics community by developing outreach activities and facilitating informal internships. The CfAO has been involved in Hawaii since partnering with ALU LIKE, a Native Hawaiian-serving organization and Lawrence Livermore National Labs (LLNL) to provide a Traineeship for Hawaiians. Two Hawaiians are trained in optical technician skills each year at LLNL. The existing partnerships between WIT, MCC, and the Maui adaptive optics community to advance women and URM in STEM were brought to the next level when CfAO offered to bring its expertise in internship program development, adaptive optics education and inquiry-based instructional design to develop an internship program for Maui students based on its successful Mainland Internship Program model.

In order to cement the relationships necessary for a successful collaboration between the stakeholders, the CfAO convened the Maui High Tech Industry Education Exchange (MHTIEE) the week prior to the formal start of the internships. The 2003 MHTIEE was a half-day event designed to catalyze collaborative activities between the CfAO and the high tech community in Hawaii. The centerpiece of the MHTIEE was cross-disciplinary poster sessions in which CfAO members presented their research at a level aimed at the general science audience.

As a means of brokering relationships and collaboration, the MHTIEE opened with an introduction exercise during which CfAO members were teamed with community organizations to learn about each other. Community attendees included representatives from MCC, MEDB, AMOS, the U.S. Air Force, Akamai Internship host sites, and other industrial organizations. When the group re-convened, each team took turns introducing one another. The CfAO members introduced the community organizations and individuals by providing information about the organizations' activities, hiring needs, human resource challenges, whether it was serving as an intern host company, whether it had short-term projects that would provide learning opportunities for students and that would benefit from student involvement, and ideas for workshops or short courses that CfAO could develop that would be beneficial to both the organization and the participants. The community representatives then introduced the CfAO

posters and individuals by providing an introduction of the poster authors, a non-technical overview of the poster, how the research presented in the poster was connected to overall CfAO efforts and its relevance to the Hawaii community. The introductions were followed by the poster sessions, during which the community had the opportunity to learn more about the research done by the CfAO members.

### The CfAO Akamai Summer Internship Program Model

The CfAO Akamai Summer Internship Program is part of the Science, Engineering Technology Training (SETT) project at the CfAO. The mission of SETT is to increase the number of underrepresented undergraduates in STEM fields, through technical training, professional opportunities, and mentoring, in the context of the interdisciplinary, national center. The major educational goals of SETT are: to provide participants with technical skills and research experiences in CfAO-related science that generates new opportunities within the scientific workforce or higher education in STEM; to enhance the professional skills of participants, such as communication skills, networking skills, and leadership skills; and to significantly increase the retention and graduation rates of participants in STEM programs, relative to reported rates for students with similar backgrounds.

The internships required a full-time eight-week commitment, for which the students were paid \$2,500 by the CfAO, with the possibility of an additional \$500 supplement during the academic year. Transportation and other support services were also made available. The CfAO Program Coordinator for the program kept in contact with both the interns and the employers to ensure that each got what they expected from the internship experience. The CfAO, in collaboration with MEDB and MCC, followed the CfAO SETT internship model for the Akamai Internship Program. This model includes recruitment and selection, preparation, research experience, and communication.

### Recruitment and Selection

The Akamai Internship Program was designed for students interested in pursuing a career in STEM fields who may have overcome barriers to achieve their educational and/or career goals. The CfAO commitment to increasing diversity in STEM meant that underrepresented groups were strongly encouraged to apply. WIT worked with MCC to recruit students for the internship with a strong focus on attracting women, Hawaiians/part-Hawaiians, and students who were first-to-college. This recruitment included targeted outreach to women and URM by MCC staff and faculty that had previously participated in WIT trainings on strategies to recruit and retain women and URM into STEM.

Twelve students submitted applications to the Akamai Internship Program. A selection committee was established comprised of MCC faculty, WIT staff, CfAO members and staff, and an AMOS representative. Students were evaluated based on their interest in science, reference reports, transcripts and personal statements. As initially mentioned, particular consideration was given to students who had overcome specific barriers to achieve their educational and/or career goals. At the end of the selection process, 55% of the eleven interns selected were URM, and 36% of the interns were women. Nine of the students were MCC students, three of the students

were pursuing bachelor degrees through distance education at the UH Center, Maui, and one of the students was preparing to pursue a master's degree via distance education at the UH Center, Maui. Four of the interns had children and six were the first in their family to attend college. An important element to the selection process included proper internship placement. The selection committee worked hard to assess the needs of the host sites and to match students appropriately, based on their interests, academic background, previous skills and maturity. In addition, it was important to know which students would be able (physically and/or logistically) to work on the 10,000 foot summit of Haleakala.

## Preparation

Preparation for interns' research experience was provided through a five-day intensive Optics Short Course held at MCC from May 20-24, 2003. Andy Sheinis, a CfAO Research Fellow at University of California, Santa Cruz was the lead instructor and developer of the course. Mark Hoffman, a MCC faculty member, Jenny Patience, a Postdoc at Cal Tech, and Fernando Romero, a Postdoc at the University of Houston, were all involved in the instruction and/or the development of the Short Course. Consistent with known strategies for successfully advancing underrepresented students<sup>22</sup> this course provided the interns with an intensive introduction to basic optics principles. Topics covered by the short course included: optics, electronics, computer control, detectors, and preparation for the industry environment. In addition, representatives from organizations who were to host interns were invited to give brief presentations about their company as well as intern projects. Two CfAO graduate students, Marla Geha (Astronomy, UC Santa Cruz) and Julianna Lin (Vision Science, University of Rochester) gave presentations on their research. The interns completed their short course with a tour of the AMOS facilities on the summit of Haleakala.

Since the interns had varied educational backgrounds and attainment, the short course played a vital role in the overall success of the internship program by providing all of the interns with an understanding of adaptive optics appropriate for the scope of their internship projects and sufficient enough for them to develop a certain degree of confidence and camaraderie before entering their internships.

## Incorporating Inquiry Into the Akamai Internship Program

A critical element of the mission of the Education and Human Resources Division at the CfAO is improving the quality of STEM education by providing professional development for graduate students, postdoctoral researchers, and other current and future educators. This focus on professional development for potential educators is an important element of increasing retention in STEM. Studies of STEM undergraduates have found that poor teaching by STEM faculty is by far the most common complaint of able students. Nine out of 10 STEM majors who switched to a non-STEM major, and three out of four who persevered, indicated that their perception of the quality of teaching in STEM is poor.<sup>4</sup> Faculty and administrators from two-year colleges, and many others, have themselves stressed the need for faculty development and better efforts to disseminate good practices among faculty.<sup>4</sup>

Each year, the CfAO hosts a Professional Development Workshop (PDW) on Maui for CfAO graduate students, postdoctoral researchers and educators, select Maui high school teachers, and MCC faculty and administrators. This year's workshop was titled "Broadening the Impact of Your Research: Teaching, Communicating, and Partnership Building." Based on recognized best practices for engaging students in STEM, and particularly for engaging underrepresented students in STEM, much of the workshop focuses on teaching educators the methods of inquiry-led education. The five-day workshop includes the following sessions: "Three Kinds of Hands-On Learning" (developed by the Exploratorium Institute for Inquiry), "Optics Inquiry," small group discussions on educational theory, "Designing for Inquiry," and a final session in which workshop participants begin designing their own inquiry-based activities to be taught in CfAO educational projects. The Akamai Optics Short Course instructors all attended the CfAO PDW and were able to immediately incorporate what they learned about inquiry into a student laboratory setting.

### Intern Research Projects

Students were placed with any one of the following organizations for approximately eight weeks and were engaged in projects that furthered the work of the host company and exposed the students to STEM jobs in their community. Akimeka, LLC, an information management/information technologies solution provider focused on the federal information technology market in Hawaii and the Pacific Rim, hosted one intern. Akimeka is a fast-growing company in Maui, specializing in developing innovative network and software engineering solutions for Department of Defense customers. W. M. Keck Observatories, located on the summit of Mauna Kea on the big island of Hawaii, hosted a Native-Hawaiian woman with a strong interest in astronomy. The twin Keck telescopes are the world's largest optical and infrared telescopes. Travel and housing expenses for the intern were provided by the CfAO. The Boeing Company, prime contractor for the Maui Space Surveillance System (MSSS), hosted five of the interns, who were placed at either the Boeing administrative facility in the Maui Research and Technology Park or at the MSSS facilities at the summit of Haleakala at an altitude of 10,000 ft. The Maui High Performance Computing Center hosted two interns at its supercomputing facility. Trex Enterprises, a high tech company specializing in government and commercial research and development in the field of applied physics, hosted one intern. The University of Hawaii, Institute for Astronomy (IFA), hosted one intern. The IFA is responsible for research and education in astronomy and for the development and management of the Mauna Kea Science Reserve and the Haleakala High Altitude Observatory Site. IFA conducts research into galaxies, cosmology, stars, planets and the sun.

The students met as a group each week for a video conference with the education staff at the CfAO headquarters at UCSC. These weekly meetings included such topics as how to write an abstract, an oral presentation workshop, and general sharing out about issues that come up in an internship position. Students were consistently reminded of the final expectation from them to produce a clear and concise final presentation on their research.

### Student Presentations

Employers have stressed that undergraduate education must provide STEM graduates communication and teamwork skills.<sup>8</sup> The internships provided the participants the opportunity to work in project teams with researchers and engineers utilizing some of the world's most advanced computer and optics technologies. The internship experience itself proved an exercise in teamwork, leadership and communication. Interns were required to showcase these skills at the end of the program. Each participant was required to give an oral presentation reporting on the research they did during their internship. To prepare them for the presentations, the interns attended a workshop on oral presentation skills provided by the CfAO. Several interns were invited to present their research in a student session at the AMOS Technical Conference. The AMOS Technical Conference brings individual researchers and research teams from around the world to present application briefs representing selected cutting edge research efforts utilizing the assets of the Maui High Performance Computing Center during the prior year. The student presentations were enthusiastically received not only by supercomputing end-users, but also by several four-star generals. Akamai Summer Interns were also invited to present at the Society for the Advancement of Chicanos and Native Americans in Science National Student Conference in Austin, Texas in October 2003.

## Program Results

The CfAO Akamai Summer Internship Program is an excellent example of the kinds of successes two-year students are capable of when presented opportunities to engage in the STEM workplace and to present STEM research to a sophisticated audience. The Program also demonstrates what is possible when academia, industry, community organizations and two-year colleges collaborate to leverage funding from the NSF to provide research experiences to two-year students. The internship program has helped to form a core group of stakeholders from MCC, industry, and academia that collaborate on workforce development issues. Such collaboration has facilitated the entry of two-year college technical graduates into industry by demonstrating their value-add to the workplace, has helped to shape curriculum development at MCC to be responsive to employer needs, and has encouraged participating interns to continue their education at the next level by showing them the relevance of advanced education to their career and personal goals. Several of the interns are continuing their STEM education at the next level, one intern is currently employed by his host company, and another has developed a long-term relationship with the Keck Observatories while pursuing her astronomy degree at UH, Hilo. The CfAO Internship Program Coordinator speaks with the interns weekly via videoconference and has provided a level of continuing educational and career guidance that ensures the interns' future success. An evaluation of the 2003 program and development of the 2004 program is ongoing at the time of this writing, the results of which will be included in the presentation of this paper at the 2004 ASEE National Conference. The 2004 Center for Adaptive Optics Summer Internship Program will be held from May 24 to July 21, 2004, with an additional two host companies. The program will be expanding its internship opportunities at the Keck Observatories on the island of Hawaii, and will hold an Observatory Short Course in June 2004 on Hawaii Island.

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