Request to Move the

**Ph.D. in Computer Sciences, University of Hawaii at Manoa**

From **Provisional** to **Established** Status

Fall 2011

[http://www.ics.hawaii.edu/logo.jpg](http://www.ics.hawaii.edu/)

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

# Introduction

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 has been 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. They 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

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. From the very beginning, the vision of ICS faculty has been to offer students a well balanced program. Currently, the ICS department offers the following degrees: the Bachelor of Arts Information and Computer Science, the Bachelor of Science in Computer Science, the Master of Science in Computer Science, the of Science in Library and Information Science (MLISc), and a PhD in CS. In addition we contribute 2 of the 4 programs in the interdisciplinary PhD program in CIS and we offer the BSCE with the department of Electrical Engineering.

**Assessment of program organization and objectives**

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.)

I**nformation and Computer Sciences Background**

The Department of Information and Computer Sciences is part of the College of Natural Sciences at the University of Hawaii at Manoa. The Information and Computer Sciences (ICS) Department offers four academic degrees:

* PhD in Computer Science (approved as provisions in 1997)
* Master of Science in Information and Computer Sciences (approved in 1968)
* Bachelor of Science in Computer Science (approved in 1974)
* Bachelor of Arts in Information and Computer Sciences (approved as provisions in 1998)

The ICS Department is also essential in the delivery of three other degrees inconjuction with other departments on campus.

* PhD in Communication and Information Sciences, Interdisciplinary (approved 1986)
* Professional Master Degree Program in Library and Information Science (approved 1969)
* Bachelor of Science in Computer Engineering (approved as provisional in 2009)

The joint programs the ICS participates in are key and vital to the department’s mission, service to the students, as well as campus collaboration and support. It is important to note in this case the evaluation of the ICS Ph.D. program cannot be based on degree offering / graduation metrics only, since they provide many other service courses to other programs and degrees. In this case, the resources, qualified faculty and interest are available to offer the Ph.D. program almost at no cost. It is essentially a small part of the students the program serves and is in addition to the already existing resources, however it is a very important function of the program. The workload implication, as will be later discussed, revolve around the delivery of a graduate 1-credit seminar in addition to directed studies and dissertation advising to a number of faculty spread throughout many areas of expertise. The research capacity of the students is also an important factor as they drive research plans and assist in ongoing projects, contracts and teaching.

The charts below identify the total number of majors and degrees awarded broken down by the different degrees offered by the ICS department.







**The Ph.D. in Computer Sciences**

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 Information and Computer Sciences 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 Ph.D. 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. 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, assessing readiness to do research with a research portfolio that is analogous to a professional tenure and promotion portfolio. We achieve these goals by guiding the students through a curriculum with the following components: (1) Demonstration of core competency; (2) Participation in ICS 690; (3) Preparation of a research portfolio; (4) Proposal defense; and (5) Final defense.

**Demonstration of core competency**

The ICS Ph.D. 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 interview 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**

According to Graduate Division guidelines, coursework is optional for University of Hawai‘i Ph.D. programs. However, the ICS Ph.D. program requires all ICS Ph.D. 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 other 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 in the proposed area of study of 20-30 pages, following the graduate division dissertation format and reviewing at least 20 published works. The second item must be one of the following: a masters 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 approved by a two-thirds majority vote of a quorum of the ICS faculty (typically

at a faculty meeting). The portfolio shall be distributed to the faculty in advance of the meeting at

which it will be voted upon.

The graduate program chair shall designate one faculty to argue for the student’s case and one

to argue against the student, who may both vote as they see fit. Faculty 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 usually is but is not required to 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 their 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.

Once the student passes the proposal defense, they then conduct their research and write a

dissertation under the direction of their advisor and their dissertation committee.

**Final defense**

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.

We believe that our five step process of demonstrating core competency, participation in ICS

690, 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**

1. **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.)

**Learning objectives**

We have defined nine student learning objectives for the ICS Ph.D. 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. 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 involves 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**

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 8 evidence regarding assessment and coverage by noting which courses the student took during their program.

Although development of assessment procedures is ongoing, we believe strongly that the basic

structure of our program as described above ensures that successful graduates have satisfactorily

achieved all of these learning objectives, as illustrated in Table 1.

Table 1: Ph.D. program components and satisfaction of student learning objectives

|  |  |
| --- | --- |
| **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 |

**Assessment of program resources**

1. **Are program resources adequate (Analysis of number and distribution faculty, faculty areas of expertise, budget and sources of funds, and facilities and equipment)**

It is important to remember this proposal reflects all the resources available to the ICS department for the degrees the program offers, participates in with other programs and service related courses funded by the department (i.e. courses offered for the general student population). The ICS Ph.D. is only one of degree program that draws on these resources and the smallest program at that. However, due to the size and complexity of the programs in total, this proposal provides information on the entire ICS department.

**Faculty Resources**

The ICS faculty is a diverse and well qualified group. The students clearly recognize the strength and the quality of faculty in the department. Students describe the faculty as high quality, well prepared, and ethically responsible. The list below illustrates the faculty, their rank and areas of expertise. This list clearly shows the diversity of research and academic strength within the faculty group.

**Professors**

M. Crosby, PhD (Chair)—human-computer interaction, augmented cognition, computer science education

D. Chin, PhD—artificial intelligence, natural language processing, cognitive science

P. Johnson, PhD (Associate Chair)—software engineering, artificial intelligence

D. Suthers, PhD—human-computer interaction, computer-supported collaborative learning, technology for education, socio-technical networks and online communities

**Associate Professors**

E. Biagioni, PhD—networks, systems, languages

K. Binsted, PhD—artificial intelligence, human-computer interaction, cognitive science, natural language processing

H. Casanova, PhD—high performance computing, distributed systems

G. Poisson, PhD—cognitive informatics, bioinformatics, machine learning

L. Quiroga, PhD (ICS/LIS)—information retrieval, databases, library systems, website design

N. Reed, PhD—artificial intelligence, autonomous agents

S. Robertson, PhD—human-computer interaction, digital government and digital democracy

J. Stelovsky, DrTechSc—computer-hypermedia, human-computer interaction

S. Still, PhD—bioinformatics/theoretical biology, information theory, machine learning

K. Sugihara, DrEng—algorithms, distributed computing, visual languages

**Assistant Professors**

K. Baek, PhD—computer vision, neural computation, machine learning

R. Gazan, PhD (ICS/LIS)—social aspects of information technology

C. Ikehara, PhD—biometrics and physiological sensors, adaptive human-computer interfaces

L. Lim, PhD—database systems

J. Patriarche, PhD—applications of computers to medicine

**Assistant Specialists**

G. Lau

M. Ogawa

**Emeritus Professors**

S. Itoga, PhD—database systems, expert systems, logic programming

D. Pager, PhD—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 Specialist’s hold other non-instructions duties. Their duties including academic support by coordinating and assisting the Department Chair and Graduate Program Chairs in major initiatives such as distance education and aspects of student services, including recruitment, financial assistance, 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 several sections of ICS 101 with the help of several student assistants (including the training of the student assistants). The department employs 12 teaching assistants. Departmental research efforts have produced several grants which employ student research 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 the faculty averages 8.82 semester credit hours for coursework (including directed reading courses, thesis advising and guest lecturing) and another 2.10 for additional teaching, for a total of 10.92 semester credit hours. On February 18, 2011 a comprehensive ICS Department Workload Documentation Procedure was approved by faculty. It is available for viewing at: http://goo.gl/IGRrr

In addition to teaching, all faculty are expected to participate with industry, agency and community groups. The list below illustrates only some of the collaborative activities being explored or carried out by the ICS faculty.

* The ICS department has discussed collaborative possibilities with the following IT companies: Alion Science, BAE, 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. We are in the initiating a process for our students to intern with ITS at UH.
* Violet Harada and Dan Suthers were principal investigators of the Hawai`i Networked Learning Communities (HNLC) Initiative, which is a partnership of the Hawai`i Department of Education and the University of Hawai`i 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.
* We have had an internship program with the Hawai`i Department of Health since 2002. Students are involved with the National Electronic Disease Surveillance System (NEDSS); an initiative that promotes the use of data and information system standards to advance the development of efficient, integrated, and interoperable surveillance systems at federal, state and local levels.
* Philip Johnson was a board member of the Hawai`i Strategic Development Corporation (HSDC) which is a State agency created in 1990 to promote economic development and diversification in conjunction with private enterprise.
* ICS faculty members have collaborated with several members of the Maui High Performance Computing Center (MHPCC) are MHPCC is an Air Force Research Laboratory Center managed by the University of Hawai'i. Ranked as one of the top twenty supercomputer sites in the world, MHPCC provides world-class, parallel computing capability to the research, science, and warfighter communities.
* Luz Quiroga, Scott Robertson and Curtis Ikehara have students work on community projects

**Support Service Resources**

In addition to the instruction staff, the department has two information technology (IT) specialists. They are responsible or system administration, networking, installation, maintenance of the department’s computer hardware and software infrastructure. The IT specialists also researches software and other products in response to instructional and research nees and manages the purchasing and budget maintenance for the department.

The department also has an administrative and fiscal support person that works with the Department Chair to develop and track an annual department budget with corresponding projections for all sources of revenues including general and all extramural funds. Fiscal support is provided to assist faculty with budgetary matters related to grant and contract proposals for agencies such as NSF, DARPA, 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 is another function of the support staff, as well as work related to curriculum and instructional needs of the department.

**Financial Program Resources**

The last major influx of general funds occurred in 2001 by the Hawaii state legislature which continues to remain in the ICS department’s line budget. This major investment into the program has allowed for 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. However, this appropriation was intended to support development of undergraduate courses and thus does not impact directly on the resources available for the ICS Ph.D. program.

The computer science department receives an annual budget assigned by the College of Natural Sciences. This budget supports operational costs for the entire department such as:

Software licensing fees Software purchase

Lab Teaching laboratory supplies Office supplies

Delivery charges, postage, freight Equipment maintenance, service agreements

Facilities repairs, maintenance, modifications Fees, subscriptions, dues

Printing and publications: program brochures Recruit Recruiting: travel, per diem

Telcom Installation, monthly fees, long distance

Travel for department business Lab Teaching laboratory equipment

Office equipment: computers, shredders Shop equipment: drills, cutters

Teaching Supplies and Equipment Instructors

Student help: office, graders

**Facilities and Equipment**

In this rapidly changing technology environment, ICS must constantly maintain and update its networking and data environment and provide up-to-date computer laboratory equipment for students and faculty at an estimated cost of $75,000 a year. The department has deployed a number of labs that focus on different learning environments. The majority use of these labs is from the undergraduate and masters level students. However, for the small population of graduate students, they too can benefit and work in these labs.

* Adaptive Multimodal Interaction (AMI) supports an environment using various metrics and methodologies to study user data. Typical experiments collect eye movements, pressure grasping, and other physiological input to develop novel and effective interactive systems. Research in this area has fostered new design principles, user interfaces, multimedia interaction systems, and visualizations of complex information

• Bioinformatics (BIL) supports Bioinformatics and Metagenomics projects.

• Collaborative Software Development Lab (CSDL) has pursued well-funded research leading to innovative software technologies in use by many academic and industrial sites worldwide.

• Concurrency Research Group (CORG) supports parallel and distributed computing, computer system simulation, and high-performance computing.

• Hawai'i Computer-Human Interaction (HI' CHI)focuses on understanding how people use information systems and is dedicated to informing design based on human performance data. Current research on digital government applications and how people use the Internet to make political decisions.

• Laboratory for Interactive Learning Technologies (LILT) is forging partnerships with the Department of Education and other local educational agencies to support innovative uses of high technology in education.

• Machine Learning (ML) supports machine learning, robotics and computational neuroscience projects

• Research Center for Information Assurance (RCIA). This serves as a learning laboratory and test bed for investigations and applications related to the generation, organization, access, preservation, and secure use of digital information

The facilities occupied by the ICS Department primarily are 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. In conclusion, we believe that current resources are sufficient for the current size of the Ph.D. program, but that growth of the program will be challenging without recover of lost resources.

**Assessment of program efficiency**

1. **Is the program efficient? (An assessment of productivity and cost/benefit considerations with in 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)**

We will assess these issues in two ways, through the use of the Academic Program Cost and

Revenues template and through a time-to-degree analysis.

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**Figure 1: *Academic Program Cost and Revenue Template***

Figure 1 presents an illustration of the Academic Program Cost and Revenues Template spreadsheet. Three spreadsheets were prepared for this program, one for AY 1997-2005, one for AY 2005-2011, and one for AY 2011-2016. All three of these spreadsheets show that the ICS Ph.D. program has positive revenue since its inception. The spreadsheet illustrated in Figure 1 shows projected revenues for this program for the next five years.

**The Ph.D. program as a virtuous circle**

We can make a more qualitative argument regarding the Ph.D. program cost and revenues. This

argument is that the incremental cost of the program to the department is extremely minimal:

essentially, just the cost of faculty advising for the Ph.D. students, and a fraction of the cost of

ICS 690 (since it is also taken by our M.S. students, so the Ph.D. students constitute less than half the enrollment.)

On the other hand, the revenue associated with the Ph.D. program is substantial, because the

Ph.D. program supplies students who amplify the ability of our faculty to produce quality scientific findings. These findings, in turn, increase the ability of our faculty to obtain external funding. In addition, the presence of a Ph.D. program, and the quality of our students, help us attract higher quality ICS faculty than we would be able to without the program. These higher quality faculty produce higher quality scientific findings, leading to increased ability to obtain external funding.

To close this “virtuous circle”, the increased external funding provides opportunities to fund new

Ph.D. students, who further amplify the ability of our faculty to produce quality scientific findings. Section 6.1 provides quantitative data on the funding and publications enabled by this virtuous circle.

**Time to degree**

An alternative measure of program “productivity” or “efficiency” for our Ph.D. program is 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 whether they 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 in terms 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 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 1 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 2. 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.

Through this process, we expect to maintain our relatively low average TTD but also to reduce

1http://www.nsf.gov/statistics/infbrief/nsf06312

2http://www.nsf.gov/statistics/nsf10309

our maximum TTD in the future. Our first graduate for the redesigned program, Mark Stillwell,

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 already found a post-doctoral position with a view to starting a promising Computer Science academic career.

**Assessment of program quality**

**5. Evidence of program quality.**

**(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…)**

**Department reputation**

The ICS department has national and international reputation and the faculty have a number of accomplishments, including grants, fellowships, awards, contracts and commissions. They have productive research records and are involved in developing information enterprises, hold technological patents and have engaged with the community in several ways.

Faculty in the ICS Department have been awarded millions of dollars in external funding from

both industry and government sources. They serve as editors on prestigious journals in their areas of expertise, have had their papers selected as the best paper at conferences, and have won prestigious awards. For example, W. Wesley Peterson was awarded the Japan Prize for his invention for the Cyclic Redundancy Check (CRC), a fundamental advance in error correcting codes. Kimberly Binsted, David Pager, Curtis Ikehara, Martha Crosby, Julia Patriarche, and Jan Stelovsky have all been awarded patents for their innovations.

Figure 2 provides a perspective on department quality 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. This is a snapshot of ICS departmental trends for the four year period of 2006 to 2009, and was generated through review of faculty curriculum vitae and online sources.

Figure 2 shows that overall aggregate external funding in which ICS faculty were directly

involved varied between $3M per year and $4.5M per year during this four year period, and the

number of refereed publications by ICS faculty varies between 35 and 45 per year. This data shows that ICS faculty are productive, generating scientific contributions through refereed publications and helping to bring significant amounts of external funding to the university. In Section 5.2, we explain why we feel the ICS Ph.D. program creates a “virtuous circle” that supports and grows the ability of our department to generate funding and scientific advances.

**Student application trends**

The average GPA of students joining our Ph.D. program over the last 5 years is a high 3.82. The

percentage of applicants that we accept in our program has ranged between 38% and 88%. The

last two years have had inordinately high acceptance rates above 80%. In fact, our acceptance

rates have increased steadily throughout the years. While this increase could be attributed to a lowering our admission standards, this is absolutely *not* the case. In fact, our faculty have been absolutely amazed at the rising quality of applicants to our Ph.D. program in the last couple of years, leading to accepting 15 out of 17 applicants in 2009-2010. This increase in quality might in part be due to the fact that our Ph.D. program is recent and is just gaining momentum with our graduates beginning to make an impact. The percentage of accepted applicants who eventually join our program has ranged between 12.5% and 60% over the years. Remarkably, in the last two years, which have seen unprecedented top quality applicants, 50% and 60% of these applicants have joined our program. As discussed below, we do not believe this represents a drop in standards, but rather an increase in the reputation and stature of our program as it matures.

The data collected by Graduate Division regarding the drop rate for our Ph.D. program is

misleading because it accounts only for students admitted between Fall 1989 and Spring 1999.

This was when our program was in its infancy and the data is for 3 students only. With the help

of a Graduate Division IT Specialist, on 8/30/2010 we obtained a full history of students in our

Ph.D. program. A total of 30 students have entered our program and not graduated, for 32 students who have either graduated or are still in the program. This would seem to indicate a high drop rate close to 50%. However, out of those 30 students who never graduated, 12 never enrolled (likely due to personal reasons or late admission to other programs) and 6 dropped out after only one semester (likely for similar reasons). Discounting those students, the overall drop rate of our program is 12/48=27%, which is basically the UHM average. Note that, out of these 12 students who dropped, 4 moved to a different PhD program at UHM (e.g., CIS), and 3 left after receiving their M.S. degree “on the way” to the Ph.D., seizing timely professional opportunities. We are left with only 5 students who entered our program, stayed in it more than one semester, and left without a degree. One of these students was recently dismissed due to poor academic performance. We conclude that most students admitted to our program are well-suited to it.

**6 Assessment of program outcomes**

**Analysis of the number of majors, graduates, SSHs offered employment, etc. in relationship to the objectives.**

As noted above, ICS Ph.D. students receive advanced training in the scientific principles and

technology required to develop and evaluate new computer systems and applications. A primary

objective is to 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. The following assessment of Ph.D. student graduates and career paths indicates that our program outcomes are meeting the program objectives.



**Student graduation and career paths**

The ICS Ph.D. program has 14 graduates to date, as listed in Table 4. Out of the 14 graduates, 6

have obtained faculty or post-doc positions, 3 work in a research or higher education institution,

and the remaining 5 have positions in industry.

A primary objective of the ICS Ph.D. program is to produce graduates that become leaders in their field once they have achieved at least one major contribution to at least one area of Computer Science research. Our graduates who went to industry all hold senior software design and development positions, which allow them to be key leaders in the high technology and information technology sector. A perfect example of such leadership is provided by one of our 2009 graduates who has recently created his own startup company in Texas. Many of our Ph.D. graduates work in “R&D” organizations, for which the research training they acquired in our program proves invaluable. This training is also key for the 3 graduates that hold positions in research institutes. Finally, 25% of our graduates to date hold faculty positions in research and/or higher education institutions. Even though this number is typical for Ph.D. programs nationwide, we note that students increasingly enter our program with the goal of obtaining a faculty position in the future. For instance, our two Fall 2010 graduates are moving on to post-doctoral positions as a transition to a faculty position hopefully within two years of their graduation.

**Local Impact of Graduates –** About 35% of our Ph.D. graduates have stayed in Hawai‘i. These 5 graduates currently contribute the Hawai‘i’s economy and higher education: 1 of them is a Senior Scientist for a local hi-tech company, 3 hold research and development positions at UHM, and 1holds a faculty position at a Community College (KCC).

**National Impact of Graduates –** All our graduates have national impact in that their work and

accomplishments further U.S. economy, research, and/or education. In general, our Ph.D. students are all engaged in original research in many fields of Computer Science. As a result, they publish their results in international competitive venues, thereby contributing to the nation’s (and Hawai‘i’s) predominance in the international Computer Science research arena. The drive of these graduates to find high-profile positions that match their research interest often entails moving to a few specific locations nationwide. Consequently, a large fraction of our graduates (7 of our 14) currently hold positions on the U.S. mainland (CA, FL, NY, TX),

**International Impact of Graduates –** Those graduates that hold positions with a strong research component have an international impact in the sense that they further the field and the global technology landscape (through original research publications, patents, and products). To date, only two of our graduates has opted for a position abroad: one in a research institute in Singapore, and one at a research institute in France. While we expect this number to increase, this relatively low number can be simply attributed to the fact that U.S. organizations offer highly attractive positions for our graduates.

**Assessment of program objectives**

**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.)**

The Ph.D. program in Information and Computer Sciences remains not only appropriate but

vital to the achievement of the University mission and development plans. The mission of the Department of Information and Computer Sciences that include Information and Computer Sciences (ICS) and Library and Information Sciences (LIS) programs 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.

The ICS mission 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 university objectives**

The University of Hawaii System strategic plan1approved by the board of regents in June 2002 has the following goals for the system:

The UH-Manoa mission is as follows:

• 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 UH-Manoa mission is as follows:

*As a land, sea, and space grant university, the University of Hawaii at Manoa is*

*dedicated not only to academic and research excellence but also to serving with aloha*

*the local, national, and international communities that surround us. Taking as its historic*

*trust the Native Hawaiian values embedded in the concepts of kuleana, ohana, and*

*ahupuaa that serve to remind us of our responsibilities to family, community, and*

*the environment, Manoas hallmark is a culture of community engagement that extends*

*far beyond the classroom to bridge theory and practice, fostering creative and critical*

*thinking, and promoting students intellectual growth and success as contributing*

*members of society.*

*Central to this mission is faculty dedication to a fertile, engaged, and ethical*

*learning environment characterized by a free exchange of ideas, shared intellectual*

*resources, cutting edge scholarship, and high academic expectations. With its unique*

*geographic location bridging East and West, Manoa serves as a portal to an exceptional*

*educational experience while striving to improve quality of life in the region through collaborative partnerships that support innovations in education, health care,*

*social development, culture and arts, earth, space, and ocean sciences, sustainable*

*land management, and technological advancement.*

The ICS department’s mission statement closely aligns with the first goal of educational effectiveness and student success since this is covered in both parts of the department’s mission. Furthermore, the department helps to provide the university system with a strong learning, research, and service network.

**Alignment with state objectives**

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.”*

The need for education in technical fields is further underscored by Office of Department of Business, Economic Development and Tourism’s report on Hawaii’s Technology which states Computer Sciences accounted for the largest share to technology jobs in Hawaii with about 26% of the total in 2009.

Given the state’s focus on building its technology capabilities and the jobs available in these fields, the Computer Science departments mission statement is well aligned with the State of Hawaii’s technology goals.

**Alignment with national objectives**

As noted at the beginning of this document, Computer Science is a fundamental discipline and

the innovations created by Ph.D. students and graduates in this field have fundamentally changed

modern society.

In addition, according to a recent Bureau of Labor Statistics report, the category “Computer and

information scientists, research” was one of the top 21 fastest growing occupations of the decade,

with a 40% increase in growth.

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.*

We believe that the ICS Ph.D. program has already produced research and graduates who have

supported this “acceleration”, and that its conversion from provisional to permanent status is well

warranted.

**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, person 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 use 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. 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 take our high-performance computing course, Biology students have taken our bioinformatics course, 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. program can be a major contributor to growing a diversified economy in Hawai‘i.

The career paths of our Ph.D. graduates is 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.

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. program provides students who are in high demand and a valued resource to other departments.

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