STRATEGIC PLAN

August 2003

Department of Computer Sciences

MISSION

The mission of the department is to advance the frontiers of computer science, to expand the pool of qualified individuals working in the discipline, and to reach out both within and beyond the university to apply computational principles to technical and societal problems. To accomplish this mission, the department seeks to:

- Perform basic and applied research that advances our knowledge about computation and its applications. The department's research focuses on existing areas of recognized strength as well as on new, emerging areas.
- Educate diverse, talented individuals in the principles, tools, and methodologies of computer science and in the scientific and social context of computing. A comprehensive educational experience exposes students to cutting edge technology and research experience.
- Apply methodologies and principles of computing to challenges in other disciplines and support multidisciplinary efforts.
- Establish viable corporate and external partnerships to help identify problems and solutions and facilitate transfer of knowledge.

VISION

The faculty will be preeminent in creating and disseminating new knowledge on computing and communication. The department will prepare students to be leaders in computer science and its applications. Multidisciplinary activities that strengthen the impact of computation in other disciplines will play an essential role. The department will be known for:

- Faculty who are recognized worldwide as leaders. They will set and implement the national agenda for discovery and education in computer science.
- A superior and diverse student body learning the values, vision, knowledge, and skills of computer science.
- Graduates who go on to be faculty at highly ranked departments, researchers at internationally recognized labs, and leaders and innovators in industry and government.
- Involvement and leadership in university institutes and centers that foster multidisciplinary research.
- Collaboration with public and private enterprises in Indiana, the nation, and the world.

DISCOVERY

Develop an excellent academic environment that allows faculty to achieve and sustain preeminence in computer science. The department will be recognized for:

- A diverse faculty of the highest quality and sufficient size to support its missions.
- Preeminence in the determined core areas.
- Support for emerging research areas having potential for establishing national preeminence.
- Significant multidisciplinary collaborations.
- Excellent graduate program with an emphasis on doctoral students.
- Effective student-faculty interactions, including student involvement in research and multidisciplinary activities.
- A cohesive and collegial atmosphere where faculty and students see the breadth and depth of computing research activities.
- Computing facilities, space, and administrative staff supporting a preeminent research environment.

The department will pursue the implementation of strategies associated with the goals below.

Goal 1

Retain faculty who have achieved national distinction.

Strategies

1. Foster a collegial and cohesive atmosphere through openness in the departmental decision-making process.
2. Keep compensation competitive compared to peer institutions.
3. Use merit-based reward system which recognizes and balances excellence in research, teaching, and service.
4. Pursue funding for endowed chairs/distinguished professorships.
5. Provide excellent space for faculty, their students, and funded research projects.
6. Implement a merit-based reallocation of resources that allows a fast response to changing needs.
7. Consolidate all office and research space into one building.
8. Implement a flexible mentoring system to guide junior faculty.
9. Recognize research-active faculty through competitive teaching assignments responsive to research interests.
10. Provide highly qualified coordinators of instruction to core courses with high enrollment.

Metrics

1. Number faculty leaving the department.
2. Number of endowed chairs and distinguished professorships.
3. Faculty awards.
4. Amount of space for research labs in each core and growth area.
5. Number of RAs and post docs in each core and growth areas.
6. Number of faculty hired.
7. Faculty-student ratio, teaching loads and class sizes compared to peer institutions.
8. Total number of undergraduate and graduateTAs and number of enrolled students per TA.
9. Diversity of faculty.
10. Compare above metrics to peer institutions, including data reported in the CRA Taulbee survey and the CIC survey.
11. Number of faculty involved in programs with international emphases.
12. Amount of media recognition for departmental activities.

Goal 2

Recruit diverse, high-quality faculty.

Strategies

1. Actively pursue high-quality hiring opportunities in core and growth areas.
2. Identify areas in need of additional senior leadership and actively seek out candidates.
3. Promote the department among highly ranked departments to raise awareness of the department among fresh Ph.D.'s at these institutions.
4. Have representation and make recruiting contacts at professional meetings tailored towards diversity (e.g., Grace Hopper conference, CRA and ACM sponsored meetings).
5. Add diversity to the metric used in evaluating qualified applicants invited for an interview.
6. Actively identify and personally contact high quality, finishing Ph.D. students.
7. Continuously evaluate and monitor guidelines and procedures ensuring well-organized recruiting visits.
8. Make competitive offers.
9. Give preferred teaching responsibilities and reduced committee assignments to new hires, in particular non-tenured hires.

Metrics

1. Faculty salaries by rank. Compare to peer institutions.
2. Size of startup packages by rank. Compare to peer institutions.
3. Number and percentage of hires increasing diversity.
4. Resources targeted for recruitment for faculty in core and growth areas, and for dual-career couples.
5. Number of new hires recruited from top 20 departments.
6. Number of diversity workshop participants.
7. Retention rate of hires increasing diversity.

Goal 3

Continuously evaluate existing research core areas and growth areas.

Strategies

1. Encourage faculty to attend meetings of professional societies focusing on new strategic directions in the field.
2. Encourage faculty participation in workshops organized by funding agencies to identify emerging areas.
3. Provide seed funding and release time for exploratory research in emerging areas.
4. Include evaluation of core and growth areas and hiring priorities in yearly faculty retreat.
5. Support seminar courses in new areas to build student interest.
6. Seek input and feedback from external sources, including an external academic advisory panel and the department's corporate partners.

Metrics

1. Number of graduates in the past ten years who have taken tenure-track positions at Ph.D. granting institutions or are research active for each core area.
2. Number of citations (using nationally known citation database) for each core and growth area.
3. Number of editorships of respected scholarly journals for each core area.
4. Number of core and focus areas ranked in the top 10 nationally.
5. Ranking of each core and focus area by external advisory committee.
6. Number of new hires in core and focus areas.
7. Number of faculty in each core and focus area.
8. Number of graduate students involved in each core and focus area.
9. Number of publications associated with work in each core and focus area.
10. Level of external funding in each core and focus area.
11. National ranking (e.g., US News).

Goal 4

Support and encourage faculty in pursuing funding opportunities.

Strategies

1. Alert faculty to funding opportunities and facilitate connections to researchers in other departments.
2. Provide faculty with an efficient and effective business office.
3. Number of editorships of respected scholarly journals for each core area.
4. Provide cost sharing within departmental budget limits.
5. Recognize leadership in group proposals through reduced committee assignments.
6. Provide funding oriented mentoring to junior faculty.
7. Seek external and internal funding to assist renovation of existing research space.

Metrics

1. Total external funding, with separate breakdowns for government and non-governmental sources.
2. Funding per FTE faculty member.
3. Total amount of cost sharing broken down by department, school, and university.
4. Number of faculty who have taken a leave to serve as program managers at Federal agencies.
5. Amount of new or renovated space and resources allocated per year.
6. Number of equipment proposals and grants, and associated funding levels.

Goal 5

Develop and support multidisciplinary activities and centers.

Strategies

1. Provide departmental support for research efforts in multidisciplinary areas, including bioinformatics, nanotechnology, computational science, and critical infrastructure protection.
2. Encourage faculty activities that strengthen and enhance university–wide efforts, including the Computing Research Institute, e-Enterprise, Bindley Bioscience Center, and Birck Nanotechnology Center.
3. Support activities and programs initiated by CERIAS.
4. Target open faculty positions to multidisciplinary hires having joint appointments with other departments.
5. Implement a policy for awarding courtesy appointments.
6. Support the introduction of multidisciplinary courses.
7. Offer incentive resources, including graduate student support, for emerging multidisciplinary fields.

Metrics

1. Number of faculty and students working in multidisciplinary areas, number of multidisciplinary centers or institutes, and number of projects with participants from CS.
2. Number of joint faculty appointments.
3. Number of CS faculty holding a courtesy appointment in another department.
4. Number of faculty having a courtesy appointment in CS.
5. Number of students from other departments enrolled in CS courses.
6. Number of multidisciplinary graduate degree programs requiring a computer science course.
7. Number of graduate student fellowships targeted for multidisciplinary work.

Goal 6

Effective recruiting, retaining, and timely graduation of diverse, high-quality graduate students with a focus on training Ph.D. students.

Strategies

1. Ensure that the graduate admissions committee processes applications in an efficient manner.

2. Actively involve faculty in making contact with admitted students.
3. Continue and expand Graduate Student Visiting Day (for example, combine it local workshops and an external seminar series).
4. Follow progress of students, especially first-year students, closely and implement an assimilation program and review process.
5. Monitor the effectiveness of the Ph.D. qualifying system and the average time it takes students to become engaged in research.
6. Encourage female and minority students to participate in existing mentoring programs (e.g., WISP) and monitor the effectiveness of these programs.
7. Use the Graduate Student Board to increase involvement of graduate students in departmental decisions and to enhance faculty-student interactions.

Metrics

1. Number of incoming graduate students from top-40 institutions accepting admission.
2. Number of graduate students holding fellowships.
3. Graduate student stipends compared to peer institutions.
4. Diversity of graduate student population.
5. Number of US citizens and permanent residents.
6. Number of students supported as RAs.
7. Size of graduate program.
8. Graduation and retention rates.
9. Graduate student time to degree.
10. Number Ph.D. graduates who go on to be faculty at top-40 departments of Computer Science and researchers at internationally recognized labs.
11. Program rankings—see metrics for Goals 1 and 2.
12. Total number of graduate students and number of Ph.D. degrees granted by area compared to peers.
13. Level of support for student conference attendance.
14. Number of local workshops.

Goal 7

A responsive, highly-qualified facilities, academic, professional, and clerical staff, to effectively assist faculty.

Strategies

1. Recruit highly qualified staff.
2. Provide a collegial and cohesive environment.
3. Provide opportunities of advancement and continued training.
4. Ensure competitive compensation to retain high-quality staff.

Metrics

1. Number of research and professional staff, retention and compensation rates.
2. Size of staff; ratio of staff to faculty, graduate program, and undergraduate majors.
3. Survey faculty and staff needs and satisfaction with all aspects of facilities.
4. Quality of staff as indicated by qualifications, training, and faculty satisfaction.
5. Number of training and growth. opportunities available to staff
6. Retention and turnover rates.

7. Salaries for academic, professional, and clerical staff according to job category.
8. Staff awards.
9. Diversity of staff.

LEARNING

Develop and maintain an academic environment that provides superior educational opportunities for computer science students. The department's academic programs will continue to be characterized by:

- An outstanding undergraduate curriculum.
- High quality students from diverse backgrounds.
- A supportive academic environment that fosters lifelong enthusiasm for learning, creativity, leadership, and varied career paths.
- Innovative uses of state-of-the-art information technology in the curriculum enriching individual learning and promoting collaboration among students in group projects.
- Involvement of undergraduates in cutting-edge research opportunities.
- A faculty and staff striving for excellence in teaching.

The department will pursue the implementation of strategies associated with the goals below.

Goal 8

Offer an outstanding curriculum in which students learn the fundamental principles and methodologies, as well as state-of the-art tools and technologies.

Strategies

1. Regularly evaluate existing courses and the entire curriculum using input from faculty, students, instructors, academic advisors, graduates, and corporate partners.
2. Continuously evaluate the undergraduate curriculum in light of available resources and emerging technologies.
3. Limit class sizes to ensure quality education.
4. Maintain course portfolios to help assure consistency among different course offerings.
5. Provide effective laboratory sessions in courses where lab experience ensures quality education.
6. Implement a coordinated departmental effort facilitating research experiences for undergraduates.
7. Achieve an undergraduate student to faculty ratio allowing research opportunities for all interested and qualified students.
8. Expose students to multidisciplinary activities as part of their free electives.

9. Implement a departmental mechanism to ensure students learn course objectives.
10. Develop firm departmental policy on dealing with academic dishonesty and plagiarism in classes.
11. Identity programs for faculty, instructors, and graduate teaching assistants to improve their teaching and pedagogical skills, including classroom climate and diversity workshops.
12. Encourage and reward faculty, instructors, and graduate teaching assistants for achieving excellence as educators.
13. Provide faculty incentives for instructional lab development.
14. Promote and develop opportunities for service learning and community service activities with value to computer science study.
15. Support the exploration and development of new approaches to education in computer science made possible by advances in information technology. Provide campus leadership in this area.

Metrics

1. Student and alumni surveys.
2. Faculty and peer assessments.
3. Survey satisfaction with curriculum among employers.
4. Student/faculty ratios in courses for majors and non-majors, and faculty teaching responsibilities compared to peers.
5. Undergraduate class size.
6. Number of courses and programs developed and offered.
7. Percentage of undergraduates involved in undergraduate research and number of faculty supervising undergraduate research.
8. Number of grants awarded with a focus on course and curriculum development.
9. Number of faculty receiving teaching awards available at Purdue and through professional societies.
10. Number of summer undergraduate research programs involving faculty.
11. Number of projects and resources allocated to development of state-of-the-art instructional labs.
12. Number of students participating in service learning and community service activities.
13. Number of students reached through new approaches in computer science education.
14. Number of courses affected by new approaches in computer science education.
15. Departmental internal and external review committee evaluations.
16. Resources for service courses.
17. Student credit hours per FTE faculty.
18. Departmental academic catalog and policies manual online.
19. Include scientific communication and ethics in curriculum.
20. Number of state-of-the-art instructional labs.
21. Funding support for undergraduate research.

Goal 9

Maintain admissions standards and ensure an academically proficient and diverse student body.

Strategies

1. Maintain a selective admission.
2. Increase women and minority enrollment in the program by actively reaching out to female and minority students through recruiting programs (e.g., WiCS, CSWN).
3. Actively participate in school-wide diversity programs.
4. Increase fellowship and scholarship opportunities.
5. Continuously re-evaluate criteria used for admission.

Metrics

1. Admissions requirements.
2. Student quality indicators. For undergraduates: SAT (incoming) GRE, and MCAT scores. For graduate students: GRE scores.
3. Percentage of women and minority students.
4. Scholarship and fellowship resources. Number of students with scholarship or fellowship support.
5. Number of National Merit Scholars.
6. Number of targeted/eligible minority students who enter CS.
7. Scholarships and other resources for diversity initiatives.
8. Review orientation programs every year.
9. Number of students with scholarship or fellowship support compared to peers.

Goal 10

Increase retention while maintaining quality.

Strategies

1. Continue to develop mentoring programs and retention strategies tailored specifically towards the challenges experienced by first-year students.
2. Provide mentoring programs addressing the needs and challenges faced by female and minority students (e.g., less confidence in skills, less programming experience).
3. Continue to provide exemplary academic advising to all undergraduates.
4. Teach introductory courses in a manner that does not favor students with previous programming experience.
5. Encourage and support student organizations and improve integration of their activities (particularly feedback) into departmental life.
6. Strengthen and enhance interaction and communication channels among students, faculty, staff, and academic advisors.
7. Promote programs, such as Study Abroad and multidisciplinary minors, with international emphases.

Metrics

1. Retention rates for undergraduates and graduate students compared to peer institutions.
2. Ratio of freshman to later year retention.
3. Retention rate for women and minority students.
4. Number of available programs to improve retention, including surveys of students, faculty, and staff.
5. Number of mentoring programs (such as CSWN, WISP, SOAR) available to women and minority students and percentage of students participating.
6. Number of faculty serving as advisors and mentors.
7. Faculty to undergraduate student ratio.
8. Student to advisor ratio.
9. Track results from exit interviews to determine why students leave the program.
10. Number and percent of students earning bachelor's degrees who are seeking graduate or professional studies.
11. Number and percent of students earning bachelor's degrees who have accepted employment.
12. Number of students involved in programs with international emphases.
13. Number of students involved in Study Abroad programs.
14. Annual student evaluations and exit surveys.

Goal 11

Develop an excellent CS Honors Program.

Strategies

1. Offer honors sections of the core courses tailored towards the high quality of the honors students.
2. Develop a support framework for all honors related seminars (i.e., 197, 397, and 497).
3. Support the integration of honors research into existing research projects.
4. Develop the CS Honors Program in concert with School and University honors programs.

Metrics

1. Number of courses with Honors sections.
2. Number of honor students.
3. Number of faculty involved in honors research projects.
4. Retention rate of students in honors program.
5. Number of Honors students later attending graduate school.
6. Review Honors Program every 5 years.

ENGAGEMENT

Establish mutually beneficial external partnerships to identify problems and solutions and facilitate knowledge transfer. The department will be recognized for:

- Research-driven, active affiliations with business and government that help advance the frontiers of computer science, assist in knowledge transfer, and create economic opportunity.
- Thriving collaborative relationships with K-12 programs in Indiana that support superior pre-college preparation and encourage the innovative use of information technology in the classroom.

The department will pursue the implementation of strategies associated with the goals below.

Goal 12

Energize and sustain a research-driven focus in partnerships with business, government, and other universities.

Strategies

1. Create a high-level, research focused departmental advisory board.
2. Partner with faculty and staff in Purdue Discovery Park, Purdue Research Foundation, Sponsored Programs, the Office of Engagement and other schools and departments to drive business development in emerging technologies.
3. Increase investment of partner companies in departmental research.
4. Facilitate research fellowships and internship opportunities with partner companies.
5. Strengthen the existing Corporate Partners Program.
6. Collaborate with Purdue faculty across campus to offer distance learning and on-site short courses.
7. Invigorate internal and external communications and development activity to enhance the impact of engagement initiatives.
8. Support faculty whose expertise is recognized for leadership both within and outside the University**.**
9. Facilitate opportunities for partner companies for interaction with top students (e.g., in courses, co-op programs, student associations).
10. Assist partner companies in meeting their hiring needs for top quality employees.
11. Work with Purdue units to strengthen a research concentration in university level corporate relations.

Metrics

1. Number of partnerships with business, government, and other universities.
2. Amount of research investment and gifts in the department.
3. Number of students receiving corporate scholarships and total dollar amount.
4. Number of new businesses created.

5. Number of employees participating and retrained as a result of distance-learning and short courses opportunities.
6. Number of press releases concerning department's accomplishments and expertise.
7. Number of faculty who have received external awards for scholarship and service.
8. Number of patents, disclosures, and copyrights.
9. Number of faculty and students involved in partnerships with business, government, and other universities.
10. Number of faculty and students involved in internships and research with business, government, and other universities.
11. Number of distance-learning courses offered.
12. Number of distance-learning participants.

Goal 13

Create and maintain a knowledge transfer, entrepreneurial focus in partnerships with Indiana businesses.

Strategies

1. Tailor some member services of the department's Corporate Partners Program to specifically meet the needs of Indiana companies.
2. Foster internships and professional practice work experiences for students with Indiana companies.
3. Facilitate research fellowships at Indiana-based corporate sites.
4. Support efforts of faculty and staff to participate in organizations that support the information science industry in Indiana –TechPoint, others.
5. Invigorate internal and external communications and development activity to enhance the impact of state-wide engagement initiatives.

Metrics

1. Number of Indiana companies who participate in the Corporate Partners Program.
2. Number of internships and professional practice work experiences.
3. Number of research fellowships and assistantships with Indiana companies.
4. Number of entrepreneurial initiatives with Indiana companies.

Goal 14

Enhance alumni and corporate relations.

Strategies

1. Cultivate alumni and business relationships by strengthening communication and involving constituents in departmental programs.
2. Increase alumni giving to the department.
3. Increase corporate giving to the department.
4. Invigorate departmental print communications.

5. Launch an interactive alumni page on the department's website.
6. Grow the number of companies participating in departmental recruiting activities.
7. Create opportunities for interaction among departmental constituents and faculty, staff, and students.

Metrics

1. Number of major gifts.
2. Number of alumni and friends engaged/contributing.
3. Total level of contributions.
4. Number of companies taking part in job fairs.
5. Number of internships for students.
6. Number of students hired by corporate partners.
7. Number of alumni and business constituents participating in departmental social activities and meetings.

Goal 15

Support a nationally recognized K-12 outreach program and promote scientific literacy.

Strategies

1. Establish partnerships within Purdue to collaborate on the creation and dissemination of outstanding K-12 programs in information technology.
2. Encourage and participate in partnerships between Indiana information technology companies and schools.
3. Support faculty participation in K-12 classroom activity.
4. Create curriculum initiatives that match teams of Purdue students and K-12 teachers in technology learning programs in Indiana schools.
5. Invigorate internal and external communications and development activity to enhance the impact of K-12 initiatives.

Metrics

1. Number of partnerships and programs with K-12 schools.
2. Number of K-12 students taking part in outreach programs.
3. Number of teachers participating.
4. Number of faculty and students participating in K-12 classrooms.
5. Number of workshops, seminars, and continuing education courses offered.
6. Number of students and teachers reached.
7. Amount of media recognition for departmental outreach activities.
8. Number of education majors participating.
9. Student evaluations of experiences.
10. Number of speakers and programs that promote scientific literacy.
11. Number of courses and activities that promote scientific literacy.
12. Number of people reached through departmental Website and publications that promote scientific literacy.

DEPARTMENTAL CORE AND GROWTH AREAS

Computing technologies have emerged as key enabling resources in virtually all disciplines of science, engineering, and commerce. This gives the Computer Science Department the unique opportunity of leveraging its own strengths in its core areas and multidisciplinary areas with the strengths of various Schools within the university. Future growth will be driven by maintaining excellence in departmental core areas, building presence and visibility in future growth areas in computer science, and advancing multidisciplinary efforts within the University.

The department has identified eight core areas as central to the mission of the department:

- Computational Science and Engineering
- Databases
- Graphics, Visualization, and Geometric Modeling
- Information Security and Assurance
- Networking, Operating Systems, and Distributed Systems
- Programming Languages and Compilers
- Software Engineering
- Theory of Computing and Algorithms

Over the next five years, these areas are expected to remain the core areas of the department. Each area is expected to have a total of 3-5 FTEs and to have strong and visible research programs. Future hires will contribute to the strengths of these core areas and, at the same time, build up emerging growth areas. The department has identified four research themes for future growth:

- Massive data handling
- Computational biology and nanotechnology
- Critical infrastructure protection
- Pervasive computing

Each one of these growth areas has strong connections to the department's eight core areas and each growth area is fundamentally multidisciplinary in nature. Furthermore, each growth area enhances at least one of the research focus areas identified by the School of Science as a School-wide priority.

Massive Data Handling

Recent years have witnessed an explosion in the amount of digitally-stored data, the rate at which data is being generated, and the diversity of disciplines relying on the availability of stored data. The nature of this data is not limited to a few esoteric fields, but, arguably to the entire gamut of human intellectual pursuit, ranging from images on web pages to exabytes (~10^{18} bytes) of astronomic data from sky surveys. The availability of massive volumes of data brings the promise of increasing knowledge. Major research advances hinge upon the ability to organize, access, analyze, visualize,

integrate, extract, compress, query, and maintain massive data, followed by a domain-specific analysis to extract the science. Future computer science hires and existing faculty will play a crucial role in the area of database tools, data mining techniques, and graphics and visualization of massive data sets.

The challenges for managing massive data go beyond the relatively simple issue of using commercial database systems to store and query relevant data. Future hires are expected to be involved in research in:

- integration of diverse and distributed data sets, including handling structured, semi-structured, and unstructured content
- seamless, transparent, and efficient storage and access techniques
- data mining tools to expose hidden, illuminating relationships and properties of the data set
- streaming data that is too massive to be stored in a database and must be processed as it "passes through" the system

A very efficient and natural way for humans to process enormous data volumes is to visualize key structural properties, as the human visual system is unexcelled in processing complex visual relationships. The communication value of visualization is fundamental and cannot be overemphasized. Graphics and visualization of large data sets are a crucial element in advancing scientific knowledge. The creation of virtual environments leads to believable, realistic replicas of complex, natural scenes, for example in training and what-if simulations. Future hires in the area of visualization will address research motivated by the needs of massive data sets including computational simulations in design and analysis of complex systems and scientific phenomena, the analysis and effective interpretation of large datasets generated from these simulations, and performing detailed predictive simulations that point to developing weaknesses of systems.

The growth area "Massive data handling" is central to the School-wide focus area on "Massive Data – Management, Analysis, Visualization, and Security" and it has ties to the other research focus areas of the school. Joint hires with any department in the SoS is a possibility. Among the Engineering cluster proposals, this growth area relates to the proposals "Information, Communications, and Perception Technologies" (ECE and ME) and "Global Sustainable Industrial Systems" (IE and CE). Within the University, this growth area is relevant to numerous centers and institutes, including Bindley Bioscience Center, Birck Nanotechnology Center, Center for Sensing Science and Technology, Computing Research Institute, Discovery Learning Center, and e-Enterprise Center.

Computational Biology and Nanotechnology

Bioinformatics and computational biology include to the development and application of computational tools and techniques to solve complex problems in biosciences. Within this new area, computer science research contributes methods and tools for acquiring, storing, organizing, archiving, analyzing and visualizing biological data and phenomena. Future computer science research in this growth area will focus on data analysis, modeling and simulation, imaging and visualization, and biological databases. Hires in this area have the potential to strengthen a number of core areas, including, computational sciences, databases, graphics and visualization, and algorithms. We

expect future hires to contribute to the subareas of data analysis, modeling and simulation, imaging and visualization, and biological databases:

- *Data analysis* will result in new theory, representations, and algorithms to quantify, predict, uncover, and combine the information content available in such data sets, plan appropriately targeted experiments, and evaluate the consequent confidence in resulting interpretations. This work will draw from a wide range of areas, including reasoning under uncertainty, machine learning, statistical AI, pattern recognition, data mining, information retrieval.
- *Modeling and simulation* play a key role in understanding and regulating biological processes. At the lowest level, modeling takes the form of molecular dynamics simulations (e.g., protein folding) for estimating structures of biomolecules, homology and fold recognition techniques, and ligand-protein and protein-protein docking. At the next higher level, challenging computational problems include the stochastic simulation of events in cell-signaling pathways and large-scale mechanical modeling of molecular assemblies.
- *Imaging and visualization* are an essential component in computational biology. Effective visualization has been recognized as a key element in understanding and interpreting complex data. Computational problems in imaging and visualization include large scale (high-resolution) visualization, geometric modeling and analysis, and model acquisition.
- The creation, use, integration, and warehousing of *biological databases* is central to large-scale efforts in understanding biological systems. These tasks pose significant challenges from the standpoint of data storage, indexing, retrieval, and system scalability, over disparate types of data.

Computational nanotechnology. Nanostructure, nanoscience and nanotechnology have begun to dominate the scientific and general press. These structures are intriguing in the sense that in the nanometer region, physical and chemical properties of systems become size dependent. This size-dependence results in entirely new design strategies for developing new materials and their applications. Computational challenges include:

- Nanostructures will contain between 10^3 and 10^{10} atoms and modeling the behavior of such structures is a daunting computational challenge.
- Computing tools of the future will involve nanoscale structures. Components such as molecular switches, nanotube connectors, nanodot memories, and crossbar arrays, and their applications in computers, sensors and actuators, embody the challenge and promise of nanomaterials in computing.

The challenge of multiscale simulation of nanostructures cannot be overemphasized. Scaling imposes great difficulties as one moves from the characteristic size of small molecules that contain few atoms, to true nanostructures that contain up to 10^10 atoms. As a result, modeling methods require a careful integration of high-accuracy quantum mechanical techniques for small structures (that range from approximate quantum dynamics to classical molecular electronics) through a form of continuum mechanics for macroscopic structures. Thus the methodologies range from the use of density-functional quantum mechanics for the smaller systems to classical molecular dynamics for medium-scale to finite element dynamics in the continuum limit. The CS Department is ideally poised to contribute to the above challenges in computational nanotechnology and nanoscience by recruiting faculty members in computational nanoelectronics,

nanomechanics, and biophysics with strong background and research interests in the design of efficient scalable parallel numerical methods, and scientific visualization.

The growth area "Computational biology and nanotechnology" is central to the School-wide focus areas on "Bioinformatics and Computational Biology", "Nanoscience", and "Computational Science". Within the University, this growth area is relevant to numerous centers and institutes, including Bindley Bioscience Center, Birck Nanotechnology Center, Center for Sensing Science and Technology, and Computing Research Institute.

Critical Infrastructure Protection

Over the last few decades, the nature of research and scholarly education has undergone fundamental change to include integration of information technology. It is thus critical that the information we all use is correct, accessible when we need it, unaffected by malicious entities, and available to the right parties (while remaining unavailable to everyone else) — in short, to be kept secure. However, it is impossible to read a newspaper or listen to television newscasts without seeing stories about attacks on information systems. Whether they are stories of computer hackers breaking into military installations, denial of service attacks that render a network unusable, yet another computer virus or worm sweeping through the Internet, or the fear of cyber-terrorist attacks against our infrastructure, it is clear there is a major concern about protection of information in computer systems and networks. Society's increasing dependence on computer networks and systems implies an urgent need to develop technologies and educational programs that lead to greater confidence in our computing systems. This includes issues of trust, of security, and of assurance of IT systems. Purdue currently has a unique position in regards to this critical need. The Center for Education and Research in Information Assurance and Security, or CERIAS, is currently viewed as the leading center for multidisciplinary research and education in areas of information security that are crucial to the protection of critical computing and communication infrastructure. We expect future hires in this area to focus on secure, dependable, and reliable systems essential for homeland security, safety-critical systems, and privacy in cyberspace. They will contribute research to areas including software engineering and security, network protocols and protections, operating system design and security mechanisms, computer crime and criminalistics, and privacy and fair information use.

The growth area "Critical infrastructure protection" is a component of the School-wide focus area on "Massive Data – Management, Analysis, Visualization, and Security". Among the Engineering cluster proposals, it relates to the proposal "Information, Communications, and Perception Technologies" (ECE and ME). Within the University, this growth area is relevant to all Homeland Security efforts and has ties to the Bindley Bioscience Center, Birck Nanotechnology Center, Center for Sensing Science and Technology, Computing Research Institute, Discovery Learning Center, and e-Enterprise Center.

Pervasive Computing

Pervasive computing creates ubiquitous environments capable of processing, collecting, disseminating, and monitoring information in a seamless and continuous manner. Instead of viewing computing devices as passive entities which must be communicated with and explicitly programmed, pervasive computing model views elements of the infrastructure as embedded, intelligent devices that operate cooperatively and transparently. Pervasive computing will transform computing, and its impact will go beyond the traditional user interfaces, on the one hand imploding them into small devices and appliances, and on the other hand exploding them onto large scale walls, buildings and landscapes.

Future computer science research will address data consistency and integration, communication, networking, security, reliability, correctness, efficiency, and human computer interfaces as we alter the scales of size, computational power, and connectivity. New hires and future research will center on

- Software for distributed and dependable systems, including scalable and adaptive software support for ad hoc networks, peer-to-peer computing systems, embedded systems, storage infrastructure, and fault-tolerant, reconfigurable computing systems.
- Mobile and wireless computing, including mobile computing software systems that scale on the order of thousands to millions of nodes, communication models in the presence of transient nodes and unreliable environments, support for resource-aware computation, network protocols for wireless environments, and the development of middleware to extend the functionality of traditional software.
- Human computer interaction, focusing on the design, implementation, and evaluation of interactive computing systems and computing devices.

The growth area "Pervasive computing" has relations to the School-wide focus area on "Massive Data – Management, Analysis, Visualization, and Security". Among the Engineering cluster proposals, this growth area has a strong relationship and is indeed a counterpart to the proposal "Information, Communications, and Perception Technologies" (ECE and ME). Within the University, this growth area is relevant to numerous centers and institutes, including Bindley Bioscience Center, Birck Nanotechnology Center, Center for Sensing Science and Technology, and Computing Research Institute.

PEER INSTITUTIONS

The department will compare itself against other nationally ranked Computer Science departments. The selected peer institutions:

- Cornell University
- Georgia Institute of Technology
- University of California, Berkeley
- University of California, Los Angeles
- University of Illinois at Urbana-Champaign
- University of Maryland
- University of Michigan
- University of Texas at Austin
- University of Washington
- University of Wisconsin-Madison