INVERNESS RESEARCH

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The Design and Evolution of the Akamai Workforce Initiative

An External Review

OVERVIEW

The Akamai Workforce Initiative (AWI) is a program that seeks to develop a skilled local STEM workforce to meet the needs of Hawai'i's growing high-tech industry. Launched as an internship program in 2002, AWI is the result of a long-term collaboration among the University of California Santa Cruz's Institute for Scientist and Engineer Educators (ISEE), the University of Hawai'i, local Hawaiian high-tech businesses, observatories, and U.S. Air Force facilities, and other higher education institutions. AWI provides courses, mentors, and field-based project opportunities to help local Hawaiian college students advance their high-tech careers. This combination of a professional development program for early career scientists and engineers with a local workforce development initiative for undergraduates is a unique design that brings benefits to both groups.

This brief presents an external perspective on the Akamai Workforce Initiative. It describes the rationale, history, and key design features, as well as the details of the Akamai Internship Program. It also discusses the particular collaborative partnerships and the mutually beneficial roles that make the program valuable to interns, to early career scientists and engineers, and to the local high-tech industry. Finally, it distills broader design lessons that may be of interest to other STEM workforce development initiatives. A separate brief, The UCSC Institute for Scientist and Engineer Educators, describes in more detail ISEE and its Professional Development Program (PDP). A third brief, Contributions of the Akamai Workforce Initiative, outlines the contributions of AWI.

Authors of this brief are Dr. Mark St. John and Dr. Pam Castori, senior researchers at Inverness Research, which has more than 25 years of experience studying the design, implementation, and contributions of a wide range of educational improvement initiatives. Inverness conducted this retrospective review of AWI through site visits, reviews of documents, and extensive discussions with AWI leaders and advisors.

DEVELOPING A STEM WORKFORCE IN HAWAI'I: ADVANTAGES AND CHALLENGES

1. **Hawai'i is a premier site for telescopes and a resource for scientific discovery and national security.**
   - The summit of Haleakalā on Maui houses telescopes used for studying the Sun, sky surveys, and satellite tracking. The new Daniel K. Inouye Solar Telescope (DKIST) is under construction on Haleakalā and will be the world's biggest solar telescope, launching a new era of studies.
   - The summit of Mauna Kea on Hawai'i is home to many national and international telescopes, including the largest optical telescope in the world. The Thirty Meter Telescope International Observatory is planned to begin construction in 2014.
2. **Hawai'i's telescopes and tech industry benefit from a local workforce; locals benefit from tech jobs.**
   - Telescope facilities seek to draw from local communities in filling their workforce needs, especially engineers and technicians.

- However, forty percent of observatory scientific and technical personnel are hired from the mainland or other countries due to an insufficient local talent pool.
- Typically, hires from overseas do not remain long in Hawai‘i. The average attrition rate is twice as fast as that of local hires. Overseas hires can cost as much as $100,000 per worker and do little to build the local workforce capacity.
- Telescope projects have promised to build a local workforce to mitigate the cultural impact of building on culturally and spiritually significant summits.

3. **Retaining college students in STEM could dramatically increase the local talent pool needed for Hawai‘i’s telescope and high-tech industries.**
   - Retention of students, particularly those from groups underrepresented in STEM at the college level, is an ongoing challenge in Hawai‘i as it is across the nation.
   - Nationally, the estimate of undergraduates who intend to pursue STEM begins at the same rate as students in other subjects, but only about 40% actually complete their degrees in STEM. For underrepresented students the number can be as low as 20%.
   - Incremental improvement can go a long way. Increasing the retention rate of students studying engineering in Hawai‘i from 40% to 60% would produce hundreds more young engineers and would make a huge difference to the local tech workforce.
4. **Undergraduate students need skills for adapting to rapidly changing technology.**
   - Companies and observatories want employees with problem-solving, critical thinking, and other professional skills such as communication and team work. Currently, college graduates often lack these skills.
   - Because technology changes rapidly, tech workers need the ability to use problem-solving skills in new contexts. This requires a different kind of education, which in turn requires a different kind of teaching.
   - There is a critical need to develop faculty members who are able to engage college students from diverse backgrounds and help them acquire the skills demanded by high-tech industry.
   - Most new and next generation faculty receive little, if any, training that prepares them to engage increasingly diverse students to be successful in STEM careers. There is dire need for high-quality professional development for faculty in this area.

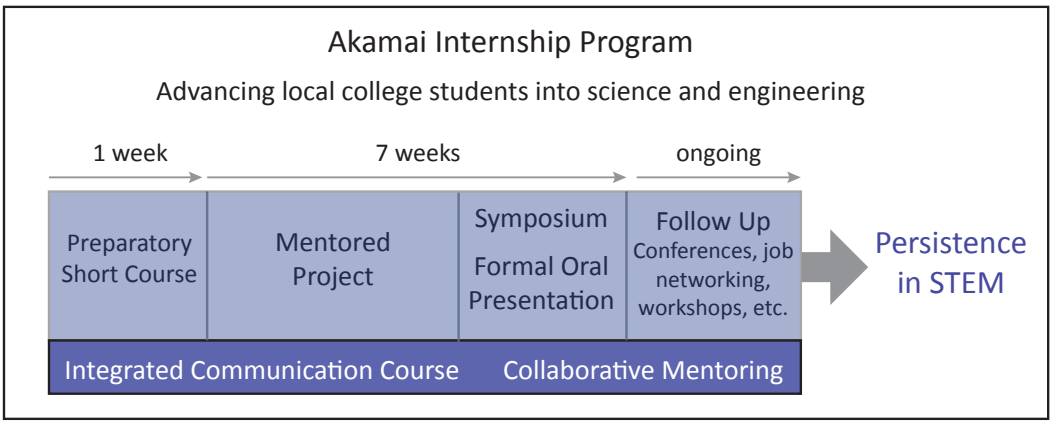
AWI KEY DESIGN STRATEGIES

Over the past seven years the Akamai Workforce Initiative has consisted of three major strategies for further developing the technical workforce needed for Hawai‘i’s telescope and high-tech industries:

1. Developing an internship program for local students to advance into STEM careers.
2. Establishing a long-term, permanent pathway for local students into local STEM careers.
3. Providing professional development of the next generation of scientists and engineers.

STRATEGY ONE: Developing an internship program for local students to advance into STEM careers

The Akamai Internship Program is the major continuing effort of AWI. It advances local students from diverse backgrounds into science and technology careers, especially those underrepresented in



STEM fields. Annually, cohorts of undergraduates from Hawai'i attending local 2- and 4-year colleges are recruited and selected for the internship program. They participate in an intensive weeklong preparation course and are then matched with a mentor from a local observatory or other hi-tech industry. Great care is taken in this matchmaking process, as it is considered a lynchpin to the success of the student and mentor experiences.

Interns then engage with their mentors in a "real-world" project for seven weeks in the STEM workplace while also participating in a communication course that facilitates their informal and formal communication. Finally, they prepare a presentation to deliver at a culminating symposium. Additionally, returning alumni are networked, tracked, assisted in finding jobs, and invited to participate in Akamai events and short courses throughout their careers.

Over the course of a decade, these program components have been tested, revised, and refined into a developmental sequence that is represented in the Akamai Internship Program model shown above.

Key Design Components of the Internship

Collaborative Mentoring: Akamai staff meet with prospective mentors to establish intern projects that will be valued contributions to the mentors' organizations and productive educational experiences for the interns. This pre-program process sets the stage for the summer program, when Akamai staff work with interns and mentors through site visits, weekly check-ins, and close monitoring of progress.

Preparatory Short Course: Interns practice working on a team to define and solve problems, design investigations, support solutions, and explain results through a series of inquiry activities designed by participants in the ISEE Professional Development Program. In addition they practice informal communication that will help them be successful in the workplace.

Mentored Project: Interns are guided by their primary mentor, as well as others in the workplace, to complete a 7-week project. The intern has ownership and choice in how they complete a major part of their project.

Communication Course: Throughout the program, interns complete communication assignments based on their projects, including a 1-minute "elevator talk," a written abstract, and an oral presentation. The course helps both Akamai staff assess interns and interns assess their own performance.

Symposium: All interns give a 10-minute formal oral presentation aimed at a technical audience. Expectations are high. Therefore, Akamai staff spend an intensive coaching day with interns and provide tools and strategies to help them deliver a high-quality presentation.

Career Development: After the summer program, intern alumni are invited back for career development activities (such as workshops), and Akamai staff work with partners to design these activities and provide employers access to highly sought after Akamai alumni. Akamai staff connect alumni with continuing education and career opportunities, keeping in touch with alumni for many years.

STRATEGY TWO: Establishing a long-term, permanent pathway for local students into local STEM careers

From the inception, Akamai envisioned a 4-year degree program on Maui and began a decade-long effort to achieve that goal. In 2007, with funding from the National Science Foundation and the U.S. Air Force Office of Scientific Research, AWI investment helped the college offer its second 4-year degree and thus contributed to the college becoming the University of Hawai'i Maui College. The objective was an inquiry-rich, learner-centered program that would prepare local students for the growth in jobs that would occur with the new telescopes. In 2010, the first cohort of students in the new Bachelor of Applied Sciences in Engineering Technology began.

Maui College Engineering Technology Degree Program

AWI made significant contributions to the University of Hawai'i Maui College (UHMC) and Maui's workforce development capacity, working in partnership over time with UHMC, the Institute for Astronomy (IfA), and ISEE. Key accomplishments include:

- **Degree Program:** AWI partners, funding, and infrastructure played a key role in the development and approval of a new 4-year Engineering Technology degree program and updating of the existing 2-year degree program.
- **Lab facilities on campus:** AWI provided, and leveraged, funding for expanding the electronics and optics labs at UHMC with new equipment and student workstations.
- **Authentic student experiences at partner lab facilities:** New equipment and infrastructure to support student projects was funded at the Maui Institute for Astronomy (IfA) to support UHMC student projects in an authentic instrumentation lab setting.
- **Faculty professional development:** UHMC faculty and faculty from other UH campuses participated in ISEE's Professional Development Program (PDP) and integrated PDP graduate students and postdocs into the classroom.
- **Recruiting, advising, and retention infrastructure:** AWI supported the development and implementation of new tools and strategies. The number of Associate's degrees doubled since AWI began.

STRATEGY THREE: Providing professional development of the next generation of scientists and engineers

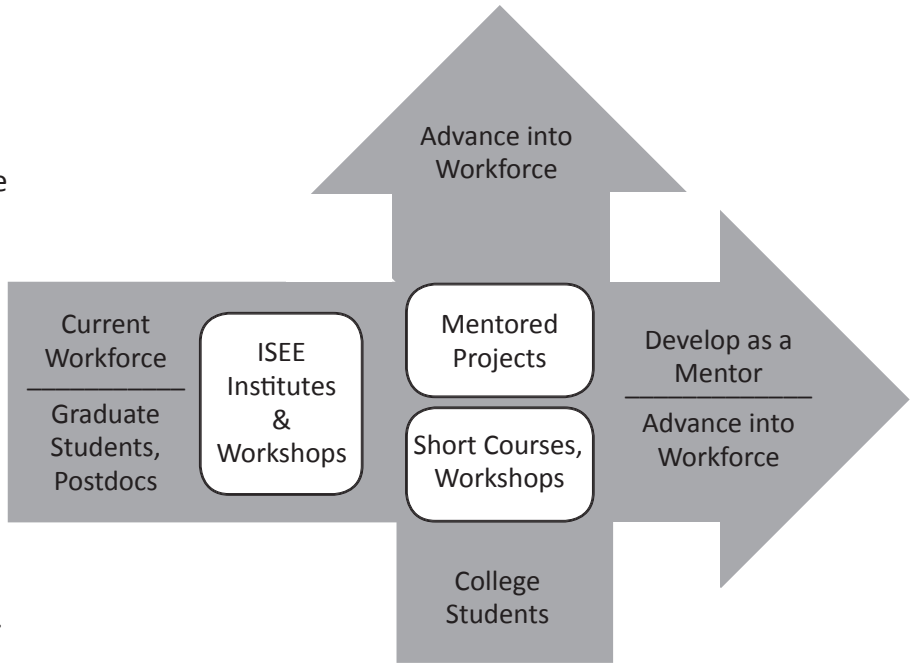
UC Santa Cruz's Institute for Scientist and Engineer Educators (ISEE) is a national-level effort to improve STEM education and workforce development by transforming how the current generation of scientists and engineers teach and mentor their successors. The Professional Development Program (PDP) is the flagship program of ISEE and is the central driving force behind the Akamai Workforce Initiative.

The PDP immerses early career scientists and engineers (graduate students and postdocs) in a professional development experience where they interact with college students in "teaching lab" environments such as the Akamai Internship Program, college courses, and other workforce development activities. PDP participants attend two intensive institutes, and then work in small teams to design and teach inquiry-rich units to college students. PDP participants may choose to be involved in the program for several years, receiving support from PDP instructors, and spending over 100 hours each year engaged in PDP training and putting their training into practice.

In Hawai'i the PDP has been critically important to the Akamai Workforce Initiative because of the constancy of the resources and leadership provided over many years. The longevity of ISEE and the multiple capacities it brings to Hawai'i have allowed ISEE to both support and advocate strongly for the Akamai Workforce Initiative. In turn, AWI has proved to be an important laboratory setting for ISEE and a stimulus for the ongoing refinement of its PDP program. The PDP, therefore, has learned much about its own design and implementation as well as about ways to address the more general challenge of broadening participation in STEM workforce development. The integration of the PDP into Akamai also helped strengthen the argument for a focus on inquiry and helped expand the program to include current professionals who then apply the PDP curriculum to mentoring in their home industry observatory settings. (For more on the role of ISEE and the PDP see The UCSC Institute for Scientist and Engineer Educators.)

Summary of AWI Design

- College students (moving up the vertical arrow) experience courses, workshops, and mentored projects through the internship program.
- Graduate students and postdocs (moving left to right in the horizontal arrow) participate in ISEE institutes and then develop and teach intensive inquiry-based educational workshops for college students.
- Current workforce mentors participate in ISEE institutes or workshops and then support college students through mentored projects.



THE ROLE OF COLLABORATING ORGANIZATIONS IN AWI'S SUCCESS

Through the Akamai Workforce Initiative, the Institute for Scientist and Engineer Educators and its PDP have cultivated relationships with many organizations. These collaborators have provided many different forms of support, in particular sponsoring intern apprenticeships in their research facilities. Interns are carefully paired with professional mentors and under their guidance carry out workplace STEM projects, which advance both their learning and their careers.

- Institutional and personal relationships have been developed over a decade. They are now the essential asset that allows for large-scale operation and well-designed placements where professional relationships between scientists and interns are mutually meaningful and productive.
- In sponsoring an intern, host institutions expect more than an extra set of hands to do menial work. They take mentoring seriously, and ISEE has helped provide multiple forms of support to mentors so that they can be effective with their assigned interns.
- Mentors' organizations also acknowledge the high quality of Akamai students they are hosting. The results of interns' summer projects are often valued and used by their sponsoring companies.

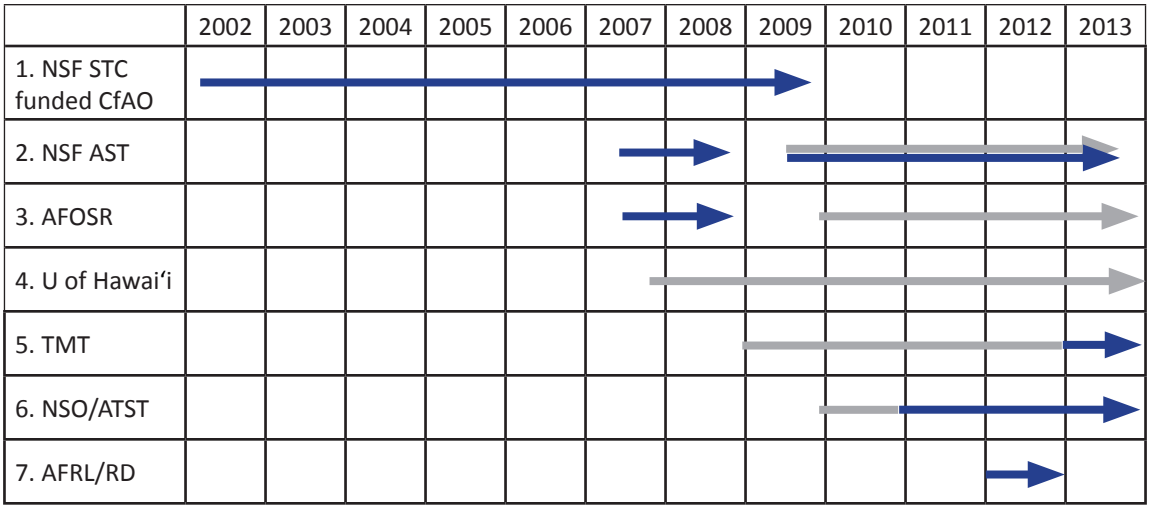
Organizations Hosting Akamai Interns 2003-2013

University of Hawai'i Institute for Astronomy
W.M. Keck Observatory
Trex Enterprises
Gemini Observatory
Akimeka LLC
Smithsonian Submillimeter Array
Subaru Telescope
Pacific Disaster Center
Oceanit
Textron Systems
HNU Photonics
Canada-France-Hawai'i Telescope
Maui High Performance Computing Center
University of Hawai'i, Hilo
Pacific Defense Solutions
Boeing
Northrop Grumman
Thirty Meter Telescope
Big Island Abalone Farm
Natural Energy Laboratory of Hawai'i Authority
2C4 Technologies
Center for Adaptive Optics
National Solar Observatory
University of Hawai'i Maui College
Air Force Research Laboratory

The Funding of the Akamai Workforce Initiative

The Akamai Workforce Initiative has benefitted from having multiple and diverse funding sources. The funding history table below demonstrates the appeal of the program to multiple audiences and shows the overlapping of major funding by various organizations over time. The garnering of many sources of support has resulted in leveraging of individual grants and program sustainability for over a decade. The consistent growth and success of the program is both a cause and a consequence of the growth and longevity of its funding sources.

Akamai Workforce Initiative Funding History



1. National Science Foundation (NSF) Science and Technology Center for Adaptive Optics, AST-9876783; 2.NSF Astronomical Sciences AST-0710699, AST-0836053, AST-0850532) 3. Air Force Office of Scientific Research (AFOSR) (via NSF AST-0710699 and FA9550-10-1-0044) 4. University of Hawai'i Vice President for Research office; 5. Thirty Meter Telescope Observatory Corp. 6. National Solar Observatory and its Advanced Technology Solar Telescope project; 7. Air Force Research Laboratory, Directed Energy Directorate.

THE RETURN ON THE INVESTMENT IN AKAMAI

Inverness Research has had the opportunity to study many STEM initiatives that represent investment of foundations into the improvement of educational opportunities and outcomes. The Akamai Workforce Initiative, we believe, is important and different from many others because it is a long-term, cumulatively building, successful effort that goes far beyond what most short, episodic grants are able to accomplish. The consistency and strength of ISEE and AWI leadership has helped this STEM initiative overcome the inevitable fluctuations and turbulence that wash through scientific and educational institutions and agencies. The combination of external expertise in the form of ISEE coupled with the local network of academic, research, and industry partners provides for a robust and sustaining force.

The partnership between ISEE's PDP and the localized AWI creates the mutually beneficial relationship that simultaneously develops the skills of the local workforce (interns) and the capacities of early career scientists and engineers (PDP participants) while also addressing industries' local workforce needs. This decade-long strategy essentially focuses on the development of human capital, while at the same time being cognizant and respectful of the institutional context. It is not a systemic change strategy but rather a synergistic strategy deliberately designed to develop human capital—the faculty, industry mentors, and young workforce members who are all key to workforce development in Hawai'i.

Not only does the Akamai effort in Hawai'i effectively address important needs in the local workforce, it provides a model for expanding the work of ISEE and the PDP. Future investments in educational improvement would do well to study the ways in which this initiative structured its work to achieve two important goals. First, it established mutually advantageous, supportive and reinforcing relationships and enduring structures. Second, at the same time, it continued to assess and improve its own design and efficacy.

What Can a College Student Accomplish in a Summer Project?

The following projects were completed by Akamai interns placed at Canada-France-Hawai'i Telescope (CFHT), and demonstrate how students from a wide range of academic institutions make very real contributions to their work site in a seven-week period.

Going Green–The CFHT Data Center Cooling Dilemma: A student who was raised on Kauai and now goes to a mainland university designed and tested the prototype of a ventilation system for the CFHT computer room. His system uses outside ambient air to cool the room, and includes a range of other modifications that decrease CFHT's electricity cost by roughly $30K per year.

Automating Astronomical Instrument Setup: A student from Hawai'i Community College (CC), developed a user interface to set up of one of the main instruments at CFHT. His interface automates many steps and saves several hours of setup each time this instrument is put on the telescope.

Audio/Video Monitoring of the Telescope: A student from University of Hawai'i (UH) Mānoa, worked on the observatory automation project at CFHT. She set up a server that stores audio and video streams from cameras installed inside the building. This archive is used every time a strange sound is heard in the dome or when visual inspection of some kind is needed.

Automated Remote Airborne-Particle Counter: A student from Honolulu Community College estimated the amount of airborne particles that enter the dome during observations. He set up and configured a particle counter and interfaced it to CFHT's network at the summit. The apparatus is still used today to monitor dust levels inside the dome.

A GUI Checklist for Astronomical Instrument Exchanges: A University of Hawai'i Hilo student created an electronic checklist for instrument exchanges. She developed the system and integrated older paper checklists. Her system is now used every few weeks by the engineers to make sure that all the steps necessary to exchange instruments are being done.

Improving Aluminizing Procedure: A University of Hawai'i Mānoa student improved the process of applying an aluminum coat to CFHT's primary mirror. He performed tests with a vacuum chamber and dummy mirrors at the summit that improve the reliability and quality of CFHT's coating process.

Funding for AWI was provided from multiple sources over many years, including: National Science Foundation (AST-9876783, AST-0710699, AST-0836053, AST-0850532); Air Force Office of Scientific Research (AFOSR) (via NSF AST-0710699 and FA9550-10-1-0044); University of Hawai'i Vice President for Research office; Thirty Meter Telescope International Observatory; National Solar Observatory; and Air Force Research Laboratory Directed Energy Directorate. More information about AWI can be found at the Akamai website: akamaihawaii.org.

Visit the Inverness Research website at inverness-research.org/abstracts/ab2014-06_Rpt_Akamai_Briefs.html to view two related briefs: The UCSC Institute for Scientist and Engineer Educators, and Contributions of the Akamai Workforce Initiative.

Inverness Research, a national education evaluation and consulting group headquartered in Northern California, has over 25 years of experience studying local, state, and national investments in the improvement of education.

Inverness Research * P.O. Box 313, Inverness, CA 94937 * Ph: 415-669-7156 * Fax: 415-669-7186
www.inverness-research.org