Review of Provisional Program of the Bachelor of Arts

Department of Information and Computer Sciences

University of Hawai‘i at Manoa

August 2011
Table of Contents

Assessment of program organization and objectives .................................................. 2
  Bioinformatics focus ........................................................................................................... 6
  Information Assurance and Computer Security focus .................................................. 6
  Distance Learning ............................................................................................................. 7
  Honors program .................................................................................................................. 7
  Undergraduate Student Mentoring and Advising .......................................................... 7

Assessment of student learning objectives ................................................................. 8
  Academic Assessment Activities .................................................................................... 8
  Student Course Assessment ............................................................................................ 9
  Direct Indicators of Learning ......................................................................................... 10
  Indirect Indicators of Learning ...................................................................................... 10

Assessment of program resources .............................................................................. 11
  Program Resources .......................................................................................................... 13
  Research Areas ................................................................................................................ 13
  Research Laboratories ..................................................................................................... 14
  Interaction with community groups ................................................................................. 15
  Student Support ............................................................................................................... 15
  Facilities and Equipment ................................................................................................. 16

Assessment of program efficiency ............................................................................ 16

Assessment of program quality ................................................................................... 19

Assessment of program outcomes ............................................................................. 22

Assessment of program objectives ............................................................................. 23
  State of Hawaii ............................................................................................................... 24
  International needs ......................................................................................................... 26
This self-study report is organized according to the “Guidelines for Assessment of Provisional and Established Programs” E5.201.

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.)

The curriculum for a BA in ICS degree was developed by the ICS faculty in response to numerous student and industry requests for a flexible undergraduate major that allowed students to develop expertise in both computer science and other subject areas. The faculty crafted a program that blends the requirements of a strong computer science core with the flexibility of a liberal arts education. Students earning the BA degree in ICS will be particularly attractive to technical businesses with needs for people with strong written and oral communication skills.

In fall 1998, ICS received provisional approval for the Bachelor of Arts (BA) degree. This degree option has allowed ICS students to combine computer science with other disciplines giving them an opportunity to explore any number of the new and challenging ways computers, networks and cell phones are impacting our society. Students with a computer science foundation have the opportunity to become key contributors to collaborative interdisciplinary teams and the flexibility to apply this background to areas beyond traditional computer science programs. The intent of the Bachelor of Arts degree is to allow computer science to be combined with another discipline. By making careful elective selections, students can target job opportunities in such diverse areas as business information systems, educational development environments, and multimedia entertainment systems. The BA program objectives are as follows:

Students will be able to:

- Use current technical concepts and practices in software development, computer networking, databases, and web related technologies,
- Manage all aspects of solving computer-based problems involving requirements analysis, design, implementation, and project management,
- Participate in collaborative team oriented activities,
- Communicate effectively using modem technologies, using oral, written, and web media.

Although the BA students take many of the same ICS courses that are required for a BS degree, the BA program allows more electives. Figure 1 shows the overall structure of the ICS curriculum requirements.
Figure 1. ICS Curriculum Structure and ICS Course Descriptions

ICS 111 Introduction to Computer Science I (4) Overview of computer science, writing programs.
ICS 141 Discrete Mathematics for Computer Science I (3) Logic, sets, functions, matrices, algorithmic concepts, mathematical reasoning, recursion, counting techniques, probability theory.
ICS 211 Introduction to Computer Science II (3) Algorithms and their complexity, introduction to software engineering, data structures, searching and sorting algorithms, numerical errors.
ICS 212 Program Structure (3) Program organization paradigms, programming environments, implementation of a module from specifications, the C and C++ programming languages.
ICS 215 Introduction to Scripting (3) Introduction to scripting languages for the integration of applications and systems. Scripting in operating systems, web pages, server-side application integration, regular expressions, event handling, input validation, selection, repetition, parameter passing, Perl, JavaScript, and PHP.
ICS 241 Discrete Mathematics for Computer Science II (3) Program correctness, recurrence relations and their solutions, divide and conquer relations, relations and their properties, graph theory, trees and their applications, Boolean algebra, introduction to formal languages and automata theory.
ICS 290 Computer Science Careers: An Exploration of the Specialties of Computer Science (1) Exploration of the specialties of computer science.
ICS 311 Algorithms (3) Design and correctness of algorithms, including divide-and-conquer, greedy and dynamic programming methods. Complexity analyses using recurrence relations, probabilistic methods, and NP-completeness. Applications to order statistics, disjoint sets, B-trees and balanced trees, graphs, network flows, and string matching.
ICS 312 Machine-Level and Systems Programming (3) Machine organization, machine instructions, addressing modes, assembler language, subroutine linkage, linking to higher-level languages, interface to operating systems, introduction to assemblers, loaders and compilers.
ICS 313 Programming Language Theory (3) Syntax, semantics, control structures, variable binding and scopes, data and control abstractions. Programming in functional (LISP) and logic (Prolog) programming styles.
ICS 314 Software Engineering I (3) System specification, modeling and analysis, prototyping, hierarchal design, program design methods, cost estimation, project management, computer-aided software design. Team-oriented software-design project.
ICS 315 Web Design and Management (3) Web design principles, XML and HTML, tables, forms, and frames, multimedia objects, security, scripting for web applications, web servers, commercial aspects, new technology.
ICS 321 Data Storage and Retrieval (3) Data storage devices, timing and capacity, programming for files, hashed and indexed files, introduction to relational database systems.
ICS 331 Logic Design and Microprocessors (4) (1 3-hr Lab) Basic machine architecture, microprocessors, bus organization, circuit elements, logic circuit analysis and design, microcomputer system design.
ICS 332 Operating Systems (3) Operating system concepts and structure, processes and threads, CPU scheduling, memory management, scheduling, file systems, inter-process communication, virtualization, popular operating systems.

ICS 351 Network Design and Management (3) Overview of the internet and its capabilities; introduction to HTTP, TCP/IP, ethernet, and wireless 802.11; routers, switches, and NAT; network and wireless security; practical experience in designing and implementing networks.

ICS 361 Introduction to Artificial Programming (3) Introduction to the theory of Artificial Intelligence and the practical application of AI techniques in Functional (Common LISP and/or Scheme) and Logic (Prolog) programming languages. Students gain practical experience through programming assignments and projects.

ICS 390 Computing Ethics for Lab Assistants (3) A lecture/discussion/internship on ethical issues and instructional techniques for students assisting a laboratory section of ICS 101. The class uses multiple significant writing and oral presentation activities to help students learn course content.

ICS 414 Software Engineering II (3) Continuation of 413. Project management, quality, and productivity control, testing and validation, team management. Team-oriented software-implementation project. Pre: 413.

ICS 415 Introduction to Programming for the Web (3) Introduction to emerging technologies for construction of World Wide Web (WWW)-based software. Covers programming and scripting languages used for the creation of WWW sites and client-server programming. Students will complete a medium-sized software project that uses languages and concepts discussed in class.

ICS 419 The Science, Psychology and Philosophy of Systems Design (3) Scientific, psychological and philosophical bases of systems design, including a survey of human-factors and ergonomic standards; the nature of innovation and creativity as it relates to systems design. Web-enhanced course.

ICS 421 Database Systems (3) Principles of database systems, data modeling, relational models, database design, query languages, query optimization, concurrency control data security.

ICS 423 Computer Security (3) Legal, ethical and technology issues in computer access, confidentiality, authentication, privacy and intellectual property.

ICS 424 Application Frameworks (3) Experience producing applications with at least two different applications frameworks. A-F only.


ICS 426 Computer System Security (3) Information flow, confinement, information assurance, malicious programs, vulnerability analysis, network security, writing secure programs.

ICS 431 Computer Architecture (3) Memory management, control flow, interrupt mechanisms, multiprocessor systems, special-purpose devices.


ICS 441 Theory of Computation (3) Grammars, sequential machines, equivalence, minimalization, analysis and synthesis, regular expressions, computability, unsolvability, Gödel’s theorem, Turing machines.

ICS 451 Data Networks (3) Network analysis, architecture, digital signal analysis and design; circuit switching, packet switching, packet broadcasting; protocols and standards; local area networks; satellite networks; ALOHA channels; examples.

ICS 452 Software Design for Robotics (3) Sensors, actuators, signal processing, paradigms of robotic software design, introduction to machine learning, introduction to computer vision, and robot-to-human interaction. A-F only. Pre: two ICS 300-level courses or consent.

ICS 461 Artificial Intelligence (3) Survey of artificial intelligence: natural language processing, vision and robotics, expert systems. Emphasis on fundamental concepts: search, planning, and problem solving, logic, knowledge representation.

ICS 464 Human Computer Interaction I (3) Application of concepts and methodologies of human factors, psychology and software engineering to address ergonomic, cognitive, and social factors in the design and evaluation of human-computer systems.

ICS 465 Introduction to Hypermedia (3) Basic issues of interactive access to information in various formats on computers. Available hardware and software: editing, integration, programming. Implementation of a sample information system.

ICS 466 Design for Mobile Devices (3) Lecture introducing design issues, programming languages, operating systems and mark-up languages for internet-enabled mobile devices, such as cell phones and PDAs.

ICS 469 Cognitive Science (3) Introduces basic concepts, central problems, and methods from cognitive science. Identifies contributions from disciplines such as cognitive psychology, linguistics, artificial intelligence, philosophy, and neuroscience.

ICS 475 Introduction to Bioinformatics Sequences and Genomes Analysis (3) Introduction to bioinformatics to computer sciences students by focusing on how computer sciences techniques can be used for the storage, analysis, prediction and simulation of biological sequences (DNA, RNA and proteins).

ICS 476 Bioinformatics Algorithms and Tool Development (3) Study of commonly used bioinformatic algorithms, with an emphasis on string, tree, and graph algorithms. Presentation of probabilistic and clustering methods. Implementation of the studied algorithms and design of applications.

ICS 481 Introduction to Computer Graphics (3) Fundamentals of computer graphics including graphics hardware, representation, manipulation, and display of two- and three-dimensional objects, use of commercial software.

ICS 483 Computer Vision (3) Introductory course in computer vision. Topics include image formation, image processing and filtering, edge detection, texture analysis and synthesis, binocular stereo, segmentation, tracking, object recognition and applications.
Since 2002, we have increased the number of advanced undergraduate level offerings with the BA degree in mind. However, these courses have proved to be popular with all of our students. ICS students seeking a BA in ICS have an opportunity to plan individualized tracks. They can currently choose from courses in areas such as Bioinformatics, Human Computer-Interaction, Information Architecture, Information Technology, Information Assurance, and Medical Informatics. Students must complete the Bachelor of Arts General Education Core, which is described in the General and Graduate Information Catalog, and an advising sheet available from the College of Arts and Sciences Student Academic Services office. For the major, BA students must complete:

- Required courses: ICS 111/L, 141, 211, 212, 241, 311, 312, 313, 321
- Junior/senior electives: three ICS (or approved) 400-level courses, including at most three credits of ICS 499 and three credits of ICS 491.
- Area concentration electives: four upper division (300-level or above) courses in some area of concentration (e.g., art, business, music, education).

Students seeking a BA must write a proposal, of one page or less, specifying the seven courses they will use for their ICS and area concentration electives. All seven electives and this course proposal need to be approved by an ICS undergraduate advisor. The proposal should explain how these courses form a coherent plan of study combining computer science with another field. Some examples of reasonable proposals are:

Bioinformatics focus

Students seeking the BA in ICS with a Bioinformatics focus must have an appropriate bioscience degree or also earn a minor in Biology and they must complete the following courses:

- **BA in ICS**
  - ICS 111, 141, 211, 212, 241, 311, 312, 313 and 321
  - 3 (300-level or above) courses from the minor will double count (BIOL 375, BIOL 4xx, and the course in botany. Biochemistry microbiology, physiology and zoology).
  - 4 ICS (300-level or above), with the three courses below required for the Bioinformatics focus:
    - ICS 475 (Bioinformatics: Introduction)
    - ICS 476 (Bioinformatics: Advanced)
    - ICS 499 (project) in a Bioinformatics related subject. This is an internship that can be done in a university research lab, a government agency or a private company.

- **Minor in Biology**
  - BIOL 172 (Introduction to biology II) , 265 (Ecology and evolutionary biology), 275(Cell and molecular biology) and 375 (Concepts of genetics)
  - Min 3 credits in: BIOL 401 (molecular biotechnology), 402(Principles of biochemistry), 405(Biochemistry), 406/406L (Cellular biology), 407/407L(Molecular biology), 409(Biology seminar), 441 (Basic biochemistry), 499 (Biological problem).
  - For these courses you need at least (BIOL 171 (Introductory biology), CHEM161(General chemistry I), 162(General chemistry II), 272, (Organic chemistry I), and 273(Organic chemistry II) if you take BIOL 402, 405, 406, 407 or 441.
  - Min 3 credits: approved upper level botany, biochemistry, microbiology, physiology and zoology.

Information Assurance and Computer Security focus

We developed a focus area in Information Assurance and Computer Security by collaborating with the Center for Information Assurance and Cybersecurity (CIAC) at the University of Washington. In June 2006, ICS teamed with the CIAC to develop a curriculum in the field of Information Assurance. The director of the CIAC has taught a series of information assurance classes across the academic year which includes: ICS425 Computer Security and Ethics, ICS426 Computer System Security and ICS491 Special Topics in Secure Development. Students who successfully complete this series earn a certificate from CIAC, a NSA/DHS Center of Academic Excellence in Information Assurance Education and Research. To date we have graduated over 75 students who have earned this credential. Additionally, we have created a student group that provides students interested in the field of Information Assurance and Cybersecurity an
opportunity to prepare for regional and national collegiate cyberdefense competitions. In its first year, UHM students placed first in a virtual regional competition that included such other institutions like the University of Alaska Fairbanks and several colleges on the islands. Part of the student group’s mission is to reach out to local high schools that want to participate in similar exercises. This has been enthusiastically embraced by our students and gives them a chance to share their newly acquired expertise.

Distance Learning

The Department of ICS is committed to expanding access to the University through distance learning. We have focused on Asynchronous Learning Network (ALN) media for learning. Asynchronous classes have no class meetings. Students learn the material "anytime, anywhere" by reading books, handouts, or Web pages and interacting with other students and the instructor via electronic media. Employing ALN enables us to provide educational offerings for the non-traditional student, the working professional and populations such as the military and neighbor island business people who cannot attend campus-based classes, whether due to scheduling conflicts such as job or childcare responsibilities, or because they are residents of neighbor islands or living outside of Hawai‘i.

In 1998, the Department received WASC approval for distance delivery of its bachelor and master programs. In 1999, while collaborating with the Outreach College, we secured a $405,000 grant from the Alfred P. Sloan Foundation to support this initiative. The UH Manoa Outreach College has marketed our online BA degree to students looking for non-traditional methods for completing their computer science degrees. The department is meeting our commitment to offer courses online by expanded ALN and hybrid course offerings each semester. Since the Department began offering online classes, we have steadily increased the number of students enrolling in ALN courses each academic year.

Honors program

ICS has participated in the honors program by offering our lower division courses as special classes for honors students. The Honors Program has distributed the courses and seats to the Selected Studies students in ICS 101, 111, and 211.

Undergraduate Student Mentoring and Advising

In 1998 ICS hired an Educational Specialist to assist in all areas of student services, including recruitment, retention, placement, and outreach services. This consolidated the Department's record keeping system for all undergraduate students and helped to manage basic intake services. Hence, the role of faculty advising in our department has moved from bookkeeping activities to mentoring and project supervision activities. In 2005, we hired a replacement Educational Specialist with a master’s degree from ICS who was particularly well qualified to mentor ICS students. Because of previous experience advising UH-Manoa students, the specialist’s advice is useful for ICS students who are
seeking a BA degree. Students interested in ICS are first referred to the Educational Specialist who provides consistent advising as serves as the departments’ contact with the Arts and Sciences Advising office. Students are immediately counseled on the differences between the BA degree in Information and Computer Sciences and the BS degree in Computer Science in order to plan a degree program that meets their career goals. Through these meetings we found that some students need additional advising and are counseled appropriately.

We began a program of mandatory student advising in 2009 for students who were: 1) entering UH Manoa for the first time; 2) transferring into the program from another college or university, or 3) changing their major to a bachelor’s degree to either the BS in Computer Science or the BA in Information and Computer Science. Advising is implemented through individual appointments and several hundred individual advising sessions have been conducted since January 1, 2009 to the present. We plan to continue conducting individual advising appointments and also conduct group sessions with individual follow-up advising.

Assessment of student learning objectives

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.)

Academic Assessment Activities

The curriculum of the ICS Department follows the standards set by the Association of Computing Machinery (ACM). ACM prepares recommendations for the curriculum of benchmark institutions for computer science. In the decades since the 1960s, ACM has endeavored to tailor curriculum recommendations to the rapidly changing landscape of computer technology (see http://www.acm.org/education/curricula-recommendations). We also use ABET program outcomes which, when appropriate, are used in course syllabi as program objectives. Currently, ABET accredits over 3,100 programs at more than 600 colleges and universities worldwide. Each year, over 2,000 volunteers from 29 member societies contribute to ABET's goals of leadership and quality assurance in applied science, computing, engineering, and technology education, serving as program evaluators, committee and council members, commissioners, and Board representatives. Table 1 shows the ABET accreditation outcomes.
Table 1. ABET Program Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An ability to apply knowledge of computing and mathematics appropriate to the discipline</td>
</tr>
<tr>
<td>2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.</td>
</tr>
<tr>
<td>3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs</td>
</tr>
<tr>
<td>4. An ability to function effectively on teams to accomplish a common goal manner.</td>
</tr>
<tr>
<td>5. An understanding of professional, ethical, legal, security and social issues and responsibilities</td>
</tr>
<tr>
<td>6. An ability to communicate effectively with a range of audiences.</td>
</tr>
<tr>
<td>7. An ability to analyze the local and global impact of computing on individuals, organizations, and society</td>
</tr>
<tr>
<td>8. Recognition of the need for and an ability to engage in continuing professional development</td>
</tr>
<tr>
<td>9. An ability to use current techniques, skills, and tools necessary for computing practice.</td>
</tr>
</tbody>
</table>

Student Course Assessment

The department uses both formative and summative evaluations for their courses. Faculty are regularly evaluated by the students. They have the choice of using the CAFÉ system or the ICS evaluation Forms. ICS was one of the first departments to encourage the use of the on-line evaluation system for both types of evaluations. Because so much of ICS students work is done on-line, we have experienced a high response rate. ICS faculty members prefer to use the on-line evaluation option because of its flexibility and the timely delivery of the results. However, faculty members have the option of using paper versions of the evaluation questionnaires.

Within the ICS department, the ICS Curriculum Committee considers all academic recommendations in modifying existing courses and introducing new curricula. Similarly, the Infrastructure Committee recommends infrastructure expenditures based in part on assessment results. Throughout the year, the standing committees (curriculum and infrastructure) of the ICS Department meet monthly to examine the department the relationship of our assessment plan to the program outcomes. The assessment results are discussed with the faculty at its monthly department meeting. At the end of each semester, the department has a planning retreat where we review the committee recommendations.
Direct Indicators of Learning

Capstone Course Evaluation: The ICS Department offers a series of senior-level software engineering courses (ICS 413 and 414) that are considered capstone experiences. In these courses, students are assigned to work on a software project with a team of their peers. A key objective of these courses is to instill in each student the ability to plan, design, implement, and test an original software project. Another objective is to expose students to nonacademic issues that arise when working in teams on substantial projects. This experience closely parallels the experience of a software engineer in the computer industry. Over the years recruiters both local and from the mainland have made positive remarks on the value of these courses.

Course-Embedded Assessment: ICS 499 is a senior-level computer project course. In this course, students propose an original programming exercise to meet their project goals to a faculty mentor. The student is expected to completely document the process of the project, including end-user meetings and training sessions. A final oral presentation of the whole project usually suffices for the final exam.

Tests and Examinations: The ICS Faculty met to discuss the use of standardized tests to measure the student-outcomes objectives of the program. The only test available that reflects measurements in computer science is the GRE Subject Area Test in Computer Science. The faculty felt that this specific test over emphasizes hardware design, does not test for competencies in software engineering, and therefore does not act as a reliable measure of mastery of our curriculum.

Indirect Indicators of Learning

Student Surveying and Exit Interviewing: Student surveys created by our faculty regarding preparedness for professions in technology industries have provided the department with indicators of student learning. The results have been used to modify curriculum and provide feedback to the overall success of the program to prepare students for their careers.

Curriculum and Syllabus Analysis: The department curriculum committee is in the process of reviewing the curriculum and assuring the role of each course toward meeting the student outcome objectives of the department. We are anticipating the release of a new curriculum standard by the ACM and plan to modify the curriculum to meet these standards.

As part of the effort to monitor the educational quality of our program we began conduction a special skills assessment activity in the fall of 2001. The results of our initial activity are presented in Attachment A. The assessment results are fed back to the standing committees (curriculum and infrastructure) of the ICS Department. The
Curriculum Committee considers all academic recommendations in modifying existing courses and introducing new curricula. Similarly, the Infrastructure Committee recommends infrastructure expenditures such as buying equipment based in part on assessment results.

Assessment of program resources

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

This section of the report describes the current resources for the department including staffing levels, funding, and facilities.

The ICS department offers the following degrees: BA in ICS, BS in CS, MS in ICS, 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.

Table 2 shows an overview of the faculty in the unit. Currently the ICS program has 4 full professors, 9.5 associate professors, 4.5 assistant professors, and 2 educational specialists in the tenure or tenure track category. The educational specialists provide 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. 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](http://goo.gl/igrRR)
Table 2. Faculty rank and areas of expertise

Profs
*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

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 specialist also researches software and other products in response to instructional and research needs and manages the purchasing and budget maintenance for the department. In 1998 we hired a Computer Specialist to manage our Computer Labs and networking environment. Later we hired assistant to the IT specialist to replace previous staff that left the department. They efficiently manage the department facilities with the help of student assistants.

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. He assists faculty with budgetary matters related to grant and contract proposals. He works with faculty and funding agencies (NSF, DARPA, etc.) to obtain the necessary application and reporting forms. He generates timely fiscal status reports to meet the needs of the college, department, accreditation bodies, and researchers. He works with clerical staff to insure prompt and accurate payment of obligations to vendors upon delivery of goods and services. In addition, we have a Secretary II who performs secretarial and administrative duties for the Department, including work relating to curriculum and instruction and personnel as well as services relating to the clerical and administrative needs of the faculty members of the Department.
Program Resources

In 2001, the Hawaii state legislature approved an appropriation of $1 million to supplement the ICS instructional budget, which we have received starting in AY 2002. Since the allocation has become part of our departmental resources, it has enabled us to: 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. Overall, 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 drop out 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. All in all, this has improved the student experience and increased the retention of students in the ICS program.

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

Research Areas

ICS Faculty members are actively engaged in research in the following area:

- Algorithms
- Artificial Intelligence and Robotics
- Biomedical Informatics and Bioinformatics
- Collaborative Systems
- Compilers
- Computational Neuroscience (Neuroinformatics)
Computer Vision  
Databases  
Human Computer Interaction  
Library and Information Science  
Machine Learning  
Mathematical Finance  
Mobile and Ubiquitous Computing  
Renewable Energy  
Security and Information Assurance  
Software Engineering  
Systems, Networking, and High-Performance Computing

Research Laboratories

- **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.
- **Hawaii's Computer-Human Interaction (H'I 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.
Interaction with community groups

- 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

Student Support

We must increase available scholarships, fellowships, and internships, and support for student activities, travel and research to ensure that all who are qualified and who wish to, have access to the finest information and computer science education.
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.

Assessment of program efficiency

4. Is the program efficient? (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.)

The required data in terms of program efficiency, the number of computer science majors and the number of student credit hours (SSH) from 2004-2010 can be found in Appendix 1. Line 26 (the net) of the academic program costs and revenue data sheet shows that the BA in ICS has made a profit every academic year (AY). The smallest amount earned was $710,185 in the 2005-2006 AY and the largest gain of $1,480,588 was made in the 2009-2010 AY. The number of computer science majors nationwide has been in decline since 2004.

Figure 2 shows that the trend began to reverse in 2007 and the number of BA majors has been steadily increasing with the greatest number enrolling in 2010.

Figure 3 shows data from lines 44 and 45 of the academic program costs and revenue data sheet. The total instructional costs with fringe per SSH for the BA in ICS ranged from 36 in the 2004-2005 AY to 92 in 2010-2011 AY. This compares with the College of Natural Sciences (NS) average of 316 in the 2004-2005 AY to 357 in 2010-2011 AY. The percentage of instructional cost of the ICS BA degree ranges from 11% to 25% of the NS college average.
Figure 2. Number of BA majors in ICS

Figure 3. Comparison of ICS BA to NS Instruction Costs per SSH
The number of students in the ICS BA program has grown from 31 in the Fall 1999 semester, to close to 78 in the Fall 2010 semester. The percent of ICS majors choosing the BA degree is steadily increasing and has more than doubled since the Fall 1999 semester. As shown in Figure 4, the proportion of BA undergraduates in ICS has increased from 6% to 33%.

Figure 4. Percent of Enrollment of ICS BA Students

Figure 5. Graduation rates of ICS BA Students
With the addition of the BA degree and the popularity of technology degrees, retention and graduation rates have steadily improved. The number of students to graduate with a BA degree has remained relatively constant with an average of 12 out of 56 graduates each fall semester. Figure 5 shows the percentage of BA graduates has changed from an initial 27% of the total ICS graduates in the Fall 1999 semester to 39.5% of the ICS graduates in the Fall2010 semester.

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…)

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. Efforts have been made to generate external funding as attested by a list of several Labs pursuing well-funded research leading to innovative software technologies; others receiving industrial support providing students with opportunities to work with state-of-the-art networking technologies or still others forging partnerships with the Department of Education and other local educational agencies.

Encouraged by the provisional approval of a BA in Information and Computer Sciences, the approval of a Minor in Computer Science and WASC approval for distance delivery of its bachelor and master programs, we have introduced major curricular changes and articulation agreements with UH-Hilo, Maui College and the Community Colleges for most of our 100 and 200 level courses.

There has been considerable discussion regarding the need to provide increased access to "information technology" (IT), "computer science", "programming" and other related general concepts. "The First Two" Project attempted to meet this need. Using funds from the state government we established a learning and support environment to directly impact the first two years of course work in ICS. This includes ICS 111 and 211 (Introduction to Computer Science I & II), ICS 212 (Program Structure), ICS 141 & 241 (Discrete Mathematics I & II), and ICS 311 (Data Structures & Algorithms). Although the changes in these foundational ICS courses are incremental, there is a long term effort to revamp the upper division undergraduate courses to reflect the latest changes in the Association for Computing Machinery (ACM) 2008 computer science curriculum. The ultimate goal is to provide an environment or cocoon of support for those students enrolled
in ICS 111, ICS 211, ICS 212, ICS 141, ICS 241, and ICS 311. These courses represent the basic concepts and skills that frame computer science and "informatics". They also provide opportunities for application of technology to other fields. The program will not differentiate between students in regular day, extended, summer, or ALN courses.

We have also been exploring different teaching methodologies that use active learning techniques. In 2007, we began testing how using a studio-based learning (SBL) methodology could improve learning outcomes in computer courses. This project was initially funded with a grant from NSF and was to addresses the dual challenge of retaining computer science students, and broadening access to computing education, by building a community of educators and researchers who will apply, and empirically validate, a novel studio-based instructional model in introductory computing education courses. Adopted from architectural education, this instructional model emphasizes learning activities in which students (a) construct personally-meaningful representations of the algorithms and programming concepts under study, and then (b) present those representations to their instructors and peers for feedback and discussion within the context of so-called “design crits.” This project brings together researchers and educators at the local and national levels in order to build a community committed to refining, adapting, applying, and studying studio-based approaches in computing education. We have sought input from a national audience, with the ultimate aim of planning a future project to implement the approach in computing education courses on a regional or national level. As a part of this initiative, from 2007 to the present, we employed SBL methodology in ICS 101, 110, 111, ICS 211, ICS 212, ICS 141, and ICS 311. We compared sections of these courses taught in the traditional format with courses taught using the SBL or studio format.

We have also teamed with George Washington University on Project PISCES (Partnership in Securing Cyberspace through Education and Service). This program provides opportunities for students with diverse backgrounds to become Computer Security and Information Assurance (CSIA) professionals and help protect the safety and security of our nation’s information infrastructure. It does this by combining scholarships, university courses in computer security and information assurance, internships, laboratories, and government service, and appropriate monitoring and evaluation for these students. A major new thrust of the project is to include students from the ICS department at the University of Hawaii at Manoa (UHM) to provide potential successful CSIA applicants.

Recently we have begun a series of initiatives to improve and award student quality. Table 3 shows some of our recent activities.
Table 3. Improving Student Quality

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Impacting:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICS Science Fair Awards - Five $200 awards for computer science project. One for the best project from each class level from 8th grade, freshman, sophomore, junior and senior. Status: On going from 2009.</td>
<td>Incoming, Undergrad &amp; Grad</td>
</tr>
<tr>
<td>Fred and Annie Chan Scholarship for incoming Freshmen. First, this requires organizing a publicity campaign to students, counselors and parents. Second, collection and organizations of applicants. Third, the assembly of a selection committee. Finally, the implementation and follow-up with the recipient. Status: On going from 2008.</td>
<td>Incoming</td>
</tr>
<tr>
<td>ICS Minor promotion – This is a promotion to recruit more undergraduates to minor in ICS requires the printing and disbursement of over 500 flyers on the ICS minor program. Status: Ongoing from 2007.</td>
<td>Incoming</td>
</tr>
<tr>
<td>ICS 290 - Computer Science Careers: An exploration of the specialties of computer science – Spring 2009. A class designed to provide students with information to help define and achieve their goals in computer science. Status: Ongoing from 2010.</td>
<td>Undergrad</td>
</tr>
<tr>
<td>W. Wesley and Hiromi Peterson Scholarship – To encourage research and scholarship among students. Status: Will start once funds become available.</td>
<td>Undergrad &amp; Grad</td>
</tr>
<tr>
<td>Bachelor’s packet, thanking graduates for selecting our department, informing of alumni services and requesting they send thank you notes to their high school mentors. The thank you notes increases awareness of the ICS program and will hopefully motivate more high school mentors to send their best students to our department. Status: Ongoing since 2008.</td>
<td>Incoming, Undergrad &amp; Grad</td>
</tr>
<tr>
<td>Promotion to encourage high end undergraduates to take a few graduate courses before graduating. This will provide high end students with transcript that stands out and confidence in their academic ability. This requires organizing a publicity campaign to students. Status: Ongoing since Fall 2009.</td>
<td>Undergrad</td>
</tr>
<tr>
<td>ICS Software Engineering Competition for undergraduate student where graduate student may mentor undergraduates. First, this requires coordinating with the faculty on the notification and incentive systems to increase student participation. Second, conducting the competition and awarding of the winners. Status: Competition held Fall 2009.</td>
<td>Undergrad &amp; Grad</td>
</tr>
<tr>
<td>Promoting the hiring of lower division CS students by commercial CS organizations as entry level help. This will provide students who cannot do CS work with the experience of working in a CS environment. Status: Started 2011.</td>
<td>Undergrad</td>
</tr>
<tr>
<td>Graduation and awards ceremony. Status: Spring 2011 graduates completed</td>
<td>Undergraduate &amp; Graduate</td>
</tr>
<tr>
<td>Short Skill Set Classes - Creating special non-credit classes to fill-out the specific skill sets requested by the local computer companies. Status: Organizing in progress – currently communicating with local companies.</td>
<td>Undergraduate &amp; Graduate</td>
</tr>
<tr>
<td>GRE Award – This award is to encourage high performing undergraduate computer science majors to prepare for graduate school. A full-time undergraduate ICS student who takes the Graduate Record Exam (GRE) and scores above the 80% percentile for two categories can apply for a $200 award. A student can only receive this award once. Status: Organizing in progress.</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Help promote the department of Information and Computer Sciences at the university open house, high school counselors meeting, and high school events. Since 2007.</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>ICS 40th Alumni Lunch with alumni, faculty and their best students. Status: Completed 2008</td>
<td>Undergrad &amp; Grad</td>
</tr>
</tbody>
</table>
Assessment of program outcomes

6. Are program outcomes compatible with the objectives?
(Analysis of number of majors, graduates, SSHs offered, service to non-majors, employment of graduates, etc., in relationship to objectives).

Successful Hawai’i-based entrepreneurial ventures provide evidence that the employment of graduates in relationship to objectives are being met. A large number of local and mainland companies that have recently recruited our graduates attest to the success of our academic programs and are shown in Table 4. Federal agencies like the FBI and CIA have also shown a strong interest in our majors.

<table>
<thead>
<tr>
<th>Company</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21st Century Systems</td>
<td>Software Engineer</td>
</tr>
<tr>
<td>aDiJasTechnology Consulting</td>
<td>President</td>
</tr>
<tr>
<td>ADTECH</td>
<td>Consultant</td>
</tr>
<tr>
<td>Aloha Island Inc.</td>
<td>Software Scientist</td>
</tr>
<tr>
<td>Amazon</td>
<td>IT Support Specialist</td>
</tr>
<tr>
<td>Arcadia</td>
<td>Software Scientist</td>
</tr>
<tr>
<td>Boeing</td>
<td>Applications Developer</td>
</tr>
<tr>
<td>Booze-Allen-Hamilton</td>
<td>Software Engineer</td>
</tr>
<tr>
<td>CampusDocs</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>Center on the Family /UHM</td>
<td>Software Development</td>
</tr>
<tr>
<td>DataHouse</td>
<td>Software Development</td>
</tr>
<tr>
<td>Decision Research Corporation</td>
<td>Applications Developer</td>
</tr>
<tr>
<td>Digital Mediums</td>
<td></td>
</tr>
<tr>
<td>eBase Solutions, Inc</td>
<td></td>
</tr>
<tr>
<td>Eckerd College</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>Electron Management Support &amp; Services</td>
<td></td>
</tr>
<tr>
<td>Guide.Net</td>
<td>Software Scientist</td>
</tr>
<tr>
<td>HECO</td>
<td>ITS Development Specialist</td>
</tr>
<tr>
<td>IBM</td>
<td>Software Scientist</td>
</tr>
<tr>
<td>IGN</td>
<td>Director</td>
</tr>
<tr>
<td>Institute of HPC</td>
<td>Principle Investigator</td>
</tr>
<tr>
<td>Kapiolani Community Colleg</td>
<td>IT Specialist PBA</td>
</tr>
<tr>
<td>Kofax</td>
<td>Senior software Engineer</td>
</tr>
<tr>
<td>Konami Entertainment</td>
<td></td>
</tr>
<tr>
<td>Lockheed Martin</td>
<td>System Engineer</td>
</tr>
<tr>
<td>Microsoft</td>
<td>Development Lead</td>
</tr>
<tr>
<td>Microsoft/Volt</td>
<td></td>
</tr>
<tr>
<td>Motorola</td>
<td>Build, Release Engineer</td>
</tr>
</tbody>
</table>
Table 4 Companies that have employed ICS graduates

These employers have written several testimonials verifying that our graduates meet our objectives: 1) Use current technical concepts and practices in software development, computer networking, databases, and web related technologies, 2) Manage all aspects of solving computer-based problems involving requirements analysis; design, implementation, and project management; 3) Participate in collaborative team oriented activities; and 4) Communicate effectively using modern technologies, using oral, written, and web media.

We offer 10-12 Sections of ICS101 each semester with 32 students in each section. As a service to non-majors, we have increased the number of seats allocated to first-year learning communities. ICS 101 is currently an admission requirement for the College of Business but it is taken by students in over 80 other majors.

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 following section addresses how the mission statements for the Department of Information and Computer Sciences support the larger missions...
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, Hawaii, 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.

The University of Hawaii System strategic plan\(^1\) approved by the board of regents in June 2002 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 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.

**State of Hawaii**

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.”\(^2\)

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

---

\(^1\) [http://www.hawaii.edu/ovppp/stratplan/UHstratplan.pdf](http://www.hawaii.edu/ovppp/stratplan/UHstratplan.pdf)

Workforce\textsuperscript{3} which states: “Computer Services accounted for the largest share of 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 department’s mission statement is well aligned with the State of Hawaii’s technology goals.

A “national needs factor”: In a recent Bureau of Labor Statistics report, the twenty-one fastest growing occupations for this decade were:

<table>
<thead>
<tr>
<th>Fastest Growing Jobs</th>
<th>Employment change</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Occupation</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>Number (thousands)Percent Increase</td>
<td>Most significant source of education or training</td>
</tr>
<tr>
<td>Computer software engineers, applications</td>
<td>380</td>
<td>100</td>
</tr>
<tr>
<td>Computer support specialists</td>
<td>490</td>
<td>97</td>
</tr>
<tr>
<td>Computer software engineers, systems software</td>
<td>284</td>
<td>90</td>
</tr>
<tr>
<td>Network and computer systems administrators</td>
<td>187</td>
<td>82</td>
</tr>
<tr>
<td>Network systems and data communications analysts</td>
<td>92</td>
<td>77</td>
</tr>
<tr>
<td>Desktop publishers</td>
<td>25</td>
<td>67</td>
</tr>
<tr>
<td>Database administrators</td>
<td>70</td>
<td>66</td>
</tr>
<tr>
<td>Personal and home care aides</td>
<td>258</td>
<td>62</td>
</tr>
<tr>
<td>Computer systems analysts</td>
<td>258</td>
<td>60</td>
</tr>
<tr>
<td>Medical assistants</td>
<td>187</td>
<td>57</td>
</tr>
<tr>
<td>Social and human service assistants</td>
<td>147</td>
<td>54</td>
</tr>
<tr>
<td>Physician assistants</td>
<td>31</td>
<td>53</td>
</tr>
<tr>
<td>Medical records and health information technicians</td>
<td>66</td>
<td>49</td>
</tr>
<tr>
<td>Computer and information systems managers</td>
<td>150</td>
<td>48</td>
</tr>
<tr>
<td>Home health aides</td>
<td>291</td>
<td>47</td>
</tr>
<tr>
<td>Physical therapist aides</td>
<td>17</td>
<td>46</td>
</tr>
<tr>
<td>Occupational therapist aides</td>
<td>4</td>
<td>45</td>
</tr>
<tr>
<td>Physical therapist assistants</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>Audiologists</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td>Fitness trainers and aerobics instructors</td>
<td>64</td>
<td>40</td>
</tr>
<tr>
<td>Computer and information scientists, research</td>
<td>11</td>
<td>40</td>
</tr>
</tbody>
</table>


Our degree programs directly address the highlighted occupations. Focusing on just these occupations, the Bureau is projecting an increase of more than 50% that would result in over 1.4 million new positions.

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.

Recently there has been a downturn in the job market because of the “dot-bomb” crash of internet companies. An article in USA Today (available at: http://www.usatoday.com/tech/news/2002-10-08-computer-science-majors_x.htm) states: “Computer science graduates are likely to be plentiful for several years, as current students finish degrees. Problems could arise when this freshman class graduates.” Providing a counterview, Verna Schuetz of Virginia Tech’s computer science department predicts that, "in four or five years, we'll see a shortage." The Department concurs with Schuetz that there will be a continued long term national need for our graduates even though there is a current decline in job opportunities.

**International needs**

The globalization of society makes this need the same as that for the national needs. The central role of information technology in almost all aspects of higher education is expected to increase dramatically for the foreseeable future. Areas such as bioinformatics, medical informatics, business informatics, and educational informatics argue for the increasing need for our interdisciplinary BA program.