Request to move the

Ph.D. in Computer Science, University of Hawai‘i at Mānoa,

From Provisional to Established Status

Spring 2013

University of Hawaii at Manoa
Information & Computer Sciences

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This self-study report is organized according to the "Guidelines for Assessment of Provisional and Established Programs" E5.201.

Introduction

The importance of Computer Science

About one-third of the economic growth in the U.S. in the last decade has been in information and computing technology. While the Internet and the Web are perhaps the most visible aspects of this change, the revolution is pervasive, touching nearly every field and discipline, from computational techniques in the physical and biological sciences, to new interactive media in the fine arts. The impact of the digital and information revolution upon society is profound. The evolution of computing and information technology will continue to be a driving force behind the creation of new industries, careers, and academic disciplines. As a result, there is a genuine and increasing need for workers with an interdisciplinary background who understand the social and organizational uses of technology and who are literate and articulate. These workers require knowledge of computing systems, global communications networks, and interactive information resources. The requisite proficiencies go beyond being comfortable with computing tools. They require the ability to apply computational ways of thinking to design, to writing, to experimentation, to artistic expression, and to problem solving.

A brief history of the Department of Information and Computer Sciences

The formative roots of the Department of Information and Computer Sciences (ICS) extend back to the late 1960's. At that time, UH began a project to provide radio-linked satellite computers to the existing University time-shared computing system. The purpose of this project, then known as the ALOHA system, was to make the full information processing capabilities of the central computing facility on the Mānoa campus available to all operating units of UH on Oahu and the neighbor Islands. Norman Abramson, the principal designer of the ALOHAnet, whose principles formed the design philosophy of the Ethernet, became the first chair of a new interdisciplinary program that awarded a Master of Science (M.S.) degree in Information and Computer Sciences (the science of processing information by natural or artificial systems). This M.S. program was designed both for students interested in careers in information sciences and those who expected to use information sciences in another profession. Other professors in the initial Information Sciences program included W. Wesley Peterson (a winner of the Japan Prize for his work on error correcting codes), David Pager, (the inventor of an early parser for computer languages), Wilbert Gersch, and Art Lew.

During the early 1970's the Information & Computer Sciences program became the Department of Information and Computer Sciences. In the mid 1970's, Professor Peterson, the ICS chair from 1973 until 1984, initiated an interdisciplinary program leading to B.S. degree in Computer Science. This program was designed to give students an understanding of computers, their operation, programming, and applications, and to provide the knowledge and skill needed for a career in the computer field. Special fields of emphasis for the B.S. degree are computer systems, data analysis, data processing systems, and scientific computation.

In 1986, the ICS Department joined with three other programs, the Department (now School) of Communications in the College of Social Sciences, the Department of Decision Sciences (now Information Technology Management) in the College of Business, and School of Library and Information

Studies (now the Library and Information Science program) to provide an interdisciplinary Ph.D. degree in "Communication and Information Sciences" (CIS). In 1994, CIS became organizationally housed in the College of Natural Sciences. In 1995, the ICS Department moved from Keller Hall to the newly constructed Pacific Ocean Sciences and Technology (POST) building. In 1998, the B.A. in ICS and the Ph.D. in Computer Science were established.

In 1997, the School of Library and Information Studies (SLIS) merged with the ICS Department and changed its name to the Library and Information Science (LIS) Program. The LIS Program offered courses through the UH Mānoa Outreach College as early as 1957. In 1965, the Graduate School of Library Studies (GSL) was formed. In 1987, the school recognized the rapidly changing world of libraries and information technologies and the role of information in society, by simultaneously changing its name to the School of Library and Information Studies and offering the Master's in Library and Information Studies degree, now the Master of Library and Information Science (MLISc) degree.

Since 2000, the ICS Department has grown substantially. By 2003, the six degree programs[1] associated with ICS at that time accounted for a total of 888 majors, making our Department larger than the entire College of Engineering and the largest Department in the University of Hawai'i system. This explosive growth motivated a special legislative allocation specifically to ICS of $1M (which the UH administration made part of the ICS budget) in order to support its mission and students. During this past decade, we have used these additional resources to establish strong research and educational programs in areas including networking, human computer interaction, software engineering, high performance computing, bioinformatics, and information assurance. While interest in computer science has dropped somewhat since the peak of the dot com boom in 2003, there is still strong interest among students as evident in our current 500 or so majors, in part because computer occupations have the highest projected growth rate (both percentage and absolute job numbers) of any major employment sector for 2006-16 according to the U.S. Bureau of Labor Statistics.[2]

Today, the Department continues to aggressively develop its role as a premier educational and research program in Information and Computer Science. The mission of the Department of Information and Computer Sciences (ICS) is to: (1) develop leading edge research that fuels economic and entrepreneurial advances, prepares information and technologically literate citizens, and drives technological improvements in curriculum and teaching and (2) provide professional education for students specializing in computer science and basic computer science education for all interested students.

Assessment of program organization and objectives

In response to E5.201 question 1: Is the program organized to meet its objectives? (Discussion of curriculum, requirements, admissions, advising and counseling, and other aspects of the program, with reference to the objectives.)

[1] B.S., M.S. and Ph.D. degrees in CS; B.A. in ICS, MLISc and Ph.D. in CIS.
[2] US Bureau of Labor Statistics *Monthly Labor Review* November 2007, pp. 89-90, 93. Available online at: http://www.bls.gov/opub/mlr/2007/11/art5full.pdf

Overview of Information and Computer Sciences

The Department of Information and Computer Sciences is part of the College of Natural Sciences at the University of Hawaiʻi at Mānoa. The Information and Computer Sciences (ICS) Department is solely responsible for six academic degrees:

- Bachelor of Arts in Information and Computer Sciences (approved in 2012)
- Bachelor of Science in Computer Science (approved in 1974)
- Master of Science in Information and Computer Sciences (approved in 1965)
- Master of Science in Computer Science (approved 1974)
- Professional Master Degree Program in Library and Information Science (approved in 1969)
- Ph.D. in Computer Science (approved as provisional in 1997)

The ICS Department participates in two other joint degree programs with other departments on campus:

- Bachelor of Science in Computer Engineering (approved as provisional in 2009)
- Ph.D. in Communication and Information Sciences, Interdisciplinary (approved in 1986)

Table 1 shows the enrollment numbers and graduation rates associated with each of these eight programs over the past five years. Our department has enjoyed a strong and significant enrollment of over 450 declared majors during this time period. Out of this pool of declared majors, we have graduated between 70 and 126 students per year. Dividing these two numbers provides a rough sense of the "throughput" of our department, which varies between 15% and 25%.

Table 1 also shows the graduation rate for our Ph.D. program, which has graduated an average of 2.6 students per year over the past five years. This rate successfully achieves the goal for this program of 2-3 students per year, as established in the provisional program request document approved by the Board of Regents. In addition, this rate is comparable to other Ph.D. programs in the College of Natural Sciences. We discuss our Ph.D. graduation rate in more detail later in this document as part of our analysis of program efficiency.

In addition to these eight degree programs, we also provide a minor in Computer Science for students who would like to develop a solid foundation in Computer Science in conjunction with their major degree program. Collaborations such as the minor in Computer Science and the two joint degree programs are vital for the department's mission, for service to the students, as well as for campus collaboration and support. For example, the Bachelor of Science in Computer Engineering (BSCE), a joint initiative between the Department of Electrical Engineering and ICS, was approved by the Board of Regents as a provisional program in November 2009. ICS provides the Discrete Math curriculum and up to 6 credits of technical electives towards the attainment of this degree.

	Major	Degree Objective	Fall 2006	Fall 2007	Fall 2008	Fall 2009	Fall 2010	Fall 2011
Enrollment	ICS	BA	57	49	58	59	78	85
	CS	BS	313	286	255	241	239	219
	CEng	BS	0	0	0	0	1	
	ICS	MS	14	4	4	2	1	0
	CS	MS	17	19	29	30	26	19
	LIS	MLIS(c)	132	98	93	90	94	102
	CIS	Ph.D.	44	45	40	31	33	27
	CS	Ph.D.	21	15	16	20	20	25
		TOTAL	**598**	**516**	**495**	**473**	**492**	**477**
	Major	**Degree Outcome**	**2006-2007**	**2007-2008**	**2008-2009**	**2009-2010**	**2010-2011**	**2011-2012**
Number of Graduates	ICS	BA	14	8	10	3	14	11
	CS	BS	33	28	30	17	25	28
	CEng	BS	0	0	0	0	0	0
	ICS	MS	7	2	1	1	2	0
	CS	MS	6	1	4	9	9	12
	LIS	MLIS(c)	55	44	38	29	33	28
	CIS	Ph.D.	8	7	9	4	6	6
	CS	Ph.D.	4	3	1	2	3	1
		TOTAL	**127**	**93**	**93**	**65**	**92**	**86**
		"Throughput"	**21%**	**18%**	**19%**	**14%**	**19%**	**18%**

Table 1: Enrollment and graduation rates for all ICS degree programs

The ICS department also offers hundreds of seats each year to students looking to fulfill one or more of their general education and/or focus requirements through the ICS program. These course offerings are large and serve a diverse campus population. Hundreds of students from outside the department take ICS courses to learn about computers. Examples (with 2011-2012 total enrollment) include: ICS 101 (626) and 110 (16). The department has also created Honors sections for select students in various disciplines. This illustrates the importance of the service courses offered by ICS to other departments.

The Ph.D. in Computer Science

The Ph.D. is the highest degree awarded by universities in the United States and thus represents the pinnacle of academic achievement. The Ph.D. Program in Computer Science is designed for students who want to contribute to the study of the description and representation of information and the theory, design, analysis, implementation, and application of algorithmic processes that transform information.

ICS doctoral students receive advanced training in the scientific principles and technology required to develop and evaluate new computer systems and applications. We equip our students with the expertise necessary to independently perform state-of-the-art research, to formulate and develop creative solutions to novel and existing problems, and to intelligently manage the research of others. Our curriculum covers all major areas of Computer Science, with active research in areas including artificial intelligence, bioinformatics, human-computer interaction, software engineering, machine learning, high performance computing, digital democracy, computer vision, and computer systems.

An applicant may be admitted with a Bachelor's degree or with an M.S. degree in Computer Science or a related field. If the applicant enters without the M.S., the applicant will earn the M.S. before proceeding to the "Ph.D. portion" of the program.

The ICS Ph.D. in CS curriculum is designed to: (1) Certify the student's core competency in Computer Science and address any deficiencies in this competency as efficiently as possible, so that the bulk of the student's Ph.D. program is focused on research. (2) Prepare the student to do research through an apprenticeship with a faculty member. We achieve these goals by guiding the students through a curriculum with the following components: (1) Demonstration of core competency; (2) Coursework (participation in ICS 690); (3) Preparation of a research portfolio that is analogous to a professional tenure and promotion portfolio; (4) Proposal defense; and (5) Final defense.

Demonstration of core competency

The ICS Ph.D. in CS student will demonstrate core competency in Computer Science by meeting the following two requirements:

1. Completion of a Master's degree in Computer Science or a related field, where what counts as "related" is at the discretion of the graduate program chair, assisted by the admissions committee;
2. Successful completion of the comprehensive exam. The comprehensive exam covers core knowledge of Computer Science at a level that might be reasonably expected of a job interviewee with a Master's degree. Students shall take the comprehensive exam at the end of the first semester of the Ph.D. portion of their studies. Student may attempt the comprehensive exam only twice and must pass this exam no later than the end of the first year of their Ph.D. studies.

Coursework

While the bulk of the coursework for the program is offered at the master's level, the Ph.D. in CS program requires all students to attend and pass the seminar course ICS 690 each semester they are in the program. ICS 690 is a one credit seminar course that meets once a week and is directed by the Graduate Chair. It provides an opportunity for all ICS graduate students (both M.S. and Ph.D.) to regularly discuss their research issues and problems and gain insight from presentations by faculty members, other graduate students, and guest lectures by visiting academic and industry professionals.

The research portfolio

By the end of the year following the passing of the comprehensive exam, the student must prepare and submit a research portfolio that includes the following:

1. A statement of purpose, which is a one to two page description of the student's professional interests in research, teaching, service, and/or product development;
2. Evidence of core competency, as described above;
3. Evidence of scholarly ability, i.e. the ability to identify, critically analyze, and research a problem, and of written communication skills, in the form of two items authored by the student and reviewed by doctoral level scholars. The first item is a written literature review of 20-30 pages focused on a relevant area of Computer Science, following the graduate division dissertation format and reviewing at least 20 published works. The second item must be one of the following: a master's thesis by the student; a publication by the student in a reviewed conference or journal; or a technical report approved by at least two other faculty members.

4. (Optional) Other evidence of professional capacity, which might include a professional vita of employment, professional presentations, reviewing of papers for conferences and journals, competitive fellowships, patents, teaching, and service on committees or as graduate student representatives contribute to the candidacy decision. Letters of reference may also be included. Students should report all forms of research, teaching, and service to the community and to the discipline when preparing their portfolios.

The portfolio is evaluated and must be approved by a two-thirds majority vote of a quorum of the ICS faculty during an ad-hoc faculty meeting. The portfolio is distributed to the faculty in advance of the meeting at which it is voted upon.

The graduate program chair designates one faculty member to argue for the student's case and one to argue against the student, who may both vote as they see fit. Faculty members that have a conflict of interest with the student (e.g., advisor or co-advisor, co-author on research articles, direct supervisor) cannot serve in these capacities.

The portfolio must be approved before undertaking the Proposal Defense.

Proposal defense

Before commencing the final dissertation research, the student shall give a public defense of his or her Ph.D. proposal. Students prepare a research proposal that includes a literature review in the chosen topic area (this may be derived from the literature review from the portfolio) and a description of research topics to be investigated. This work should be done under the direction of an appropriate faculty adviser. Students must also form their dissertation committee prior to the proposal defense.

The defense includes both a presentation of the student's research proposal and an oral examination covering his or her general preparation for the research involved, as specified in the General and Graduate Information Catalog.

It is generally advised that the proposal defense be scheduled for a time period of 3 hours.

After the student passes the proposal defense, they conduct their research and write a dissertation under the direction of their advisor and their dissertation committee.

Final defense and dissertation

The final defense is a public presentation of the student's completed research and dissertation. The dissertation must be presented to and approved by a doctoral committee, as specified in the General and Graduate Information Catalog.

Our five step process of demonstrating core competency, coursework, preparation of a research portfolio, proposal defense, and final defense, when combined with our graduate curriculum and research areas, creates an effective and efficient program for students who wish to contribute to the study of the description and representation of information and the theory, design, analysis, implementation, and application of algorithmic processes that transform information. Our program is thus organized in such a way as to meet its objectives.

Assessment of student learning objectives

In response to E5.201 question 2: Is the Program meeting its learning objectives for students? (An assessment of the quality of student learning as indicated by systematic analysis of student performance with reference to standard expectations, surveys of student satisfaction with instructional aspects of the program, etc.)

Description of learning objectives

We have defined nine student learning objectives for the ICS Ph.D. in CS program, six of which are shared with our M.S. program plus an additional three learning objectives specific to the Ph.D. program.

The ICS M.S. graduate program provides courses for advanced education in Computer Science and affords opportunities to conduct research. Our objective is to help students achieve a high level of professional competence and lifelong learning, with the following Student Learning Objectives:

1. Master core Computer Science theoretical concepts, practices and technologies;
2. Identify, formulate and solve problems employing knowledge within the discipline;
3. Contribute effectively to collaborative team oriented activities;
4. Communicate effectively about Computer Science topics using appropriate media;
5. Demonstrate advanced knowledge in an area of specialization within the discipline;
6. Engage in significant research in their area of specialization within the discipline and/or in projects that respond to community and industry needs.

The ICS Ph.D. in CS graduate program provides advanced, individualized training in research in Computer Science, preparing students for research careers in academia and industry. Beyond those for the M.S. program, the Ph.D. program has the three following Student Learning Objectives:

7. Develop a research portfolio that demonstrates the capacity to carry out original research in the field;
8. Become an expert in the area of specialization including mastery of the relevant research skills and methods, develop a research vision, and formulate a research plan that will lead to novel scientific contributions;
9. Execute a research plan and demonstrate original contributions to the field, as shown through findings and/or publications, culminating in a Ph.D. dissertation and oral defense.

Assessment of learning objectives

To begin, the basic structure of our program has been designed to ensure that successful graduates have satisfactorily achieved all of these learning objectives. Table 2 below illustrates the relationship between SLOs and our program structure:

Ph.D. program component	Student Learning Objective(s)Addressed
Demonstration of core competency	1
Participation in ICS 690	3, 4,
Preparation of a research portfolio	2, 4, 5, 7, 8
Proposal Defense	1, 2, 4, 5, 6, 8
Final Defense	1, 2, 4, 5, 6, 8, 9

Table 2: Ph.D. program components and satisfaction of student learning objectives

Starting Spring 2011, we implemented a new process to assess SLOs #4, #5 and #6 (M.S. program), and #7, #8 and #9 (Ph.D. program). Essentially, these are the SLOs that are not necessarily assessable in courses, but rather in other components of a graduate degree (e.g., graduate seminar presentation, proposal defenses, final defenses, Ph.D. portfolio evaluations). Following guidelines provided by the UHM Assessment Office, we developed an "assessment grid" for both groups of SLOs. This grid is filled either by ad-hoc committees of the faculty (e.g., by the Ph.D. dissertation committee after a Ph.D. proposal defense) or by the graduate chair (e.g., after a graduate seminar presentation), for each student. As of October 2012, 25 Ph.D. SLO assessment grids have been collected and assessment results have been reported in 2011 and 2012 to the UHM Assessment Office. While it is too early to draw statistically significant conclusions regarding historical trends, we have already identified how our program can be improved and are currently working on implementing these improvements. For instance, we have found that our students need more training and guidance for producing the high-quality literature reviews expected for the Portfolio submission and thus for the Related Work chapter of their dissertation. We will dedicate several ICS690 (the graduate-level seminar) sessions to the topic of literature reviews.

Our development of empirically based assessment procedures for these student learning objectives is ongoing. For example, we are planning an "exit interview" procedure in which we can gather data directly from each graduating student regarding their subjective view as to whether each of these student learning objectives were achieved. We also plan to classify each course in the curriculum according to the program SLOs that it covers, which would provide an additional level of evidence regarding assessment and coverage by noting which courses the student took during their program.

Assessment of program resources

In response to E5.201 question 3: Are program resources adequate (Analysis of number and distribution faculty, faculty areas of expertise, budget and sources of funds, and facilities and equipment)

Due to the overlapping nature of our M.S. and Ph.D. degree programs, and the level of shared infrastructure between graduate and undergraduate programs, it is impossible to provide a precise accounting for the department resources dedicated solely to the Ph.D. degree program. In order to provide an appropriate perspective, this section presents the resources associated with the ICS Department as a whole, not just the resources associated with the Ph.D. program.

Faculty resources

The ICS faculty is a diverse and well qualified group. A brief listing of our faculty and their areas of expertise follows.

Professors

- D. Chin, Ph.D. (Chair)—artificial intelligence, natural language processing, user modeling
- M. Crosby, Ph.D.—human-computer interaction, augmented cognition, computer science education
- P. Johnson, Ph.D. (Associate Chair)—renewable energy, software engineering
- D. Suthers, Ph.D.—human-computer interaction, computer-supported collaborative learning, technology for education, socio-technical networks and online communities

Associate Professors

- E. Biagioni, Ph.D.—networks, systems, languages
- K. Binsted, Ph.D.—artificial intelligence, human-computer interaction, cognitive science, natural language processing
- H. Casanova, Ph.D.—high performance computing, distributed systems
- R. Gazan, Ph.D. (ICS/LIS)—social aspects of information technology
- G. Poisson, Ph.D.— bioinformatics, computational biology
- L. Quiroga, Ph.D. (ICS/LIS)—information retrieval, databases, library systems, website design
- N. Reed, Ph.D.—artificial intelligence, autonomous agents
- S. Robertson, Ph.D.—human-computer interaction, digital government and digital democracy
- J. Stelovsky, Dr.Tech.Sc.—computer-hypermedia, human-computer interaction
- S. Still, Ph.D.—statistical mechanics, information theory, machine learning, theoretical biology
- K. Sugihara, Dr.Eng.—algorithms, distributed computing, visual languages

Assistant Professors

- K. Baek, Ph.D.—computer vision, machine learning, bioinformatics
- C. Ikehara, Ph.D.—biometrics and physiological sensors, adaptive human-computer interfaces
- L. Lim, Ph.D.—database systems
- J. Patriarche, Ph.D.—applications of computers to medicine
- P.-M. Seidel, Ph.D. —computer architecture, formal methods

Assistant Specialists

- G. Lau—student advising, professional software engineering
- M. Ogawa, Ph.D.—multimedia course design

Emeritus Professors

- S. Itoga, Ph.D.—database systems, expert systems, logic programming
- D. Pager, Ph.D.—compiler theory, theory of computability, artificial intelligence

Two of the faculty above, Dr. Gazan and Dr. Quiroga, hold dual appointments and are assigned half load to ICS and LIS.

The Assistant Specialists hold substantial non-instructional duties. These duties include academic support by coordinating and assisting the Department Chair and Graduate Program Chairs in major initiatives such as distance education, student services, recruitment, financial aid, and placement services. The specialists also coordinate outreach programs and act as liaisons with other campus-wide committees, alumni groups and the community. One specialist manages the many sections of ICS 101 with the help of a large number of student assistants.

The average instructional workload for each faculty member is two courses per semester. Using the Teaching Equivalent Workload Spreadsheet adopted by the College of Natural Sciences, we estimate that our faculty averages 8.82 semester credit hours for coursework (including directed reading courses, thesis advising and guest lecturing) and another 2.10 semester credit hours for additional teaching, for a total of 10.92 semester credit hours. On February 18, 2011 a comprehensive ICS Department Workload Documentation Procedure[3] was approved by faculty.

In addition to teaching, faculty members are expected to participate with industry, agency and community groups. ICS has established relationships with a variety of local and national companies including: Alion Science, B.A.E, Booz Allen Hamilton, Camber, Central Intelligence Agency, DataHouse, Decision Research Corporation, FBI, High Technology Development Corporation, Hoana, Ikayzo, Infraguard, Orincon/Lockheed Martin, National Security Agency, Progeny Systems, Referentia, SAIC, TREK, and Oceanit. In addition, we are working with Information and Technology Services to establish internships within the UH Mānoa environment.

Research and teaching laboratory resources

In today's rapidly changing technology environment, ICS must constantly maintain and update its networking and data environment in order to provide up-to-date equipment for students and faculty. The department has developed a number of research labs to support both research and teaching. These include:

The Adaptive Multimodal Interaction (AMI) lab studies user behavior. Typical experiments collect eye movements, pressure grasping, and other physiological input to develop novel and effective interactive systems. Research in the AMI lab produces new design principles, user interfaces, multimedia interaction systems, and visualizations of complex information. The website of the AMI lab is at: http://www2.hawaii.edu/~amilab/.

The Bioinformatics (BIL) Lab pursues research in bioinformatics and metagenomics. For example, a recent project studied the diversity and ecology of marine RNA viruses. The website of BIL is at: http://navet.ics.hawaii.edu/~poisson/BiL/index.html.

The Collaborative Software Development Lab (CSDL) has performed research and development in a variety of areas including renewable energy technology, software engineering, and computer supported cooperative work. A recent focus of CSDL is the Kukui Cup project, in which 1,000 first year students living on-campus participate in a three week energy challenge. The website of CSDL is at: http://csdl.ics.hawaii.edu/.

The Concurrency Research Group (CORG) performs research in parallel and distributed computing, computer system simulation, and high-performance computing. For example, CORG is part of an international research consortium developing SimGrid, a toolkit for simulation of distributed applications

[3] http://goo.gl/IGRrr

in heterogeneous distributed environments. The website of CORG is at: http://navet.ics.hawaii.edu/~casanova/corg/index.html.

The Hawai'i Computer-Human Interaction (HI'CHI) lab focuses on understanding how people use information systems based on human performance data. Current research includes digital government applications and how people use the Internet including Facebook to make political decisions. The website of the HI'CHI lab is at: http://manoa.hawaii.edu/hichi/.

The Laboratory for Interactive Learning Technologies (LILT) partners with the Department of Education and other local educational agencies to support innovative uses of high technology in education. A recent project, Traces, will develop a theoretical foundation for analysis, a data model, and software tools to trace out the movements, confluences, and transformations of people and ideas in online social networks. The website of LILT is at: http://lilt.ics.hawaii.edu/.

The Machine Learning (ML) group pursues research in machine learning, information theory, statistical mechanics, quantitative finance, robotics, time series analysis, and computational neuroscience. Ongoing projects focus on the theory of interactive learning, optimal predictive coding, the thermodynamics of systems driven far from thermodynamic equilibrium, energy efficient information processing in (silicon) neurons, novel approaches to robust clustering, the effects of regularization on portfolio optimization, the analysis of volcanic features on Io, the analysis of whale songs, document classification, and the development of games for the use in psychophysics research. The website of the ML Group is at: http://www2.hawaii.edu/~sstill/MLL.html.

The Research Center for Information Assurance (RCIA) provides a learning laboratory and test bed for investigations and applications related to the generation, organization, access, preservation, and secure use of digital information. The website of RCIA is at: http://www2.hawaii.edu/~rcia/.

The research and teaching facilities occupied by the ICS Department are primarily located on the 3rd floor of the POST building. This includes office space for all the faculty and staff as well as a small conference meeting room.

Information technology and fiscal support resources

In addition to the instructional staff, the department has two information technology (IT) specialists. They are responsible for system administration, networking, installation, and maintenance of the department's computer hardware and software infrastructure. The IT specialists also acquire software, hardware, and other products in response to instructional and research needs.

The department also has an administrative and fiscal support person who works with the Department Chair to develop and track an annual department budget with corresponding projections for all forms of revenues including general and extramural funds. This person also provides fiscal support to faculty for grant and contract proposals with funding agencies such as NSF, DARPA, NIH, etc. Timely fiscal status reports are required to meet the needs of the college, department, accreditation bodies and researchers. Prompt and accurate payments of obligations to vendors upon delivery of goods and services are another function of this staff person, as well as fiscal work related to curriculum and instructional needs of the department.

Department financial resources

In 2001, the Hawai‘i state legislature directed an allocation of $1M that became a permanent part of the ICS department's budget. This major investment has enabled us to accomplish the following: 1) hire instructors to expand our lower division course offerings, 2) increase the number of teaching assistants assigned to high enrollment classes, and 3) purchase equipment to support these individuals and the computer labs servicing the students. In general, the funding allowed us to increase the number of sections of high-demand classes, improve the quality of education in each class, and reduce the dropout rate from its undergraduate programs. As a result, we have been able to improve the faculty-student ratio of our classes, provide additional course assistance, and provide additional computer laboratory facilities for student use. We believe the net result of this investment has been a significant improvement in the student experience and an increase in the retention of students in the ICS program.

The department receives an annual budget determined by the College of Natural Sciences. This budget supports operational costs such as:

- Software licensing fees
- Lab teaching supplies
- Delivery charges, postage, freight
- Facilities repairs, maintenance, modifications
- Printing and publications: program brochures
- Telecom installation, fees, long distance
- Travel for department business
- Office equipment: computers, shredders
- Teaching Supplies and Equipment
- Software purchases
- Office supplies
- Equipment maintenance, service agreements
- Fees, subscriptions, dues
- Recruiting: travel, per diem
- Student help: office, graders
- Laboratory equipment
- Shop equipment: drills, cutters
- Instructors

Finally, our Department financial resources are augmented significantly by extramural funding. As shown in Figure 6, ICS faculty have generated over $3M in extramural funding every year for the past four years. As the next section concludes, the ICS Ph.D. program is quite directly responsible for the existence and level of these financial resources.

Assessment of program efficiency and outcomes

In response to E5.201 questions 4 and 6: Is the program efficient, and are the outcomes compatible with objectives? (An assessment of productivity and cost/benefit considerations within the overall context of campus and University "mission" and planning priorities. Include quantitative measures comparing, for example, SSH/faculty, average class size, cost per SSH, cost per major with other programs in the college, on the campus and, as appropriate, similar programs to other UH campuses)

Resources required and generated by the Ph.D. in Computer Science program

To properly understand the efficiency of the ICS Ph.D. in Computer Science program, it is useful to better understand the impact of the program on Departmental resources. The last section overviewed the total resources available to the ICS Department. We now discuss the resources required for the Ph.D. program alone.

One reasonable way to estimate Ph.D. resource consumption is to calculate the percentage of our students who are in the Ph.D. program, and use that to estimate the resource requirements for the program. Table 1 shows that out of the 464 declared majors in the ICS Department in Spring 2011, 20 of those were Ph.D. students, or roughly 4% of our student population. Thus, one might estimate that the ICS Ph.D. in Computer Science program consumes 4% of the total ICS Department resources.

In conclusion, the Ph.D. in Computer Science program does not require extraordinary resources, with a reasonable estimate being 4% of overall department resources per year. Furthermore, the ICS Ph.D. in Computer Science program contributes significantly, if not fundamentally, to the demonstrated ability of ICS faculty to generate over $3M in departmental extramural funding resources per year. In light of these numbers, we do not feel it is at all unreasonable to claim that the Ph.D. in Computer Science program actually generates more resources than it consumes per year.

Efficiency with respect to Ph.D. numbers and graduation rates

As second way to evaluate efficiency of our program is through review of the number of Ph.D. students and our graduation rate. Table 3 provides this data along with comparable data for the other five departments in the College of Natural Sciences over the past five years.

			Ph.D. degrees awarded				
Year	**Botany**	**Chemistry**	**ICS**	**Math**	**Micro**	**Phys/Astro**	**Zoo**
2006-2007	2	3	4	3	0	6	6
2007-2008	1	2	3	0	2	9	8
2008-2009	6	2	1	0	5	3	13
2009-2010	4	2	2	1	5	10	11
2010-2011	10	4	3	2	1	9	13
2011-2012	8	1	1	2	1	5	7
Awards/year	**5.2**	**2.3**	**2.3**	**1.3**	**2.3**	**7.0**	**9.7**
			Number of Ph.D. students				
Fall 2006	35	27	21	13	17	67	79
Fall 2007	39	26	15	14	20	67	79
Fall 2008	46	32	16	14	19	65	74
Fall 2009	42	29	20	22	16	63	70
Fall 2010	37	29	20	22	15	62	60
Fall 2011	30	25	25	31	16	69	58
Students/year	**38**	**28**	**20**	**19**	**17**	**66**	**70**
"Throughput"	**14%**	**8%**	**12%**	**7%**	**14%**	**11%**	**14%**

Table 3: Ph.D. degrees awarded, Ph.D. program size, and throughput

Data for the number of awarded Ph.D. degrees comes from STAR, and enrollment numbers come from the UH Institutional Research Office.

The table indicates that the ICS Ph.D. in Computer Science program is quite typical with respect to the number of Ph.D. degrees awarded within the College of Natural Sciences. Our average number of degrees awarded over the past five years is 2.3, which is better than Math, equal to Microbiology and

Chemistry, but less than Zoology, Botany and Physics/Astronomy. Note that the ICS graduation rate satisfies the proposed goal of 2-3 students per year in the program proposal document that was approved by the Board of Regents.

The table also indicates that our program is doing well with respect to "throughput," which we calculate as the percentage of students in the program that graduate each year. Over the past five years, our throughput has averaged 12%, which is better than Chemistry, Math, and Physics/Astronomy, but less than Botany, Microbiology, and Zoology.

Time to degree

A third perspective on program efficiency can be provided through time-to degree (TTD). While the TTD can be predicted fairly accurately for students in M.S. or undergraduate programs (depending on whether they are full-time students or have full-time jobs), the same cannot be said of the TTD for a Ph.D. program. This is due to the original research component, whose duration depends both on the student and on the chosen area of research within Computer Science. Variations among students of one year or more is thus common. Furthermore, some Ph.D. students are admitted in our program right after obtaining their B.S., while others come into the program with a M.S. in hand, which shortens their TTD by at least 1 year and typically 1.5 years if that degree is in Computer Science or a related field.

According to data collected by the Graduate Division, the mean TTD in our Ph.D. program is 5.8 years, with a median of 6.0 years. We can attempt a comparison with national averages. The report *Time To Degree of U.S. Research Doctorate Recipients* available from the National Science Foundation (NSF) Web site[4] presents data specific to Computer Science programs for academic year 2003. It reports mean TTD between 8.3 and 15.1 years depending on student categories (Research Assistants, Teaching Assistants, supported by fellowships, unsupported). The registered-to-degree (RTD) metric is also reported, which accounts for time during which the student is actually registered in graduate school, and which ranges between 7.0 and 9.0 depending on the student category. These times are "since obtaining a Bachelor." We can thus see that our program compares favorably to nationwide averages, even accounting for the fact that the Graduation Division data does not account for M.S. degrees obtained in other institutions. A recent report on nationwide doctorate recipients is also available from the NSF Web site.[5] It presents data for the 2007-2008 academic year, but unfortunately does not present data specific to Computer Science programs. Instead is shows aggregate data for "Physical Sciences." A median TTD of 6.7 years is reported, which seems to confirm the above observations regarding our program.

The conclusion is that our program allows students to graduate at the same or at a faster pace than the national average. While this is good news, we still see some students who graduate in more than 8 years and up to 9.5 years. To try to reduce the maximum time to graduation, in 2005 we redesigned our Ph.D. program. Like many high-profile programs nationwide (UC Berkeley, Univ. of Washington, UC San Diego, etc.) we did away with the traditional comprehensive exam that occurs after the second or third year of study. Instead, our comprehensive exam occurs early on with a subsequent "research portfolio" exam that ensures our students are actively engaged in the research process.

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[4] http://www.nsf.gov/statistics/infbrief/nsf06312
[5] http://www.nsf.gov/statistics/nsf10309

Through this process, we expect to maintain our relatively low average TTD but also to reduce our maximum TTD in the future. Our first graduate for the redesigned program successfully defended his dissertation in 2010. He graduated in 4 years (he already held a M.S. degree in Mathematics prior to applying to our program), has a very strong publication record, and has recently accepted a tenure-track position at a UK university.

Efficiency with respect to cost and revenue data

Our final perspective on efficiency comes from review of the data in the administration cost and revenue spreadsheets provided in Appendix A, which are a required supplement to this document. We intend this section to serve as a useful narrative to the data presented in that Appendix by highlighting various data of interest. It is important to note that the data in Appendix A is based upon student enrollment in our Ph.D. program courses, where students can come from any graduate program, and not based just upon ICS Ph.D. students. Thus, these figures provide a perspective on our program as a service to the entire University community.

Head count trends

We begin with a simple chart showing the enrollment of students in our Ph.D. program courses from 1998 to 2010, taken from the data in Appendix A.

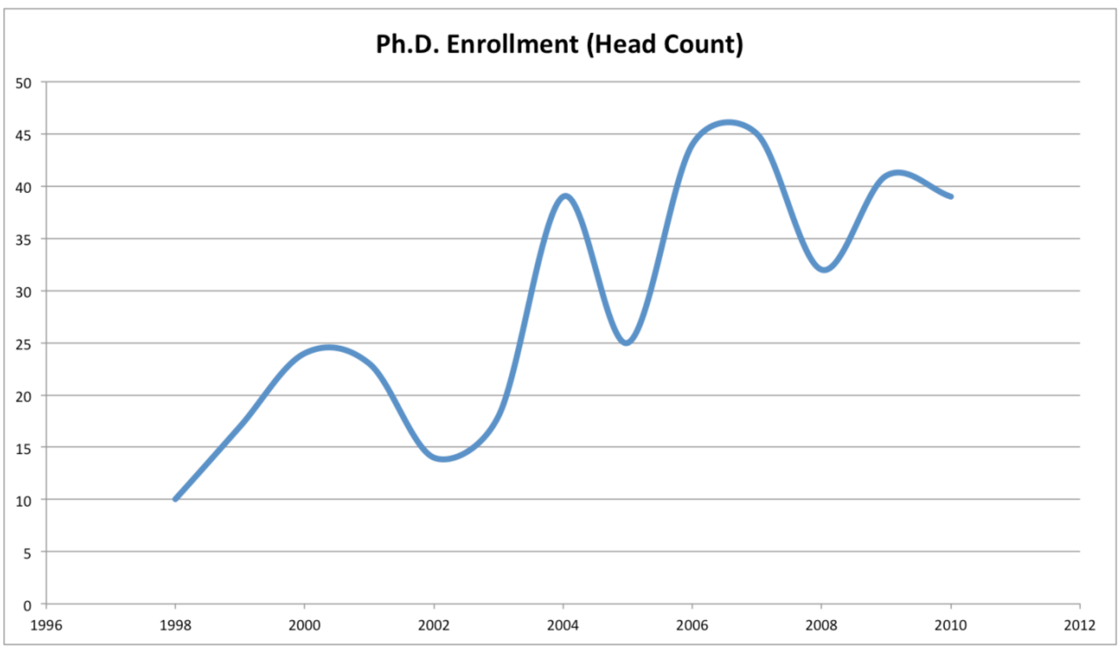

Figure 1: Ph.D. Enrollment (Head Count)

Figure 1 reveals that enrollment has trended upward since 1998. In the planning spreadsheets, we conservatively predict that the number of students enrolling in our Ph.D. program courses will remain roughly constant at 39 for the next few years. However, we believe it is also quite possible that our enrollment will continue to increase as it has in the past, since the larger the student population, the more effectively we are able to compete for extramural funding, leading to more funded student positions, which leads to increased enrollment. At some point, of course, this positive feedback cycle decays due to the inability of faculty to effectively leverage these student resources, but we do not believe we have reached that "ceiling" yet.

Student semester hours

Appendix A also provides information on student semester hours, illustrated in the following chart:

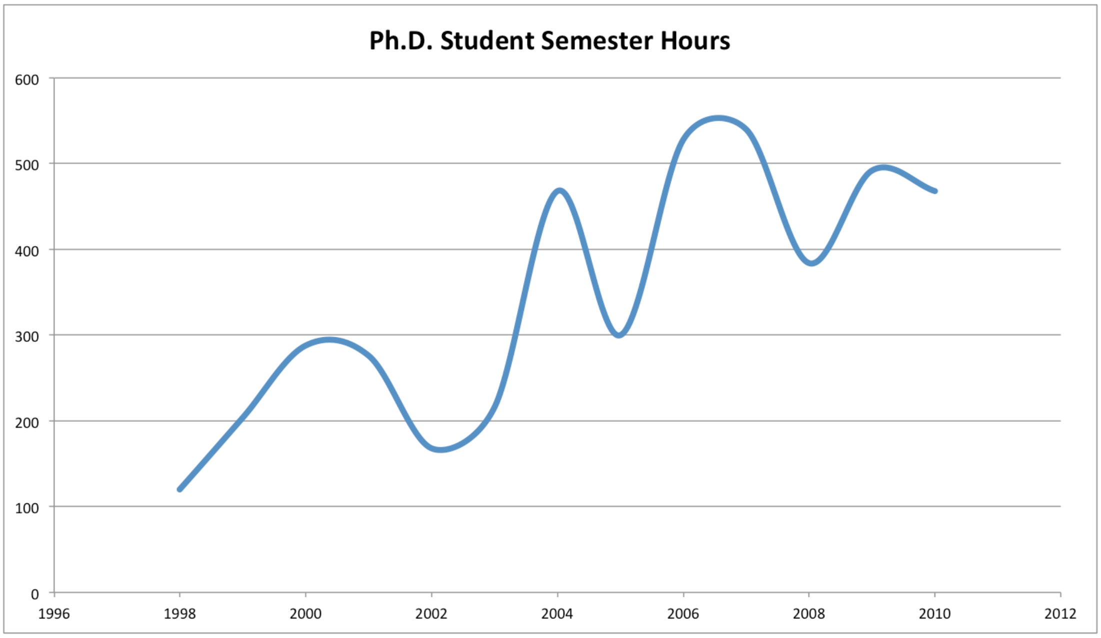

Figure 2: Student semester hours in the Ph.D. program

Figure 2 shows the trend in student semester hours (SSH) to be quite similar to the head count. This is because almost all of the students enrolling in our Ph.D. program courses take 12 credit hours per year (6 per semester) in order to qualify for financial aid under full time student status.

Program cost per SSH

The next chart highlights the total program cost per SSH from Appendix A:

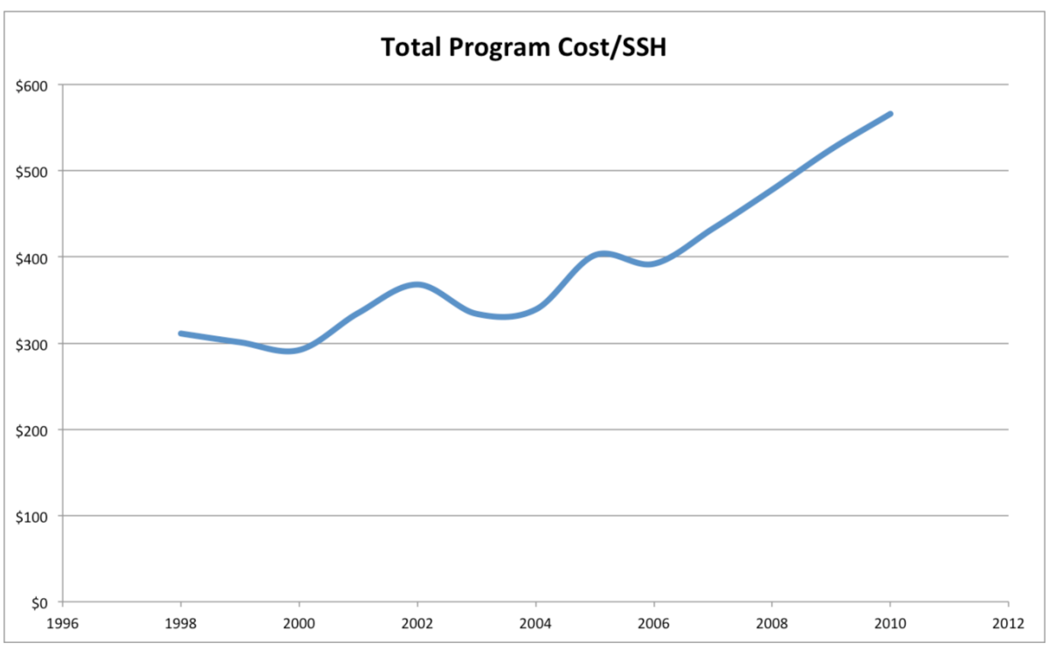

Figure 3: Cost of Ph.D. program per student semester hour

Figure 3 reveals that program cost has risen steadily over the past decade. Although this trend is somewhat disconcerting, the next two charts provide some additional context that we believe puts this trend in a favorable light.

Comparison of Cost/SSH (Ph.D. CS vs. Ph.D. EE)

The following chart shows Cost/SSH for the Ph.D. as well as Cost/SSH for the PhD. degree in Electrical Engineering. The selection of the Ph.D. in EE as the comparison was suggested by the office of the Vice Chancellor for Academic Affairs, based on similar sizes and time since inception.

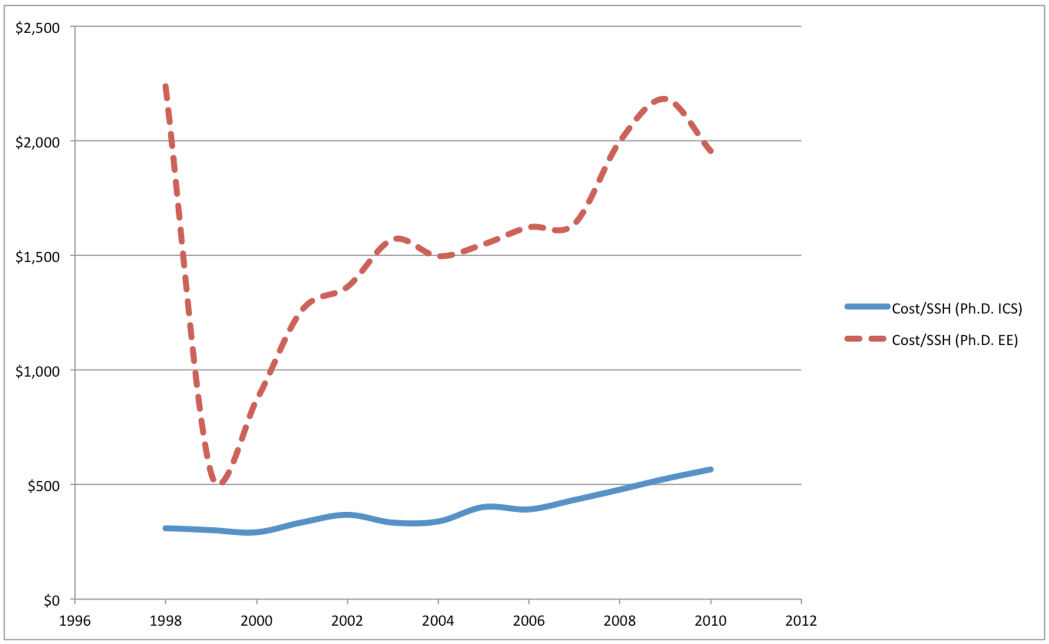

Figure 4: Comparison of Ph.D. CS vs. Ph.D. EE degree programs

Figure 4 shows that the Cost/SSH for the Ph.D. in CS is consistently below the Cost/SSH for a comparable program (Ph.D. in Electrical Engineering). Thus, while our cost/SSH has increased, we are still a relatively "cheap" program compared to Electrical Engineering. In addition, the Cost/SSH for the Ph.D. in EE has also steadily risen (apart from a one year drop). We conclude that the trend in Cost/SSH for the ICS Ph.D. in CS program is consistent with other programs, and that the absolute Cost/SSH is relatively low.

Revenue

Our final excerpt from Appendix A illustrates revenue.

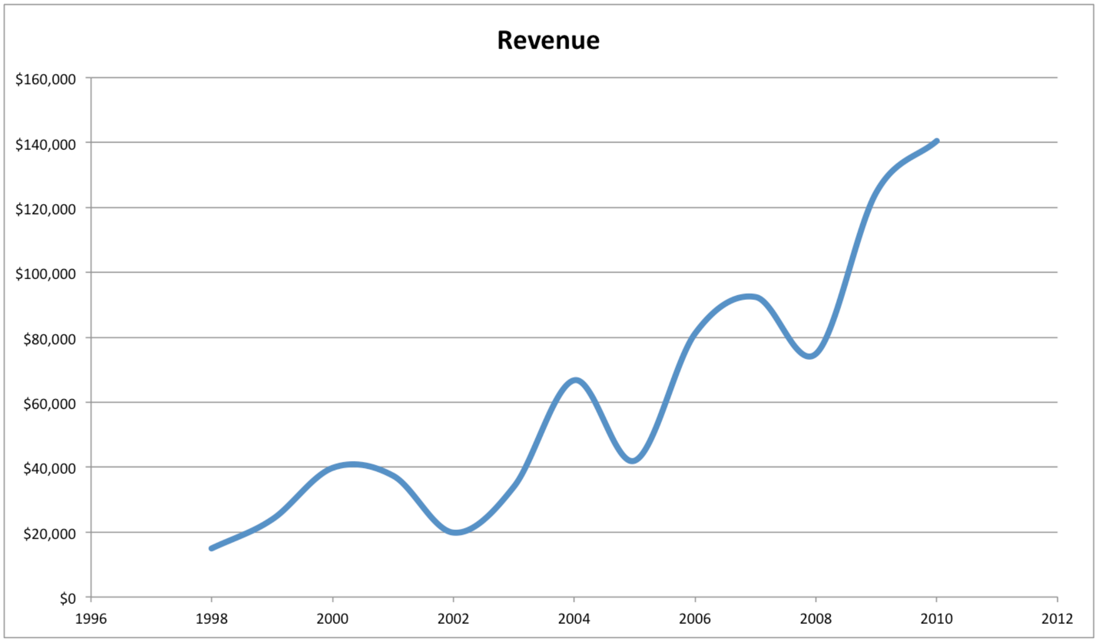

Figure 5: Revenue from the Ph.D. program

Figure 5 shows that revenue has remained positive throughout the entire program, and more importantly, that the overall trend in revenue is strongly positive. Thus, although we are investing more in the students (in terms of Cost/SSH), the net result has been an increase in revenue for the program as a whole. We take this data to indicate that our program is a good investment, both for the students and for the University's bottom line.

Assessment of program quality

In response to E5.201 question 5: A qualitative assessment of the program in relation to competing demands for resources by new programs and continuing programs. Accreditation or other external evaluation, student performance [e.g., on external exams], satisfaction, placement and employer satisfaction, awards to faculty and students faculty publication record, evaluation of faculty…

The ICS department has a national and international reputation and our faculty are regularly awarded grants, fellowships, awards, contracts and commissions. In prior sections of this document, we have presented evidence for the quality of our faculty. In the introduction, we noted that Wesley Peterson won the Japan Prize for his work on error correcting codes, and that Norman Abramson designed an early version of Ethernet. The next section presents a snapshot of recent ICS faculty activities as evidence of the quality of our work.

Faculty research activities

Digital democracy

Professor Scott Robertson and his students have developed projects to understand the way participation in public debate and deliberation is influenced by emergent social media such as Facebook. The research includes user-centered design of enhancements to search engine tools, laboratory studies of how potential voters browse, and longitudinal studies through at least three election cycles. This research has been funded by multiple NSF grants totaling over $1.3M.

Artificial intelligence and medicine

Professor Julia Patriarche and her students have developed a system for the detection of change in serial magnetic resonance imaging studies of brain tumor patients. The system is a multi-level AI system, which demonstrates how such systems can augment patient care by performing routine tasks and thus elevating the role of the clinician to the more interesting and less routine parts of patient care. Dr. Patriarche's work has resulted in a diagnostic system that has been adopted as a standard part of patient care for brain tumor patients at the Mayo Clinic. This research has been funded by multiple grants from the National Institute of Health and has resulted in two patent applications.

Socio-technical network analysis

Professor Dan Suthers and his students are studying the new emergent forms of socio-technical systems enabled by modern communication and information technologies. A recent project called Traces provides a theoretical foundation for analysis, a data model, and software tools to trace out the movements, confluences, and transformations of people and ideas in online social networks. Professor Suther's recent research is funded by the National Science Foundation for approximately $400K.

Data management

Professor Lipyeow Lim and his students have developed efficient algorithms for evaluating XPath queries on XML data that exploit the multi-core parallelism available in modern processors resulting in performance improvements of up to an order of magnitude. Other students have also designed query processing algorithms for mobile devices (e.g., iPhones, Android phones) that optimize the energy efficiency in such devices in order to improve battery life. A recent project investigates using the streaming paradigm to forecast wind profiles for the purpose of wind energy monitoring and management. This project has been funded by an IBM innovation award.

Biometrics

Professors Martha Crosby and Curtis Ikehara have been applying biometrics to study cognitive overload in specific situations. In 2007, they received patent No. US 7,245,218 B2 for an “Input Device to Continually Detect Biometrics.” This patent was granted for a method and system that uses surface finger pressures to identify the biometric characteristics of a user from a computer input device (such as a mouse).

User modeling

Professor David Chin and his students perform research to create models of users to improve information systems. A recent project involves a prototype agent-based simulation system that will allow analysis of the long-term effects of policy on culture, and to predict the effects of cultural change on the level of violence in various localities. The goal is to better predict which policy alternatives are likely to minimize long-term violence. Professor Chin's recent research has been funded by a variety of grants totaling over $1M.

Space exploration

Professor Kim Binsted manages a NASA-funded 4-month simulated space-exploration mission using an environment on the Big Island. Six crewmembers will live in a habitat for four months, while researchers study their diet, psychology, teamwork, etc. ICS graduate students will work on automated tools for data collection, as well as on advanced communication strategies for long-term space missions. In addition, Professors Binsted and Rich Gazan are applying computational methods to the search for life in the universe, funded by a 5-year, $8M NASA Astrobiology Institute grant. They work with a cross-disciplinary team at UH including researchers from Astronomy, SOEST, Physics and Chemistry, and NASA researchers nationwide, using information-theoretic clustering methods to relate the work of researchers in diverse fields, and to model the galactic habitable zone.

Quantitative Finance

Professor Susanne Still and her collaborators have argued that portfolio optimization must be regularized for large portfolios, such as those of banks and insurance companies. They have shown that regularization gets rid of an intrinsic instability that is otherwise present in portfolio optimization. They are studying the effects of regularization on investment strategies and on market dynamics, with the goal of finding mechanisms that could help prevent future crashes.

High performance computing

Professor Henri Casanova and his students have developed a novel method for sharing computing resources among competing users. This approach, called Dynamic Fractional Resource Scheduling, makes both theoretical and practical advances and outperforms state-of-the-art techniques by orders of magnitude. Among its benefits are a higher level of user satisfaction, a quantifiable and optimized measure of fairness among users, and enhanced resource economy both in terms of hardware and electrical power expense. This research has been funded by multiple grants from the National Science Foundation totaling over $500K.

Wireless networking and security

Professor Edo Biagioni and his students have developed a seamless voting system that lets voters vote from home, verify that their vote has been counted, yet remain anonymous. Another project involves a virtual machine system that detects attacks on the operating system. In embedded systems, a student designed a wireless system that can track buses, similar in function but different in technical details from the system that TheBus is currently using.

Studio-based learning

Professor Martha Crosby and her students perform research in studio-based learning, an innovative paradigm for science education that adapts concepts from architectural education including “design crits.” Professor Crosby's recent research has been funded by multiple grants from the National Science Foundation totaling over $2M.

Broadening Participation in Computing (BPC)

Working with Chaminade University (CU) and the University of Hawai’i at Hilo (UHH), Professor Martha Crosby is part of a NSF Broadening Participation in Computing (BPC) alliance grant for planning and developing the infrastructure for serving higher education institutions in the Pacific region with significant Native Hawaiian (NH) and Pacific Island (PI) student populations. CU and UHH are two of the three NH-serving institutions in Hawai’i.

Collaborative Research in Computer Security Education

Since 2006, Professor Martha Crosby has collaborated with The George Washington University (GW), a DHS/NSA designated Center of Academic Excellence in Information Assurance Education and Research (CAE/IAE and CAE/IAE-R), in Project PISCES (Partnership in Securing Cyberspace through Education and Service) to expand computer security and information assurance (CSIA) education opportunities to potential successful CSIA applicants from ICS. In 2011 Professor Crosby built on this partnership and received an NSF Collaborative Research grant to make this educational perspective available to ICS students.

STEM education

Professors Violet Harada and Dan Suthers are principal investigators of the Hawaiʻi Networked Learning Communities (HNLC) Initiative, which is a partnership of the Hawaiʻi Department of Education and the University of Hawaiʻi to improve science, mathematics and technology learning in K-12 rural schools. It directly supports the effort to form a seamless connection between UH and the State DOE. This initiative has been funded by grants from the Department of Education totaling over $1M.

Renewable energy and sustainability

Professor Philip Johnson and his students perform research on consumer-facing energy analysis and visualization that results in open source technology and empirical data to guide policy making. For example, they designed and implemented "The Quest for the Kukui Cup," an energy challenge for all 1,000 first year students living in the Hale Aloha residence halls. The project involves novel information technology, pedagogy, and game design techniques designed to raise student awareness of the energy challenges facing Hawaiʻi, help them to learn how to use energy more efficiently, and connect them with organizations and curriculum if they decide to pursue energy studies at the University. Professor Johnson's recent research is funded by grants from the National Science Foundation totaling over $400K.

Bioinformatics

Professors Guylaine Poisson and Kyungim Baek are Director and Associate Director for the Bioinformatics cores of the COBRE Pacific Center for Emerging Infectious Diseases Research and the INBRE Hawaiʻi State Research and Education Partnership programs. They work with their students on research projects that include metagenome analysis, prediction of phosphorylation sites in proteins, and population clustering using human SNPs (single nucleotide polymorphism) data. As Directors of the Bioinformatics cores, Professors Poisson and Baek manage research funds from multiple grants from the National Institute of Health totaling around $1.8M.

Machine Learning

Professor Susanne Still has developed a new approach to interactive learning. Her theoretical work has spawned a number of applications in machine learning and robotics. Her students are using this approach to implement curiosity driven learning and exploration in robotics, to understand human learning and behavior in simplified scenarios, such as computer games, and for devising intelligent agents which are to be embedded into computer games. Professor Still and her collaborators have developed a novel robust clustering algorithm, and they have improved the state-of-the-art in cluster analysis methods. Her students are applying these methods to document classification, whale song analysis, and, in collaboration with researchers at NASA, to problems in geophysics and planetary sciences.

Computer vision

Professor Kyungim Baek and her students designed and implemented a traffic density estimator, which provides traffic monitoring information by analyzing images from Hawaiʻi state traffic cameras. Other students implemented a wrist pose estimator for robotic surgical instrument that helps human-robot interaction in a minimally invasive robotic surgery environment.

Software Visualization

Professor Jan Stelovsky and his students developed a visualization tool embedded within a popular software development environment. This tool allows a programmer to view algorithm execution in a textbook-like graphical fashion. When the resulting video is replayed, the programmer can switch between a variety of different visualizations. The tool was successfully used in introductory ICS courses to help students understand the behavior of typical algorithms.

Undergraduate education

Professor M.B. Ogawa supervises a variety of research projects related to undergraduate education. As one example, four undergraduate students were semi-finalists in the 2009 ImagiNations Competition sponsored by Walt Disney Corporation. These students designed a mobile device to enhance the experience of Walt Disney park goers with live data feeds to determine ride wait times, GPS mapping, and historical information about the park. This is part of an overall research program on student learning that has been funded by multiple grants totaling over $500K.

Human computer interaction

While the ICS faculty prides itself on providing a diversity of research interests and activities to its students and the community, the focus area of human computer interaction (HCI) encompasses such a substantial number of ICS faculty interests that it deserves special mention. Professors Scott Robertson, Martha Crosby, Dan Suthers, David Chin, Rich Gazan, Curtis Ikehara, Jan Stelovsky, and Philip Johnson have all published research in HCI related conferences and journals. When viewed in aggregate, HCI is an area in which the ICS faculty have achieved a special level of national and international recognition.

Faculty productivity: external funding and refereed publications

Figure 6 provides a perspective on faculty productivity based upon the aggregate value of external funding that ICS faculty have been awarded as PIs or co-PIs, along with the number of refereed publications that ICS faculty have authored or co-authored.

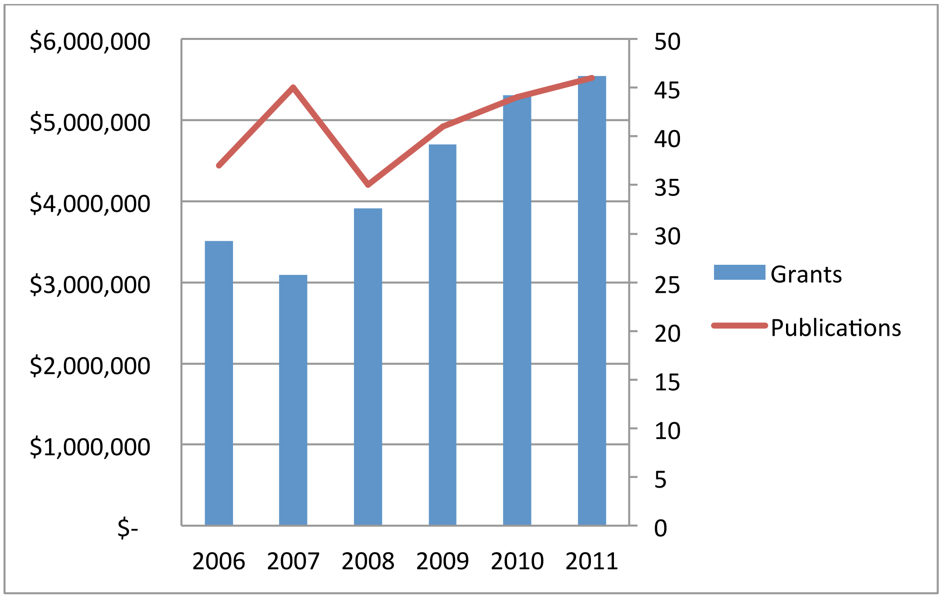

Figure 6: External funding and refereed publications by ICS faculty

Figure 6 shows that aggregate external funding in which ICS faculty were directly involved varied between $3M and $5.5M per year during this six year period, and the number of refereed publications by ICS faculty varied between 35 and 45 per year.

For a listing of recent faculty extramural funding awards, please see Appendix C. For faculty publications, please see Appendix D.

Assessment of appropriateness of program objectives

In response to E5.201 question 7: Are program objectives still appropriate functions of the college and University? (Relationship to University mission and development plans, E5.201 P 13 of 13 evidence of continuing need for the program, projections of employment opportunities for graduates, etc.)

ICS Mission

The following section addresses how the mission statements for the Department of Information and Computer Sciences support the larger missions of the University of Hawai‘i at Mānoa, the University of Hawai‘i system, the state of Hawai‘i, and the overall national picture.

The mission of the Department of Information and Computer Sciences is to nurture a world-class community of students and faculty dedicated to innovative scientific and information-related research and education for the benefit of the participants, Hawai‘i, the United States, and the world. A goal of the ICS program is to prepare students to be research and development leaders in computer science and computer technology. To this end, the program is a catalyst and a resource for shaping the future of the broad discipline of computer science. The faculty embraces the mutual interdependence of research and teaching to achieve excellence in both. As part of its mission the program brings the latest research findings into courses and actively involves students in research endeavors of the faculty. The program also provides leadership in the application of high technology to improve the educational experience.

Alignment with the UH Mānoa strategic plan

The Achieving Our Destiny, the University of Hawaiʻi at Mānoa 2011–2015 Strategic Plan has been released, and central to the UHM mission statement is to "support innovations in education, health care, social development, culture and arts, earth, space, and ocean sciences, sustainable land management, and technological advancement." In its broad-based research, teaching and professional networks, the ICS department is a catalyst for innovation in each of these areas.

Alignment with the UH System strategic plan

The University of Hawaiʻi System strategic plan approved by the Board of Regents has the following goals for the system:

- Educational Effectiveness and Student Success
- A Learning, Research, and Service Network
- A Model Local, Regional, and Global University
- Investment in Faculty, Staff, Students, and Their Environment
- Resources and Stewardship

The ICS department's mission statement closely aligns with the first goal of educational effectiveness and student success. Furthermore, the department helps to provide the university system with a strong learning, research, and service network.

Alignment with the State of Hawaiʻi

At the state level, Governor Neil Abercrombie's Technology and Information platform states the need for human capital and education in the area of technology, specifically:

"The fuel of an innovation economy is our human capacity to learn and create. Everyone can contribute. Education at all levels is the fundamental investment we will make to improve our economy. Industry and public education must work very closely to support each other and ensure highly skilled employees are being prepared at the same rate that high skill jobs are being created."

In a U.S. Department of Commerce, Office of Technology Policy report entitled "The Digital Workforce: Building Infotech Skills at the Speed of Innovation" (June 1999) Alan Greenspan said, "The rapid acceleration of computer and telecommunications technologies is a major reason for the appreciable increase in our productivity in this expansion, and is likely to continue to be a significant force in expanding standards of living into the twenty-first century." This bodes well for the increasing use of information technology and for the strategic role that the ICS Department might play in delivering high-quality teaching and research at UHM.

Appendix C provides letters of support from local high technology leaders.

Need Factors

In response to E5.201 request for information regarding state, national, and international need factors in the case of graduate programs.

National and International need factors

Computer Science is a fundamental discipline whose advances in research and development impact the lives of millions of people every day across the globe. In 2009, a panel of 8 experts from the Wharton School of Business (University of Pennsylvania) was asked to name the 20 biggest innovations of the last 30 years, with the results published in the New York Times in March of that year. Out of the 20 innovations, 9 are directly from the field of computer science (the Internet, personal computers, email, the microprocessor, office software, open source software, e-commerce, media file compression, and social networking) and 5 of the remaining 11 are directly enabled by it.

Given this impressive coverage, it is not surprising that Computer Science Ph.D. programs are mainstays of virtually all first tier research universities worldwide. What makes Computer Science unique is its cross-cutting impact and relevance for other disciplines. Indeed, computers are used today not only in virtually all disciplines of science and engineering (where computer modeling and simulation are pervasive), but also in all the humanities (e.g., due to the use of large-scale and distributed digital databases), with direct involvement in fields as diverse as education (e.g., for internet collaboration technologies for learning) and even music (e.g., for computer-aided composition). Far from being straightforward applications of computers, many important developments in those fields require that Computer Science challenges be addressed through innovative research and development activities, such as those pursued by ICS Ph.D. students. Consequently, advances in computer science research are fundamental for furthering human knowledge and progress in general.

University need factors

Since Computer Science's relevance is pervasive across so many disciplines, our Ph.D. program is an invaluable resource for the university:

- ICS Ph.D. in CS students are often engaged in collaborative projects between professors in ICS and in other departments. They are thus key contributors to the fostering of interdisciplinary research at UHM, which is highly strategic given the amount of federal funding available for such research.
- A significant fraction of our Ph.D. students are currently or were previously supported by Research Assistantships hosted in other departments. This is because many research projects require the type of expertise that only our students have through the training provided in our Ph.D. program. We regularly receive requests from Principal Investigators on campus asking us to advertise Research Assistantship opportunities to our graduate students. Thus, our Ph.D. students provide a unique and important research workforce for the university.
- Our graduate program offers courses that provide advanced training for graduate students outside of our programs. Every semester, such students take our graduate-level courses. For instance, Oceanography and Astronomy students have taken our high-performance computing course, Biology students have taken our bioinformatics course, and Educational Technology students have taken our Human-Computer Interaction courses.
- Almost 30% of our Ph.D. graduates to date have chosen to stay in the University of Hawai‘i system and contribute either to research and development activities or to information technology management.

Hawai‘i need factors

Innovations in computing through Ph.D. research drive economic growth for the state of Hawai‘i. This growth occurs not just in the IT industry, but across the entire economy. A strong Computer Science Ph.D. program provides a nexus for this growth and the means to both build Hawai‘i’ capacity for technical innovation and to staff Hawai‘i’s research and development community. In the specific case of Hawai‘i, the benefit goes beyond economic growth to (much needed) economic diversification. Consequently, a strong ICS Ph.D. in CS program can be a major contributor to growing a diversified economy in Hawai‘i.

The career paths of our Ph.D. graduates are a clear testimony of the dramatic impact that our students have on the state’s economy. Approximately 35% of our Ph.D. graduates so far have chosen to stay in Hawai‘i and work in local research and development organizations. The impact of these graduates is also felt at the level of the community. As just one example, many of our Ph.D. students are active contributors to TechHui, Hawai‘i’s premier social network for science, technology and new media.

Our Ph.D. program fulfills a clear local educational need. We have admitted many outstanding local students who were exposed to research during their undergraduate experience at the University of Hawai‘i, and although many alternatives were available to them, they chose our Ph.D. program based on their interactions with our faculty and the opportunities this degree would make available to them.

As further evidence of Hawai‘i needs factors, Appendix C provides letters of support from local high technology leaders.

In summary, the national and international need for Computer Science Ph.D. graduates is currently strong and will only grow stronger in future. Regionally, the diversification of the Hawai‘i economy requires skilled, innovative thinking in high technology areas which Computer Science Ph.D. graduates are ideally suited to provide. Finally, the ICS Ph.D. in CS program provides students who are in high demand and a valued resource to other departments.

We believe strongly that the ICS Ph.D. in CS program satisfies university, state, national, and international need factors.

Appendix A: Head counts, student semester hours, and costs

	A	B	C	D	E	F	G	H	I	J	K
1	**Academic Program Cost and RevenuesTemplate: Provisional to Established**										
2											
3	**ENTER VALUES IN HIGHLIGHTED CELLS ONLY**										
4	**CAMPUS/Program**			MANOA/PHD in Computer Sci							
5				**Provisional Years (adjust as needed to show all provisional years)**					**Projected Years**		
6				Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 4	Year 5
7	**ENTER ACADEMIC YEAR (i.e., 2004-05)**			1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
8	**Students & SSH**										
9		A. Headcount enrollment (Fall)		10	17	24	23	14	18	39	25
10		B. Annual SSH		120	204	288	276	168	216	468	300
11											
12	**Direct and Incremental Program Costs Without Fringe**										
13		C. Instructional Cost **without** Fringe		$ 4,000	$ 8,300	$ 8,600	$ 9,000	$ 9,400	$ 4,900	$ 20,300	$ 15,900
14		C1. Number (FTE) of FT Faculty/Lecturers		0.08	0.16	0.16	0.16	0.08	0.16	0.32	0.24
15		C2. Number (FTE) of PT Lecturers		-	-	-	-	-	-	-	-
16		D. Other Personnel Costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17		E. Unique Program Costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18		F. Total Direct and Incremental Costs		$ 4,000	$ 8,300	$ 8,600	$ 9,000	$ 9,400	$ 4,900	$ 20,300	$ 15,900
19											
20	**Revenue**										
21		G. Tuition		$ 18,960	$ 32,232	$ 48,384	$ 46,368	$ 29,232	$ 38,880	$ 87,048	$ 57,900
22		Tuition rate per credit		$ 158	$ 158	$ 168	$ 168	$ 174	$ 180	$ 186	$ 193
23		H. Other		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24		I. Total Revenue		$ 18,960	$ 32,232	$ 48,384	$ 46,368	$ 29,232	$ 38,880	$ 87,048	$ 57,900
25											
26	**J. Net Cost (Revenue)**			-14,960	-23,932	-39,784	-37,368	-19,832	-33,980	-66,748	-42,000
27											
28											
29											
30	**Program Cost per SSH With Fringe**										
31		K. Instructional Cost **with** Fringe/SSH		$ 45	$ 55	$ 40	$ 44	$ 76	$ 31	$ 59	$ 72
32		K1. Total Salary FT Faculty/Lecturers		$ 4,000	$ 8,300	$ 8,600	$ 9,000	$ 9,400	$ 4,900	$ 20,300	$ 15,900
33		K2. Cost Including Fringe of K1		$ 5,400	$ 11,205	$ 11,610	$ 12,150	$ 12,690	$ 6,615	$ 27,405	$ 21,465
34		K3. Total Salary PT Lecturers		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
35		K4. Cost Including fringe of K3		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
36		L. Support Cost/SSH		$ 266	$ 246	$ 252	$ 291	$ 292	$ 303	$ 280	$ 330
37		Non-Instructional Exp/SSH		$ 320	$ 296	$ 306	$ 332	$ 345	$ 351	$ 338	$ 386
38		System-wide Support/SSH		$ 48	$ 42	$ 44	$ 53	$ 56	$ 51	$ 51	$ 53
39		Organized Research/SSH		$ 102	$ 92	$ 98	$ 94	$ 109	$ 99	$ 109	$ 109
40		M. Total Program Cost/SSH		$ 311	$ 301	$ 292	$ 335	$ 368	$ 334	$ 339	$ 402
41		N. Total Campus Expenditure/SSH		$ 588	$ 499	$ 552	$ 568	$ 547	$ 592	$ 571	$ 624
42											
43	**Instruction Cost with Fringe per SSH**										
44		K. Instructional Cost/SSH		$ 45	$ 55	$ 40	$ 44	$ 76	$ 31	$ 59	$ 72
45		O. Comparable Cost/SSH		$ 2,239	$ 547	$ 870	$ 1,262	$ 1,363	$ 1,570	$ 1,497	$ 1,549
46			Program used for comparison:	PhD in Electrical Engineering							
47											
48		**Reviewed by campus VC for Administrative Affairs:**			**(date)**						

	A	B	C	D	E	F	G	H	I
1	**Academic Program Cost and RevenuesTemplate: Provisional to Established**								
2									
3	**ENTER VALUES IN HIGHLIGHTED CELLS ONLY**								
4	**CAMPUS/Program**			MANOA/PhD in Computer Sci					
5				**Provisional Years (adjust as needed to show all provisional years)**					
6				Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
7	**ENTER ACADEMIC YEAR (i.e., 2004-05)**			2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
8	**Students & SSH**								
9		A. Headcount enrollment (Fall)		44	45	32	41	39	43
10		B. Annual SSH		528	540	384	492	468	516
11									
12	**Direct and Incremental Program Costs Without Fringe**								
13		C. Instructional Cost **without** Fringe		$ 24,400	$ 38,800	$ 34,900	$ 37,200	$ 33,600	$ 43,900
14		C1. Number (FTE) of FT Faculty/Lecturers		0.32	0.48	0.40	0.40	0.40	0.56
15		C2. Number (FTE) of PT Lecturers		-	-	-	-	-	-
16		D. Other Personnel Costs		$ -	$ -	$ -	$ -	$ -	$ -
17		E. Unique Program Costs		$ -	$ -	$ -	$ -	$ -	$ -
18		F. Total Direct and Incremental Costs		$ 24,400	$ 38,800	$ 34,900	$ 37,200	$ 33,600	$ 43,900
19									
20	**Revenue**								
21		G. Tuition		$ 105,600	$ 131,220	$ 109,824	$ 161,868	$ 174,096	$ 214,140
22		Tuition rate per credit		$ 200	$ 243	$ 286	$ 329	$ 372	$ 415
23		H. Other		$ -	$ -	$ -	$ -	$ -	$ -
24		I. Total Revenue		$ 105,600	$ 131,220	$ 109,824	$ 161,868	$ 174,096	$ 214,140
25									
26	**J. Net Cost (Revenue)**			-81,200	-92,420	-74,924	-124,668	-140,496	-170,240
27									
28									
29									
30	**Program Cost per SSH With Fringe**								
31		K. Instructional Cost **with** Fringe/SSH		$ 62	$ 97	$ 123	$ 102	$ 97	$ 115
32		K1. Total Salary FT Faculty/Lecturers		$ 24,400	$ 38,800	$ 34,900	$ 37,200	$ 33,600	$ 43,900
33		K2. Cost Including Fringe of K1		$ 32,940	$ 52,380	$ 47,115	$ 50,220	$ 45,360	$ 59,265
34		K3. Total Salary PT Lecturers		$ -	$ -	$ -	$ -	$ -	$ -
35		K4. Cost Including fringe of K3		$ -	$ -	$ -	$ -	$ -	$ -
36		L. Support Cost/SSH		$ 330	$ 336	$ 355	$ 423	$ 469	$ 375
37		Non-Instructional Exp/SSH		$ 386	$ 399	$ 422	$ 497	$ 551	$ 450
38		System-wide Support/SSH		$ 53	$ 56	$ 60	$ 68	$ 72	$ 56
39		Organized Research/SSH		$ 109	$ 119	$ 127	$ 142	$ 154	$ 131
40		M. Total Program Cost/SSH		$ 392	$ 433	$ 478	$ 525	$ 566	$ 490
41		N. Total Campus Expenditure/SSH		$ 624	$ 650	$ 690	$ 793	$ 870	$ 736
42									
43	**Instruction Cost with Fringe per SSH**								
44		K. Instructional Cost/SSH		$ 62	$ 97	$ 123	$ 102	$ 97	$ 115
45		O. Comparable Cost/SSH		$ 1,623	$ 1,638	$ 1,998	$ 2,183	$ 1,956	
46			Program used for comparison:	PhD in Electrical Engineering					
47									
48		**Reviewed by campus VC for Administrative Affairs:**			**(date)**				

	A	B	C	D	E	F	G	H
1	**Academic Program Cost and RevenuesTemplate: Provisional to Established**							
2								
3	**ENTER VALUES IN HIGHLIGHTED CELLS ONLY**							
4	**CAMPUS/Program**			MANOA/PhD in Computer Sci				
5				**Provisional Years (adjust as needed to show all provisional years)**				
6				Year 1	Year 2	Year 3	Year 1	Year 2
7	**ENTER ACADEMIC YEAR (i.e., 2004-05)**			2011-12	2012-13	2013-14	2014-15	2015-16
8	**Students & SSH**							
9		A. Headcount enrollment (Fall)		39	39	39	39	39
10		B. Annual SSH		468	468	468	468	468
11								
12	**Direct and Incremental Program Costs Without Fringe**							
13		C. Instructional Cost **without** Fringe		$ 32,800	$ 34,200	$ 35,800	$ 37,400	$ 39,100
14		C1. Number (FTE) of FT Faculty/Lecturers		0.40	0.40	0.40	0.40	0.40
15		C2. Number (FTE) of PT Lecturers		-	-	-	-	-
16		D. Other Personnel Costs		$ -	$ -	$ -	$ -	$ -
17		E. Unique Program Costs		$ -	$ -	$ -	$ -	$ -
18		F. Total Direct and Incremental Costs		$ 32,800	$ 34,200	$ 35,800	$ 37,400	$ 39,100
19								
20	**Revenue**							
21		G. Tuition		$ 214,344	$ 226,044	$ 240,552	$ 258,336	$ 277,524
22		Tuition rate per credit		$ 458	$ 483	$ 514	$ 552	$ 593
23		H. Other		$ -	$ -	$ -	$ -	$ -
24		I. Total Revenue		$ 214,344	$ 226,044	$ 240,552	$ 258,336	$ 277,524
25								
26	**J. Net Cost (Revenue)**			-181,544	-191,844	-204,752	-220,936	-238,424
27								
28								
29								
30	**Program Cost per SSH With Fringe**							
31		K. Instructional Cost **with** Fringe/SSH		$ 95	$ 99	$ 103	$ 108	$ 113
32		K1. Total Salary FT Faculty/Lecturers		$ 32,800	$ 34,200	$ 35,800	$ 37,400	$ 39,100
33		K2. Cost Including Fringe of K1		$ 44,280	$ 46,170	$ 48,330	$ 50,490	$ 52,785
34		K3. Total Salary PT Lecturers		$ -	$ -	$ -	$ -	$ -
35		K4. Cost Including fringe of K3		$ -	$ -	$ -	$ -	$ -
36		L. Support Cost/SSH		$ 467	$ 467	$ 467	$ 467	$ 467
37		Non-Instructional Exp/SSH		$ 534	$ 534	$ 534	$ 534	$ 534
38		System-wide Support/SSH		$ 68	$ 68	$ 68	$ 68	$ 68
39		Organized Research/SSH		$ 135	$ 135	$ 135	$ 135	$ 135
40		M. Total Program Cost/SSH		$ 562	$ 566	$ 570	$ 575	$ 580
41		N. Total Campus Expenditure/SSH		$ 736	$ 736	$ 736	$ 736	$ 736
42								
43	**Instruction Cost with Fringe per SSH**							
44		K. Instructional Cost/SSH		$ 95	$ 99	$ 103	$ 108	$ 113
45		O. Comparable Cost/SSH		$ 1,956	$ 1,956	$ 1,956	$ 1,956	$ 1,956
46			Program used for comparison:	PhD in Electrical Engineering				
47								
48		**Reviewed by campus VC for Administrative Affairs:**			**(date)**			

	A	B	C
49	**Instructions**		
50	Please include an explanation of this template in your narrative.		
51	A.	Headcount Enrollment: Headcount enrollment of **majors** each Fall semester. Located at url: http://www.iro.hawaii.edu/maps/mltitles.asp	
52	B.	Annual SSH: Course Registration Report located at http://www.iro.hawaii.edu/maps/mltitles.asp. Add the SSH for the Fall and Spring reports to obtain the annual SSH. This is all SSH taught by the program, including to non-majors.	
53	C.	Instructional Cost **without** Fringe (automated calculation): Direct salary cost for all faculty and lecturers teaching in the program. *Formula for column D: =IF(OR(D32<>"",D34<>""),D32+D34,"")	
54		C1. Number of full time faculty and lecturers who are ≥.5 FTE.	
55		C2. Number of part time lecturers who are <.5 FTE.	
56	D.	Other Personnel Cost: Salary cost (part or full time) for personnel supporting the program (APT, clerical lab support, advisor, etc.) This includes personnel providing necessary support for the program who may not be directly employed by the program and may include partial FTEs. Add negotiated collective bargaining increases and 4% per year for inflation thereafter.	
57	E.	Unique Program Cost: Costs specific to the program for equipment, supplies, insurance, etc. For provisional years, this would be actual cost. For established years, this would be projected costs using amortization for equipment and add 4% per year for inflation thereafter.	
58	F.	Total Direct and Incremental Cost: C + D + E *Formula for column D: =IF(OR(D13<""",D16<>0,D17<>0),SUM(D13,D16,D17),"")	
59	G.	Tuition : Annual SSH X resident tuition rate/credit *Formula for column D: =IF(D10>0,D10*D22,"")	
60	H.	Other: Other sources of revenue including grants, program fees, etc. This should not include in-kind contributions unless the services or goods contributed are recorded in the financial records of the campus and included in Direct and Incremental Costs in this template.	
61	I.	Total Revenue: G + H *Formula for column D: =IF(OR(D21<>"",D23<>0),SUM(D21,D23),"")	
62	J.	Net Cost: F - I This is the net incremental cost of the program to the campus. A negative number here represents net revenue (i.e., revenue in excess of cost.) If there is a net cost, please explain how this cost will be funded. *Formula for column D: =IF(AND(D18<>"",D24<>""),D18-24,"")	
63	K.	Instructional Costs **with** Fringe/SSH: (K2 + K4) / B *Formula for column D: =IF((D10<>""),(SUM(D33,D35)/D10,"")	
64		K1. Salaries **without** Fringe of Full Time Faculty and Lecturers who are ≥ .5 FTE based on FTE directly related to the program. Add negotiated collective bargaining increases and 4% per year for inflation thereafter.	
65		K2. K1 X 1.35 *Formula for column D: =IF(D32="","",D32*1.35)	
66		K3. Salaries **without** Fringe for Lecturers who are < .5 FTE based on FTE directly related to the program. Add negotiated collective bargaining increases and 4% per year for inflation thereafter.	
67		K4. K3 X 1.05 *Formula for column D: =IF(D34="","",D34*1.05)	
68	L.	Support Cost/SSH:The **campus'** non instructional expenditure/ssh + systemwide support – organized research (UHM only) as provided by UH Expenditure Report (http://www.hawaii.edu/budget/expend.html) *Formula for column D: =IF(OR(D37>0,D38>0,D39>0),D37+D38-D39,"")	
69			
70		For example, from the 2005-06 UH Expenditure Report, the support expenditure/ssh per campus is:	
71			
72		UHM	$382.00 + $60 - $112 for organized research = $330
73		UHH	$278 + $40 = $318
74		UHWO	$179.00 + $32 = $211
75		Haw CC	$111.00 + $33 = $144
76		Hon CC	$168.00 + $38 = $206
77		Kap CC	$114.00 + $30 = $144
78		Kau CC	$346.00 + $68 = $414
79		Lee CC	$112.00 + $28 = $140
80		Maui CC	$175.00 + $39 = $214
81		Win CC	$257.00 + $44 = $301
82			
83	M.	Total Program Cost/SSH: K + L *Formula for column D: =IF(OR(D31<>"",D36<>""),D31+D36,"")	
84	N.	Total Campus Expenditure/SSH: Taken from UH Expenditures Report For example, for 2005-2006: UHM = $799-112 (organized research) = $687, UHH = $528, UHWO = $429, HawCC = $329, HonCC = $375, KapCC = $300, KauCC = $677, LeeCC=$279, Maui CC= $385, WinCC=$442	
85	O.	Comparable Program/Division Instructional Cost/SSH: Taken from UH Expenditures Report (http://www.hawaii.edu/budget/expend.html) or campus data, as available. Please note in the space provided, the program used for the comparison.	
86			
87			
88	Rev. 04.28.09		

Appendix B: Letters of support

The ICS Ph.D. in CS program has widespread support from local industry. This section provides a few letters to illustrate this support.

Letter from Henk Rogers, CEO, Blue Planet Software

BLUE PLANET SOFTWARE, INC.

December 20, 2011

TO: University of Hawaii, Board of Regents

FROM: Henk Rogers, Chairman, Blue Planet Software, Inc.; Founder, Blue Planet Foundation

RE: Continuation of the Ph.D. Degree in Computer Science

Dear Regents of the University of Hawaii,

I remember fondly my time as a student in the ICS department at UH in the 1970's. It was a time of enormous discovery and growth for me. During that time I learned the skills in computer programming which have sustained me throughout my professional career. The ICS faculty guided me into a world of computers in which I have innovated and created companies on 3 continents and have been proud to do so here in Hawaii as well.

I understand now that the ICS department is petitioning you, the Regents, to formalize and make permanent its Ph.D. degree program which has been operating provisionally for many years. I wanted to raise my voice of support for this action, as having a strong ICS department in our State is absolutely crucial to our long term economic development and future. Without the Ph.D. program, students here in Hawaii will not have a home to do advanced research in the field. This would be a step backwards, and a blow to enhancing the role of technology in the State of Hawaii. Technology companies, such as my own, need to have a pool of talent to hire and the demand for this pool will only continue to grow. In my opinion, a full complement of degrees in computer science is a wise investment for the University, and for our State.

With aloha,

Henk B. Rogers
Chairman & CEO
BluePlanet Software

55 Merchant Street, 17th Floor // Honolulu, HI 96813 U.S.A.
Tel: 808-954-6100 // Fax: 808-954-6101

Letter from Yuka Nagashima, CEO, High Technology Development Corporation

HTDC Cultivating Hawaii's tech sector
HIGH TECHNOLOGY DEVELOPMENT CORPORATION

December 12, 2011

The Board of Regents
The University of Hawaii System
2444 Dole Street, Bachman Hall, Rm. 209
Honolulu, HI 96822

SUBJECT: Support letter for the Ph.D. Program in Information and Computer Sciences

Dear UH Board of Regents:

As the Executive Director of the High Technology Development Corporation (HTDC), I write today to show my enthusiastic support for updating the Information and Computer Sciences (ICS) Ph.D. Program at UH Manoa from provisional to the established status.

HTDC is the lead agency in the State of Hawaii tasked with tech-based economic development (TBED) and as such, we are dedicated to improving the growth of the technology and the innovation industry sectors in Hawaii. To that end, UH and HTDC have overlapping goals. National think-tanks, federal agencies, and economic development specialists internationally have recognized the important roles research and educational institutions play in regional economies. The State Science and Technology Institute, a national umbrella organization for TBED entities, even identified universities as drivers for economic development in their resource guide commissioned by the U.S. Dept. of Commerce's Economic Development Administration.

There are numerous reasons why a bona fide Ph.D. program is needed at UH. Here are three points that affect our mutual missions for your consideration:

1. Alignment with the State of Hawaii economic development goal
Our traditional industry sectors can no longer support the level of economic growth the State needs to sustain the quality of life we have come to expect. A prospering innovation economy is crucial to augment our industries, and UH's declaration to upgrade the Ph.D. program in ICS from provisional to established is well-aligned with the needs of our State. If we aim to grow the innovation sectors of our economy, we must rely on UH to produce more graduates in computer science and related disciplines at all levels for that growth in the private sector. There is a crucial, demonstrable need in local industry for more qualified graduates in the field of computer science and software engineering. This need was further emphasized by the strong interest in addressing this gap at the Software Development Skills Panel, a forum organized by HTDC and the Workforce Development Council in conjunction with UH in 2011.

2. Attraction of top professors and retention of top students here on the islands
In order to produce more top-notch computer science students, we need to attract and retain top-notch professors and graduate students. Without the Ph.D. standing for the program, the department's desire for excellence will be undermined. The attraction and retention of top professors and students are important factors for growth of the local businesses, as "shipping in talent" from the mainland or abroad is prohibitive to them (cultural adjustment and other issues result in shorter tenure and below average results). Further, having a reputation for a solid Ph.D. program in ICS is considered a strong indicator for business attraction. Many established companies when considering building an additional "campus" look at both the quality and the number of graduates associated with the local university.

2800 Woodlawn Drive, Suite 100, Honolulu, HI 96822 | Ph.: (808) 539-3806 | Fax: (808) 539-3611 | info@htdc.org | www.htdc.org

3. ICS is now an established field

It is hard to imagine for the flagship school for the Pacific Islands as a land-grant university not to have a Ph.D. program in what has now become an established field. Further, ICS nationally and internationally is a growing field, affecting the technological development of non-computer science fields. This growth is mainly due to its interdisciplinary nature and the need for many other disciplines to effectively process data and the move to convert human transactions to electronic transactions (e.g., renewable energy, biometrics, astrophysics, financial forensics, e-commerce, user-interface, online education). The established status for ICS Ph.D. would not simply serve the computer science arena but also other disciplines now reliant on various aspects of computer science, both on and off campus. Ph.D. graduates are no longer just needed for the technology companies but in finance, engineering, health care and other disciplines. UH's research funding has grown tremendously in the last decade. With more federal and foundation funding available for ICS-related disciplines, giving ICS the established Ph.D. status is also in line with President Greenwood's vision and leadership for UH to double its research funding. Such a bold goal is important for the industry because we rely on the university as the engine of innovation. ICS being considered more of an applied field of science, there are more opportunities for technology transfer and commercialization of their research findings to be adopted by the industry, forging UH's role as part of the economic driver for the State of Hawaii.

I have personally interacted with many of the devoted professors and students in the ICS program, who have willingly given their time to reach out outside of their own program to improve the quality of education for UH and to contribute back to its community as a whole. I hope the UH Board of Regents will share my strong support to give the ICS program the recognition it deserves by declaring its established status.

Sincerely,

Yuka Nagashima
Executive Director and CEO

Letter from Nelson Kanemoto, CEO, Referentia, Inc.

referentia 155 Kapalulu Place, Suite 200 | Honolulu, Hawaii 96819 p 808.840.8500 | f 808.423.1960 www.referentia.com

15 December 2011

University of Hawai'i at Manoa
College of Natural Sciences
Department of Information and Computer Sciences
1680 East-West Road, POST Building, Room 317
Honolulu, HI 96822

Dear Sir or Madam:

As President & CEO of Referentia Systems, I am pleased to write in support of the Information and Computer Sciences (ICS) Ph.D. program's transition from provisional to established status.

Referentia Systems is a software research and development company in Hawaii. We rely on science and technology to drive the development of new relevant innovation to achieve our business goals. The ICS Ph.D. program will provide us with a good source of new hires. Approximately 30% of our employees have advanced degrees and we have found success with the quality of candidates from the UH ICS graduate and undergraduate programs. The Ph.D. program will provide stronger candidates that have the increased academic and research background that we desire.

Being located in Hawaii offers us unique opportunities for high technology development. Referentia has been working with government, local utilities, and academia to help position Hawaii as a leader in cyber-security as well as in alternative energy solutions. Referentia has partnered with faculty at the UH College of Engineering and other universities on various projects in these areas. We have also collaborated with ICS faculty, and with an established ICS Ph.D. program, we may garner an even stronger relationship with UH from stronger research capabilities of the ICS Ph.D. program.

In conclusion, I fully support the efforts of the ICS department as they seek to create an established Ph.D. program. Computer science is playing a large role at both the national and state level and its importance will continue to grow. Hawaii's economy and academia are key elements that support the success of high technology companies like Referentia. An established Ph.D. program will create sustainability in development of new research to attract more students into the field and in turn provide new highly-skilled workers that will grow the community.

Sincerely,

Nelson Kanemoto
President & CEO

Letter from Christoph Aschwanden, CEO, Noble Master Games, Inc.

NOBLE MASTER

December 10, 2011

To Whom It May Concern,

I am writing in support of moving the University of Hawaii's Information & Computer Sciences Department's Ph.D. program from provisional to established status.

I personally went through the ICS Department's Ph.D. program from 2001 to 2005 and have successfully graduated in December of 2005. After my graduation, I was offered a job at the John A. Burns School of Medicine, where I worked on several medical related research projects as a technical leader. The ICS Ph.D. program offers a great opportunity for students to work in the high-tech field. Because of my experience in the ICS Department's PhD. Program, I was able to found my own computer game company, Noble Master Games (http://www.noblemaster.com).

I believe the University of Hawaii and its students will best be served by a strong computer science department. The presence of a Ph.D. program provides great value to ICS faculty increasing both productivity and quality. The ICS Ph.D. program positively affects high technology development in the state of Hawaii. It enables high-tech companies in Hawaii to hire skilled professionals on one hand and will enable graduate students to later work locally in the state.

I therefore highly recommend moving the ICS Department's Ph.D. program from provisional to established status. Feel free to contact me at any time for further information at ceo@noblemaster.com or +1 (302) 261 2018.

Sincerely,

Christoph Aschwanden
CEO Noble Master Games

NOBLE MASTER LLC • 16192 COASTAL HWY • LEWES DE 19958
HTTP://WWW.NOBLEMASTER.COM • CONTACT@NOBLEMASTER.COM
PHONE: +1 (302) 261 2018 • FAX: +1 (866) 550 1790

Appendix C: Faculty extramural funding

This section provides a listing of extramural funding awards with ICS faculty participation as Principal or co-Principal Investigator during the past five years.

Kim Binsted, co-PI, Effects or retronasal smelling, variety, and choice on appetite and satiety, NASA, 2011, $395,000.

Kim Binsted, co-PI, UH-NASA Astrobiology Institute, NASA, 2008, $7,824,000.

Henri Casanova, PI, DiRT: A Testbed for Distributed Research, National Science Foundation, 2009, $31,764.

David Chin, co-PI, Coherence-Based Modeling of Cultural Change and Political Violence, National Science Foundation, 2007, $1,074,754.

David Chin, PI, Agent-based modeling for PMRF Intent Analysis, SAIC, 2006, $186,638.

Martha Crosby, PI, Teaching Strategic, Operational, and Defensive Cyber-security to the Next Generation from Sea to Shining Sea, National Science Foundation, 2011, $86,438.

Martha Crosby, PI, Broadening Studio-Based Learning in Computing Education, National Science Foundation, 2010, $220,299.

Martha Crosby, co-PI, PISCES 2006, 2010, 2014: Partnership in Securing Cyberspace Through Education and Service, National Science Foundation, 2010, $9,000,000.

Rich Gazan and Kim Binsted, co-PIs, Water and Habitable Worlds, NASA, 2009, $8,000,000.

Curtis Ikehara, co-PI, Center for Ohana and Self-Management of Chronic Illnesses in Hawaiʻi, National Institutes of Health, 2008, $300,000.

Curtis Ikehara, co-PI, Development of Compact Teleoperated Robotic Minimally Invasive Surgery, National Institute of Health, 2008, $134,560.

Curtis Ikehara, co-PI, Magnetic Levitation Systems for Human Interaction, National Science Foundation, 2006, $95,248.

Stephen Itoga, PI, Historical Native Hawaiian Archive, US Department of Education, 2008, $191,593.

Philip Johnson, PI, Innovative Information Architectures for the Smart Grid, National Science Foundation, 2009, $397,000.

Michael-Brian Ogawa, co-PI, Pathways to excellence and achievement in research and learning, IMLS, 2009, $249,917.

Michael-Brian Ogawa, co-PI, Examining the link between informal social networks and innovation: Using netometrics to quantify the value of distributed hierarchical networks, National Science Foundation, 2007, $199,766.

Guylaine Poisson and Kyungim Baek, co-PIs, COBRE Pacific Center for Emerging Infectious Diseases Research, National Institutes of Health, 2010, $11,000,000.

Guylaine Poisson and Stephen Itoga, co-PIs, INBRE II, National Institutes of Health, 2010, $9,000,000.

Guylaine Poisson, co-PI, Diversity and ecology of marine RNA viruses, National Science Foundation, 2008, $498,325.

Nancy Reed, co-PI, Automated interpretation of pediatric heartsounds, a multi-site recording device, US Army, 2007, $195,000.

Scott Robertson, co-PI, Digital Deliberation: Search and deciding how to vote, National Science Foundation, 2006, $400,000.

Scott Robertson, PI, Social search and deliberation in digital political information and collaboration domains, National Science Foundation, 2011, $948,537.

Dan Suthers, co-PI, Traces: Understanding distributed socio-technical systems, National Science Foundation, 2009, $382,421.

Dan Suthers, co-PI, HiMax Research and Development, 2006, $1,034,927.

Appendix D: Faculty publications

The following links provide access to the publications associated with our faculty.

Kyungim Baek, http://www2.hawaii.edu/~kyungim/research.html

Edo Biagioni, http://www2.hawaii.edu/~esb/cv/2010.html

Kim Binsted, http://www2.hawaii.edu/~binsted/papers/Publications.html

Henri Casanova, http://navet.ics.hawaii.edu/~casanova/homepage/vita.pdf

David Chin, http://www2.hawaii.edu/~chin/chin_vita.pdf

Martha Crosby, http://www.dblp.org/db/indices/a-tree/c/Crosby:Martha_E=.html

Rich Gazan, http://www2.hawaii.edu/~gazan/publications.html

Curtis Ikehara, http://www2.hawaii.edu/~cikehara/

Philip Johnson, http://csdl.ics.hawaii.edu/~johnson/CV/curriculum-vitae.pdf

Lipyeow Lim, http://www2.hawaii.edu/~lipyeow/ - publications

Julia Patriarche, http://www2.hawaii.edu/~julia4/PatriarcheCV.pdf

Guylaine Poisson, http://navet.ics.hawaii.edu/~poisson/BiL/publications/index.html

Luz Quiroga, http://www2.hawaii.edu/~lquiroga/LuzMQuirogaVita.htm

Nancy Reed, http://www2.hawaii.edu/~nreed/nreed-cv.pdf

Scott Robertson, http://manoa.hawaii.edu/hichi/pubs.html

Jan Stelovsky, http://www.dblp.org/db/indices/a-tree/s/Stelovsky:Jan.html

Susanne Still, http://www2.hawaii.edu/~sstill/pubs.html

Kazuo Sugihara, http://www.dblp.org/db/indices/a-tree/s/Sugihara:Kazuo.html

Dan Suthers, http://lilt.ics.hawaii.edu/?page_id=42