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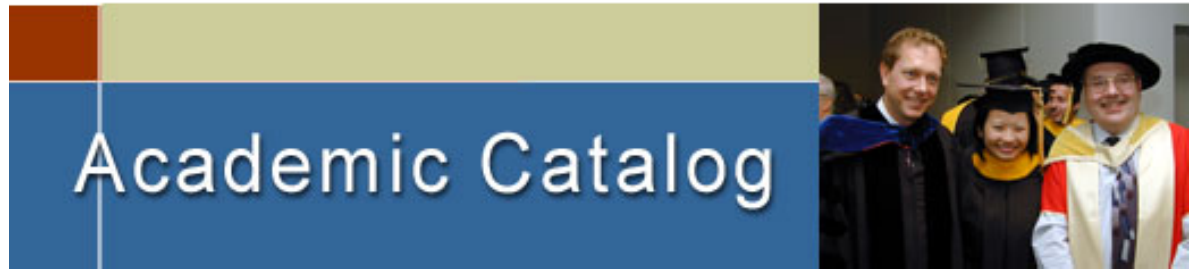
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2000-2001 Academic Catalog

Oregon Graduate Institute of Science and Technology is the region's premier provider of high-technology graduate education and home to a talented array of world-class scientists and researchers.

Established in response to the needs of the emerging high-technology industry in metropolitan Portland, OGI - with its mission of education and research in science and technology - has grown as Oregon's "Silicon Forest" has grown around it.

OGI offers masters of science and doctor of philosophy degrees in five academic departments.

- [Biochemistry and Molecular Biology](#)
- [Computer Science and Engineering](#)
- [Electrical and Computer Engineering](#)
- [Environmental Science and Engineering](#)
- [Management in Science and Technology](#)

Under its original name, the Oregon Graduate Center for Study and Research, the institution was incorporated in 1963, hired its first staff and faculty in 1966, and admitted its first students in 1969. The first master's degree was awarded in 1971 and the first doctor of philosophy degree in 1973.

In 1989, we formally adopted the name of Oregon Graduate Institute of Science and Technology to more appropriately represent the nature of our institution.



Accreditation

The Oregon Graduate Institute of Science and Technology is accredited by the Commission on Colleges of the Northwest Association of Schools and Colleges, an institutional accrediting body recognized by the Council for Higher Education Accreditation and/or the U.S. Department of Education. Their address is: Commission on Colleges, NWASC, 11130 NE 33rd Place, Suite 120, Bellevue, WA 98004.

Equal Opportunity

Oregon Graduate Institute of Science and Technology is committed to providing equal opportunity and access to all institute facilities to everyone without regard to race, color, religion, gender, national origin, age, sexual orientation, disability, or veteran's status. OGI has established an Affirmative Action Program to ensure that nondiscrimination is a pervasive part of the institute's environment.

Information contained herein may change during the course of any academic year. OGI ☐ reserves the right to make changes including but not limited to changes in policies, fees, ☐ tuition, course offerings and requirements. This document should not be construed in any ☐ way as forming the basis of a contract.



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Departments and Degree Programs

Oregon Graduate Institute of Science and Technology

Academic Departments

[Biochemistry and Molecular Biology](#)

[Computer Science and Engineering](#)

[Electrical and Computer Engineering](#)

[Environmental Science and Engineering](#)

[Management in Science and Technology](#)

Research and educational interaction among these departments is assured in part by research programs utilizing faculty members from different departments. This encourages the exchange of ideas between persons working in related research areas and provides fullest use of the wide range of instrumentation available at OGI.



Degree Programs

Oregon Graduate Institute offers thesis Masters of Science degrees and Ph.D. degrees in Biochemistry and Molecular Biology, Computer Science and Engineering, Electrical Engineering, and Environmental Science and Engineering.

OGI also offers degrees in these disciplines:

- [Master of Sciences in Computational Finance](#)
- [Oregon Master of Software Engineering](#)

Certificate Programs

- [Applied Computing](#)
 - [Computational Finance](#)
 - [Management in Science and Technology.](#)
-

Students Not Seeking Degrees

Any qualified student may take courses at OGI, in a part-time capacity, without enrolling in a degree program. Students may take a full-time course load for only one quarter, while waiting for a decision regarding admission to a degree program. Up to 21 credits taken at OGI prior to matriculation (enrollment in a degree program) may be accepted towards degree requirements. Departmental regulations may be more restrictive.

Colloborative/Joint Programs

Full-time students in OGI's Computer Science and Engineering (CSE) and Electrical and Computer Engineering (ECE) departments may take certain courses at Portland State University at no additional cost. Similar arrangements are being explored for other OGI departments. Contact the [Office of Academic and Student Services](#) for details.

OGI participates in the Oregon Master of Software Engineering (OMSE) program, a joint program with Portland State University, Oregon State University, and the University of Oregon. Students apply for this Master's degree through one of the participating schools. For more information contact (503) 725-2900 or lytler@omse.org.



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Admission Procedures and Finance

Oregon Graduate Institute of Science and Technology

Admission Procedures

Printed application forms are available by contacting:

Office of Academic and Student Services

Oregon Graduate Institute
20000 N.W. Walker Road
Beaverton, Oregon 97006-8921
Phone: (503) 748-1027
Toll-free: 1 (800) 685-2423
Fax: (503) 748-1285
E-mail to: admissions@admin.ogi.edu



You may also apply for admission on-line.

► **Click here to apply on-line for admission to OGI.**

Students may not become matriculated (enrolled in a degree program) without having completed requirements for a bachelor's degree or its equivalent, although they may be provisionally admitted prior to that time.

For degree programs, the following items must be submitted:

- Complete OGI or OMSE degree program application form
- \$50 nonrefundable application fee, which is valid for one year and cannot be waived or deferred
- Official transcripts from each college or university attended
- Three letters of recommendation
- Official GRE scores

The GRE general test is required for M.S. applicants in Computational Finance (GMAT could be substituted); Computer Science and Engineering; Environmental Science and Engineering; Environmental Systems Management and Oregon Master of Software Engineering.

The GRE general test is required for PhD applicants in Biochemistry and Molecular Biology (subject test is also required); Computer Science and Engineering; Electrical and Computer Engineering and Environmental Science and Engineering.

Applications may be submitted as early as one year before the proposed date of enrollment. Applications received by March 1 (February 15 for the ESE department) will receive priority review for admission and financial support.

For certificate programs, the following items must be submitted:

- Completed OGI certificate program application form
- \$20 nonrefundable application fee, which is valid for one year and cannot be waived or

deferred

Additional Requirements for International Students

To be considered for admission to OGI for a full course of study, international students must also provide documents to show that they meet the requirements described below.

- Evidence of adequate financial resources to pay for their OGI education and their cost of living.
- Written TOEFL scores are required of all MS and Ph.D. applicants whose native language is not English. Students who have earned a degree in the United States are exempt from this requirement. Minimum required TOEFL scores vary by department: BMB 550; CSE 600; ECE 575; ESE 600; MST 625. The minimum desired TOEFL score for admission is 575, but a lower score may be offset by excellent GRE scores. Please note: the minimum TOEFL scores above are for the paper-based test only. The computer-based TOEFL uses a different score scale. For more information on the computer-based score scale, please visit www.toefl.org.

Finances

Tuition

For the 2000-2001 academic year, tuition for full-time matriculated students is \$4,680 per quarter. Part-time tuition for regular OGI courses is \$520 per credit hour or audit unit. Please note that there is no full-time tuition rate for non-matriculated students, except when an admission decision is pending. There are no student fees.

ESE students pay tuition on an annual basis, which may be paid in full at the beginning of the year, or in quarterly installments.

Tuition for Computational Finance core courses is \$665 per credit hour or audit unit. Students matriculated in the Computational Finance degree pay only for credits required to fulfill degree requirements. Credits taken during the 12-month program beyond the 45 required to fulfill degree requirements will not be charged for (up to a limit of 54 credits).

Full-time quarterly tuition for students not matriculated in the Computational Finance program who take one Computational Finance course is \$5,115; with 2 Computational Finance courses it is \$5,550.

Courses in the Oregon Masters of Software Engineering (OMSE) program are \$495 per credit hour. Full-time matriculated students may register for OMSE courses when paying full-time tuition.

Payment or arrangement for deferred payment for all courses must be made before your place in a class is confirmed. OGI offers students the option of deferring most of the payment through no-interest promissory notes. Students who are reimbursed for their courses must make these arrangements with their employers but still incur financial responsibility for courses. Courses sponsored by the Oregon Center for Advanced Technological Education (OCATE), whether taken for credit or audit, must be paid in full at the time of registration.

Financial Aid

Entering full-time Ph.D. students can obtain financial support through a combination of tuition scholarships, OGI fellowships, named fellowships, graduate research assistantships and (for U.S. citizens only), low-interest student loans. Part-time Ph.D. students may be eligible for some of the above. Partial-tuition scholarships may be awarded to entering full-time MS students, and full- and part-time MS students who are US citizens may apply for low-interest student loans.

Fellowships, scholarships, and assistantships are awarded by departments. The "free application for student aid" (FAFSA) forms are available from the Office of Academic and Student Services.



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Academic Policies

Oregon Graduate Institute of Science and Technology

Residency Requirements

OGI has a two-year Ph.D. residency requirement. For full-time students, this requirement is normally met by an on-site dissertation project. In exceptional circumstances (e.g., dissertation topics requiring access to special facilities only available elsewhere), other arrangements may be proposed to the Educational Policy Committee (EPC). In such cases, a written plan of the research, with a schedule and description of the special circumstances and understandings between the student, thesis advisor, and SPC, must be included. Approval of this plan by the EPC is required before a student is granted candidacy status for Ph.D. work under such an arrangement. For part-time Ph.D. students, the first year of the residency requirement can be satisfied by attendance in classes on the OGI campus. The second year of residency, however, must be spent full-time on campus under the advisement of an OGI faculty member.



There is no residency requirement for M.S. or certificate programs at OGI.

Time Limits to Complete the Degree

Ph.D.: Six years of full-time study or eight years of part-time study.

M.S.: Three years of full-time study or four years of part-time study.

Petitions for extensions must be approved by the department and submitted to the Educational Policy Committee for approval.

Continuous Enrollment

A Ph.D. or Master's student who has begun work on the dissertation or thesis must register and pay for at least one credit hour of research per quarter in order to maintain matriculated status. At the end of four consecutive academic quarters, if satisfactory progress towards completion has not been made, or if an alternate plan of completion has not been approved by the department and the EPC, matriculated status will be terminated. If, at a later date, the student wishes to return to his/her program, it will be necessary to reapply for admission.

Continuous enrollment is not required of Master's students not pursuing a thesis, nor of M.S. or Ph.D. students who have not yet begun working on the dissertation or thesis. However, all matriculated students are required to register for courses OR indicate temporary inactive status, by filing the appropriate forms with the Office of Academic and Student Services. [Click here for a temporary inactive status form.](#)

Leaves of Absence

Leaves of absence are granted only in exceptional circumstances. Leaves are not granted to complete theses or dissertations. Requests must be submitted in writing to the advisor. The department head must authorize all leaves, with final approval being granted by the Educational Policy Committee.

Student Status

Full-time matriculated students are admitted to a degree program, and carry a minimum of nine credits per quarter. (Audit units do not count towards this minimum, except in special circumstances.) Academic departments may require students to carry more than nine credits per quarter as a condition of eligibility for a stipend and/or tuition scholarship.

Part-time matriculated students are admitted to a degree program, carry fewer than nine credits per quarter, and pay tuition at the appropriate per credit rate.

Non-matriculated students have not been admitted into a degree program, typically carry fewer than nine credits per quarter, and pay tuition at the appropriate hourly rate.

Auditing a Course

Students may register to audit any OGI course. Audit units are recorded on the student's transcript at the discretion of the instructor, based upon a reasonable expectation of attendance and minimal participation. Audit units are charged at the standard tuition rate. Audit units do not count toward a student's full-time status nor do they fulfill degree requirements.

Credit Load Per Quarter

Twelve credits per quarter is considered a normal course load for full-time students, although nine or more is considered full-time. Up to 18 credits may be taken with the approval of the department. Registering for more than 18 credits requires EPC permission; 18 credits plus up to 4 audit units does not require EPC permission and does not incur additional cost.

Transfer Credit

OGI accepts transfer credit from accredited institution that has not been previously applied toward another degree. A maximum of 21 credits earned prior to matriculation at OGI may be applied. This may include up to 12 credits transferred from other institution (up to 18 from Portland State University, University of Oregon and Oregon State University) and/or up to 21 credits taken at OGI prior to matriculation. Contact each academic department for specific policies and procedures. Transfer credit grades (not from OGI) are not calculated in the OGI grade point average.

Grading/Satisfactory Academic Progress

All OGI courses are graded with a letter grade; an exception is that Ph.D. students may receive P/NP for work in a seminar. In addition, faculty may assign P/NP or letter grades to research work, but grades for research cannot be counted in students' GPAs.

The following scale is employed at OGI:

A = 4.0

A- = 3.67

B+ = 3.33

B = 3.0

B- = 2.67

C+ = 2.33

C = 2.0

C- = 1.67

F = 0.0

The grading system is defined as:

A = Excellent

B = Satisfactory

C = Below graduate standard

F = Failure

The following marks are also used:

AU = Audit, no credit

P = Satisfactory completion

NP = No credit, unsatisfactory

I = Incomplete

W = Withdrawn (after the add/drop period)

Matriculated students must maintain a cumulative GPA of 3.0 on all work taken at OGI. Failure to do so may result in probation or dismissal.

OGI's policy is that Incomplete must be completed by the end of the quarter following that in which

the Incomplete was awarded. In cases where the Incomplete is not completed, the instructor has the choice of assigning a grade or converting the Incomplete into a Permanent Incomplete. The grade may be an F, if the course work was not completed, but instructors have the option of assigning another grade if they feel quality and quantity of work that was accomplished warrants it.

If an extension of this one-quarter deadline is desired, the student may petition the EPC, showing the instructor's support of the extension (a separate letter or signature on the petition will suffice). Normally an extension will be granted, as long as the plan is specific and includes a date by which the grade will be assigned, and is submitted to the Registrar in writing.

400-Level Courses

Courses offered and designated by 400-series numbers within academic departments at OGI are not considered to satisfy any degree requirements. These courses do not carry graduate credit at OGI, but are entered on the transcript.

Confidentiality of Students' Records

Confidentiality of Student Records

With the passage of the Federal Family Educational Rights and Privacy Act of 1974, OGI adopted rules to govern the collection, use, and disclosure of student records with the goal of ensuring their privacy. Students have the right to inspect their educational records that are maintained by OGI; the right to a hearing to challenge the contents of those records when they allege the records contain misleading or inaccurate information; and the right to give their written consent prior to the release of their records to any person, agency, or organization other than OGI officials and certain authorized federal and state authorities.

Certain public domain information, known as directory information, can be released by OGI unless a student files a written request in the Office of Academic and Student Services. OGI limits this information to the student's name, address, date(s) of attendance, degrees and awards received, number of credits earned and the fact of enrollment, including whether the student is enrolled full- or part-time. OGI does not make this information available to vendors.

Transcripts

Your transcript is a formal, written record of your OGI educational experience. All courses you take at OGI are recorded on it, as are all grades and degrees you earn while at OGI. If you have transferred credits from another institution, they will be recorded on your transcript, as well.

By law, requests for transcripts must be in writing, submitted either by fax, mail, or in person to the [Office of Academic and Student Services](#). Official transcripts are on special paper and have the official OGI seal; unofficial transcripts are printed on regular paper without the seal. There is no charge for unofficial; official transcripts cost \$4.00 per copy. Requests are usually processed immediately, but we ask that you allow three days.

On your request we must have your name; signature; social security number (if applicable); whether you will pick the transcript(s) up or the address(es) to where it/they should be mailed; and payment information, relevant. You can send a check, write down credit card numbers or call with them, or pay cash. Sending cash through the mail is not recommended.

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The Campus

Oregon Graduate Institute of Science and Technology

Geographic Setting

The greater-Portland metropolitan area has a population of about 1 million, nearly half the population of Oregon. Oregon Graduate Institute is located 10 miles west of the downtown area, which provides diverse cultural activities including art, music, entertainment and sports. Portland has an extensive park system, including the largest wilderness park within the limits of any city in the United States. OGI is situated in AmberGlen, a science and business park. The campus area, the nucleus of the park, consists of modern, attractive buildings, providing spacious laboratories, faculty and administrative offices, and a research library.



Library

The [Samuel L. Diack Memorial Library's](#) collection of 30,000 volumes supports the teaching and research efforts at OGI by providing texts, conference proceedings, reference materials, journals (466 titles), and research monographs in the subject areas of materials science, computer science, electrical engineering, environmental sciences, biochemistry, molecular biology, and management as related to science and technology. Materials unavailable at OGI are obtained on interlibrary loan for faculty, staff, and students. An on-line catalog (SADICAT), acquisitions, and circulation system is in place. Access to other college and university collections is provided by access to databases and library catalogs and grants circulation privileges to OGI students at 13 other institutions in the area, including Portland State University, Oregon Health Sciences University, and private institutions such as Reed College. The Library's public micro-computers not only provide for searching SADICAT and the Library's databases-both CD-ROM and on-line-but also provide entry to the Internet and World Wide Web resources, telnetting, and ftp options for faculty, staff, and students. The library is open 86 1/2 hours per week during term. Reference service is provided 49 1/2 hours per week. Librarians perform searches on the many systems and databases that are not available directly to students. Library orientation is part of the introduction to OGI for new students, and classes on library research methods are offered throughout the year..

Computer Facilities

OGI provides excellent computing facilities to support its academic and research programs. Students and faculty have access to a wide variety of computer systems, including several super-minicomputers, a variety of desktop and personal computers, and workstations. These are connected through a campus-wide local area network. This makes available on-line text and document processing, as well as powerful facilities for scientific computing. The campus LAN is connected to Verio Northwest using several high-speed data paths, providing Internet connectivity to all campus platforms.

Housing

While OGI has no on-campus housing, affordable apartments and rental houses are located nearby. The Office of Academic and Student Services maintains a [list of local apartment buildings](#) for students to reference. Additionally, students looking for roommates can send a post-card to the office, to be posted on physical and virtual bulletin boards prior to their arrival.

Student Council

The [Student Council](#) serves as the liaison between the student body and both the faculty and the administration and strives to improve the quality of life for students at OGI. Representatives make themselves available to students in their department in order to forward their comments, ideas, and concerns to the Student Council and to promote their involvement in student body activities. Representatives also serve to disseminate all pertinent information to the students in their departments. All of our meetings are open and we actively encourage all students to participate!

As liaison, members of student council represent the student body and student interests on a wide variety of task forces and committees at OGI, including the Faculty Senate, the Educational Policy Committee, and the Safety Committee.

Additionally, Student Council sponsors and co-ordinates at least one major social event each quarter, open to everyone at OGI. These events have included a coffeehouse with live music performed by people from the OGI community, an annual International Food and Cultural Fair, and an Educational Forum. There are also monthly and weekly events including movie nights and bagel breakfasts in our new student lounge.

If you would like more information, we invite you to visit our web site for a list of our past and future activities.

Visit their web site at cslu.cse.ogi.edu/council/ or contact them at scouncil@admin.ogi.edu



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Mission Statement

Oregon Graduate Institute of Science and Technology

Mission Statement

The mission of the Oregon Graduate Institute of Science and Technology is to provide outstanding graduate and professional education and conduct internationally acclaimed research in science and technology to meet regional and national needs.

To implement this mission, OGI:

- Provides students with the necessary knowledge, skills and breadth for leadership in a technological society;
- Supports, through research, education and training, the people, industries and organizations that drive the economic growth of the Pacific Northwest; and
- Attracts and develops high-quality faculty, students and staff.





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A Letter from Ed Thompson

President and CEO of Oregon Graduate Institute

Oregon Graduate Institute of Science and Technology is one of the most innovative, exciting and productive institutions of its size anywhere in the world.

Indeed OGI's modest size is part of what makes the institution so attractive. Students have intimate access, for instance, to top-notch faculty in both the classroom and the research lab. (Our student-faculty ratio is a low 8:1.) And as a nimble institution devoid of any lumbering bureaucracy, we pride ourselves on our ability to accommodate students' needs in every possible way.

Yet we are also extremely successful in competing with much larger institutions for limited research dollars. A wide variety of public- and private-sector funding organizations believe in us so firmly, in fact, that they support more than \$20 million in research annually at OGI. Students can thus rest assured that OGI faculty are providing instruction grounded on leading-edge research in their discipline. Such research-informed education has always been the cornerstone of our approach to graduate education in disciplines such as computer science, environmental science, electrical engineering and molecular biology.

OGI's close relationship with the high-tech industry is also very important. Many of our part-time students, for instance, are full-time employees of companies both large and small. As a result, these students acquire pragmatic knowledge and skills that will enhance their careers, plus our full-time students establish networking contacts within industry, and classroom interactions benefit from a healthy measure of real-world experience.

Classroom and research interactions are further enhanced by the diverse backgrounds of our faculty and students, who represent a cross section of cultures and sub-disciplines.

All of which taken together helps explain why our alumni find great success in a variety of career paths-whether their inclinations lead them toward academia, entrepreneurship or advancement within established companies. As 1995 graduate Judy Cushing said of her experience at OGI, "It changed my life in very important ways."

Welcome to OGI.

A handwritten signature in black ink, reading 'Ed Thompson'. The signature is fluid and cursive, with a long horizontal line extending from the end.





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Academic Calendar

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2000 Fall Quarter

Aug. 7	Registration begins for Fall Quarter
Sept. 21	Last day to register without late fees
Sept. 22	New Student Orientation, Office of Academic and Student Services closed

Sept. 25 Fall Quarter instruction begins

Nov. 13	Registration begins for Winter Quarter
Nov. 23-24	Thanksgiving Holiday (offices closed)
Dec. 4-9	Final Exams
Dec. 25	Christmas holiday (offices closed)
Dec. 25-Jan. 1	Office of Academic and Student Services closed

2001 Winter Quarter

Nov. 13	Registration begins for Winter Quarter
Jan. 1	New Year's holiday (offices closed)
Jan. 4	Last day to register without late fees
Jan. 5	Registrar's office closed

Jan. 8 Winter Quarter instruction begins

Feb. 12	Registration begins for Spring Quarter
Feb. 19	No class - President's day
Mar. 19-23	Final Exams

2001 Spring Quarter

Feb. 12	Registration begins for Spring Quarter
Mar. 29	Last day to register without late fees
Mar. 30	Office of Academic and Student Services closed

Apr. 2 Spring Quarter instruction begins

May 7	Registration begins for Summer Quarter
May 28	Memorial Day holiday (no classes, offices closed)
June 11-15	Final Exams
June 16	Commencement

2001 Summer Quarter

May 7	Registration begins for Summer Quarter
June 21	Last day to register without late fees
June 22	Office of Academic and Student Services closed
June 25	Summer Quarter instruction begins
July 4	Independence Day holiday (no classes, offices closed)
Sept. 3	Labor Day holiday (no classes, offices closed)
Sept. 4-8	Final Exams



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Department of Biochemistry and Molecular Biology

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Email Inquiries: christie@bmb.ogi.edu **Phone:** (503) 748-1070

The [Department of Biochemistry and Molecular Biology](#) offers graduate study leading to M.S. or Ph.D. degrees. Participation in research begins immediately upon entering our program. This early exposure to research allows each student to become familiar with the variety of activities represented in the department and aids the student in thesis research selection.

Research Focal Points Include:

Fungal and yeast biochemistry and molecular biology (with an emphasis on gene regulation and enzyme characterization).

Ion transport across biological membranes (with an emphasis on molecular biology and reconstitution of cation or anion carriers).

Metallobiochemistry (with an emphasis on the structure and function of metal ions in proteins).

The research experience at OGI is extensive. Much of the research is interdisciplinary, covering basic as well as applied aspects. Students are involved in all aspects of the departmental research program and have ready access to modern research instrumentation. As a result, our graduates are well qualified for research careers in academia, government and industry.



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Email Inquiries: csdept@cse.ogi.edu **Phone:** (503) 748-1151

The [Department of Computer Science and Engineering](#) has an internationally acclaimed research program. The breadth and depth of the research program is evidenced by the research projects, research centers, and the educational program.

Four degrees are offered:

1. [Master of Science in Computer Science and Engineering](#)
2. [Master of Science in Computational Finance](#)
3. [Oregon Master of Software Engineering](#)
4. [Doctor of Philosophy in Computer Science and Engineering](#)



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Department of Electrical and Computer Engineering

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Email Inquiries: [ECE Department](#) **Phone:** (503) 748-1418

The primary objective of the [Department of Electrical and Computer Engineering](#) is to provide innovative teaching of and research into technologies that enable the computer to interact more effectively with the real world, with a secondary goal of commercializing these key technologies. These technologies involve intelligent signal processing and the semiconductor structures that support such intelligent computation.



To meet these goals, the department offers a wide variety of formal courses in core areas as well as in specific research areas. The curriculum for each student is determined in part by his or her academic background and interest, and is set after discussion with a faculty advisor.

The major fields of research activity in the department are:

- Advanced Lithography
- Atmospheric Optics
- Biomedical Engineering
- Digital Signal Processing
- Display Technology including Thin Film Transistors and Phosphors
- Electro-Optic Systems
- Human Information Processing
- Image and Video Processing
- Man-Machine Interfaces
- Neural Networks
- Optical Remote Sensing
- Pattern Recognition
- Processing for Ultra Shallow Device Technology
- Semiconductor Electronic Devices
- Semiconductor Materials and Processing
- Speech Recognition, Enhancement, and Synthesis
- Systems Dynamics
- Technology Transfer
- Transient Thermal Processing
- VLSI Architecture for Intelligent Computing

Students may become involved in relatively fundamental investigations (such as atmospheric effects on laser beams, and semiconductor materials characterization and processing) or in advanced engineering applications (such as video display technology or signal/image processing). In all cases, the emphasis is on scientific and engineering investigations having well-defined goals and real utility in an atmosphere resembling that of a working research and development laboratory. The academic program, while rigorous, is innovative and individually planned to meet each student's needs. The limited number of students in residence assures close attention to each

student and progress at a rate determined by the student's ability and effort.

Industry-Sponsored Fellowships

OGI coordinates with corporate sponsors to make a 21-month Industrial Fellowship available to students. Selected students will attend OGI half-time during the nine-month academic year, and intern half-time for the industrial sponsor. During summer months, the student will intern full-time for the sponsor. In this way, the student learns about real-world problems through structured, temporary work experiences. At the end of this program the student will have an M.S. in electrical engineering and extremely valuable work experience.

The Industry-Sponsored Fellowship is based upon the needs of corporate sponsors, and may not be available each academic year. Contact the ECE department in writing if you are interested in learning more about this program.

Department Seminars

The department and other local educational and corporate organizations host invited [talks and seminars](#) on topics of interest in the field of electrical engineering. Although not required for graduate credit, we recommend that all ECE students attend these informative meetings. Seminar schedules are posted each quarter. Additionally, the ECE Department in conjunction with Portland State University's Department of Electrical and Computer Engineering sponsor the [Portland Area Semiconductor Seminar Series \(PASSS\)](#). These seminars offer an opportunity to meet leading local and nationally recognized EE professionals and learn about the latest technical advancements in the high-technology industry.

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Department of Environmental Science and Engineering

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Email Inquiries: info@ese.ogi.edu **Phone:** (503) 748-1196

The [Department of Environmental Science and Engineering](#) offers graduate study in water, soil, and air sciences. The master's degree program offers both nonthesis and thesis options, and can be pursued on a part-time basis. Ph.D. students participate in a program that includes both formal course work and research.

For Ph.D. and M.S. thesis students, the research experience is intensive and consists of laboratory, computational, theoretical and/or field studies. Thesis students are involved in all aspects of departmental research and have ready access to modern analytical instrumentation and computers.



www.ese.ogi.edu

The Ph.D. program can be completed in 4 to 5 years. Students can pursue a Ph.D. in environmental science and engineering or in the [Environmental Information Technology \(EIT\)](#) track (beginning Fall 2001).

The nonthesis M.S. program can be completed in 12 months. Students in this program can concentrate in the following areas:

- Contaminant Hydrology
- [Ecosystem Management and Restoration](#)
- Environmental Chemistry
- Estuarine and Coastal Dynamics
- [Environmental Information Technology](#) (beginning Fall 2002)

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Department of Management in Science and Technology

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Email Inquiries: vtyler@admin.ogi.edu **Phone:** (503) 748-1335

OGI's [Department of Management in Science and Technology](#) department provides the rigorous educational preparation necessary for highly effective managerial- and professional-level work in industries, organizations and departments that have a strong technical, engineering, manufacturing or scientific orientation.

Our courses, certificate and Master's degree programs focus on managing people and processes and building effective and competitive organizations in the specific contexts of technology and science. Managing change and competing in the global marketplace are prominent themes in the MST program.



Learn On-line, Anytime, Anywhere

MST delivers challenging and engaging versions of its courses over the Internet. This is an excellent option for students facing time pressures or working in locations where travel to the OGI campus is not feasible. The course delivery system is based on interactive multimedia lectures and lessons, faculty-managed chat, and on-line discussions, all in a seamless browser-centric environment. Students can take individual courses, enroll in the Certificate in Management in Science and Technology program, or apply for the full Master of Science degree (currently only the Managing the Technology Company degree option is offered on-line). Courses offered on-line will have a "D" designation following the course number. For further information dial toll free in the U.S. 1-877-GO TO OGI (1-877-468-6644) or visit the MST on-line learning web site: <http://elearning.cenquest.com/>

Individual Courses in MST

Each MST course has been designed as a valuable professional development experience for working professionals. Project Management, Quality Management, Building Effective Organizations in Science and Technology, for example, may be taken as stand-alone courses. Any class, with the exception of MST 550/550D: Capstone Project and MST 530/530D: Strategic Management, may be taken as a stand-alone course, with no need for the student to enroll in a degree or certificate program.

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Department of Management in Science and Technology

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certificate options

The MST department offers certificates in [Management in Science and Technology](#), [Building the General Manager](#), and [Industrial Design](#).

MANAGEMENT IN SCIENCE AND TECHNOLOGY

MST offers a six-course certificate in Management in Science and Technology. The following five courses, plus an additional MST elective course chosen in consultation with a faculty advisor, are required:

MST501/501D*	Managerial and Financial Accounting for Science and Technology	4 credits
MST503/503D*	Marketing in Science and Technology	4 credits
MST510/510D*	Principles and Trends in Technology Management	3 credits
MST512/512D*	Project Management	3 credits
MST520/520D*	Managing in Science and Technology	4 credits
	<i>Elective to be chosen after consultation with faculty advisor</i>	3-4 credits

*Indicates a course that is also offered online in one-credit modules. A maximum of 12 modules is permitted for Certificate credits. Please see the section on modules.

BUILDING THE GENERAL MANAGER (BGM)

A Certificate Program for Senior Managers in Technology-Intensive Companies

The program focuses on building general management skills needed to successfully manage the established but still-growing high-tech business, and can be completed in a series of long weekends over the course of one year.

The BGM Certificate Program prepares senior functional managers (CFOs, CIOs and chief manufacturing, marketing and engineering officers) of business units and medium size companies for the strategic and operational challenges of managing a business unit. The program focuses on building general management skills needed to successfully manage the established but still-growing high-tech business, and can be completed in a series of long weekends over the course of one year.

The ideal BGM participant does not need an additional degree for career advancement, can spare the time only for a concentrated program, and wishes to leverage the learning experience to build

a network of peers in other technology companies.

The three key areas of the BGM Certificate are Building Executive Leadership Skills (the core of the program, with [MST541/541D](#) and [MST522/522D](#)); Business Management Foundations, which selectively draws on MSTcourses; and Executive Assessment and Coaching, which is incorporated into the program with pre- and post-assessment and jointly undertaken with incumbent companies.

In addition, four workshops, chosen in consultation with the firms employing each BGM participant, help build executive skills. Workshops conclude with a team project-a high-impact business project for the company. Nationally recognized instructors join the OGI faculty to teach these executive workshops. Titles include: Leading the Strategy Process; Mindset and Skills for Managing Globally; Managing Development Projects for Profits, Growth and Renewal; and Managing for Innovation and Leading Change.

INDUSTRIAL DESIGN

This program introduces participants to the full range of activities involved in the design of products for industry and the marketplace. The role of the ID process within the organization is addressed, as are the key elements of an effective design project from conceptualization to product manufacturing, product launch and marketing program.

Topics taught include new product development and design management strategy, application of CAD in product development (including CAD/CAE/CAM integration), and an overview of future development in technology for ID and manufacturing. Previous certificate requirements included 40 contact-hours in Industrial Design, 40 contact-hours in Modeling Computer Aided Development, 20 contact-hours in management seminars, plus a number of site visits.

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admissions and degree requirements

Admission Requirements

Admission requirements are the same as the general requirements of the institution. In addition, Ph.D. applicants must submit general GRE scores as well as subject scores in (a) biology, (b) chemistry, or (c) biochemistry, cell, and molecular biology. M.S. applicants are not required to submit GRE scores.

Prospective students should carefully examine the faculty research interests and departmental research programs to determine whether their specific professional needs can be fulfilled at OGI. Communication with individual faculty members is encouraged prior to applying or enrolling.



► [Click here to apply on-line for admission to OGI.](#)

Degree Requirements

M.S. PROGRAMS

Two options are offered with the M.S. in biochemistry and molecular biology.

NON THESIS OPTION

The nonthesis M.S. requires satisfactory completion of 44 credits, 28 of which are in graded courses and 16 of which are derived from an experimental research project. Graded courses include 12 credits in BMB527, 528, and 529, and 16 or more credits in advanced courses (see course offerings, BMB530-542), Student Seminars (BMB594, 596, 598), and Special Topics (BMB580). The research for the nonthesis degree is typically a specific contribution to a larger project, providing the student with extensive hands-on experience in biochemical and molecular biological techniques. The nonthesis M.S. degree can be completed in one year of full-time study.

THESIS OPTION

The thesis M.S. is a research degree that requires satisfactory completion of 44 credits, 20 of which are in graded courses, and a written thesis based on independent research (BMB700).

PH.D. PROGRAM

The department offers a Ph.D. in biochemistry and molecular biology. Ph.D. candidates are required to take the BMB527-529 biochemistry sequence and three of the following core courses:

BMB530	Enzyme Structure and Function	4 credits
BMB531	Enzyme Mechanisms	4 credits
BMB532	Bioenergetics and Membrane Transport	4 credits
BMB534	Instrumental Methods in Biophysics I	4 credits
BMB540	Advanced Molecular Biology	4 credits
BMB542	Molecular Cell Biology	4 credits

Students must register for 12 credits per quarter. These credits typically include Student Seminars (BMB594, BMB596, or BMB598), Departmental Seminar (BMB 591), and Research (BMB600 or BMB800).

The qualifying examination for the Ph.D. is a comprehensive examination. The qualifying exam must be completed within two years of entering OGI. A defense of the Ph.D. dissertation is required.

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Department of Biochemistry and Molecular Biology

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research programs

Biochemistry of Lignin Degradation

Lignin is the most abundant renewable aromatic polymer, constituting approximately 25 percent of woody plant cell walls. Our multidisciplinary research program aims to understand and exploit the fungal degradation of this underutilized resource. The metabolic pathways and enzymatic components of the lignin degradative system are examined using biochemical, enzymological, and molecular biological methods. Two novel extracellular heme peroxidases (lignin peroxidase and manganese peroxidase) involved in the degradation of lignin were discovered in our laboratory. Lignin peroxidase oxidizes a variety of nonphenolic lignin model compounds and priority pollutants. Manganese peroxidase oxidizes MnII to MnIII, which in turn oxidizes phenolic substrates. The structures, active sites, mechanisms, catalytic cycles, and regulation of these enzymes are being characterized in our laboratory and via collaborations using spectroscopy, stopped-flow kinetics, protein chemistry, enzymology, X-ray crystallography, and bioorganic and molecular genetic methods. Recently, we developed a homologous expression system for these peroxidases. This system allows structure/function studies by site-directed mutagenesis. Applications for lignin-degrading systems include the more efficient utilization of biomass, nonpolluting forest products technologies, and toxic waste cleanup. We also are studying several intracellular enzymes such as quinone reductases, ring-cleaving dioxygenases, and others that are involved in lignin and pollutant degradation. *Gold*

Molecular Biology and Genetics of *Phanerochaete chrysosporium* and Its Lignin-Degrading System

We are isolating and sequencing the genes encoding components of the *P. chrysosporium* lignin-degrading system. These include genes encoding lignin and manganese peroxidases and a novel quinone reductase. We are analyzing the coding and promoter regions of these genes and studying the regulation of their transcription. We have discovered that Mn peroxidase is regulated by Mn ion, the substrate for the enzyme, as well as by nutrient nitrogen, heat shock and oxidative stress. Using reporter genes and RT-PCR, we are elucidating the molecular mechanisms involved in Mn peroxidase gene regulation. We also are undertaking molecular biology studies on the manganese peroxidase gene of *Dichomitus squalens* and on their heterologous expression in *P. chrysosporium*. *Gold*

Biodegradation of Aromatic Pollutants

The nonspecific and oxidative nature of the lignin degradation system of the fungus *Phanerochaete chrysosporium* enables this organism to degrade a variety of toxic aromatic pollutants including polychlorinated phenols, polychlorinated dioxins, chlorophenoxyacetic acid, and nitrotoluenes. We are examining the biochemical pathways, enzymes and regulatory mechanisms involved in the total degradation of these compounds. We have shown that the fungus utilizes extracellular peroxidases as well as intracellular quinone reductases, methyl transferases, and dioxygenases to carry out these processes. We are attempting to characterize these enzymes and their encoding genes to more fully understand the mechanisms involved in the degradation of these pollutants. *Gold*

Interaction of Nitric Oxide with Metalloproteins

Nitric Oxide (NO) is currently the subject of intense interest due to its role in a diverse range of biological processes. The importance of NO in mammalian physiology is indicated by the award of the 1998 Nobel Prize for Medicine for the discovery of its role as a signaling molecule in the cardiovascular system. In bacteria, NO is produced as an intermediate during denitrification - the process by which certain organisms convert nitrate through to N₂ or N₂O. The production of NO is the first opportunity for fixed nitrogen to be lost from the soil to the atmosphere with implications ranging from fertilizer loss to atmospheric pollution. Throughout biological NO-chemistry, proteins with Fe or Cu-containing active sites play a central role in generating and releasing NO as well as in sensing and initiating chemistry in response to changes in NO-levels. Our research is aimed at investigating the structures and mechanisms of these metalloproteins through the use of a variety of spectroscopic, biochemical and kinetic techniques. *Andrew*

Oxidative Enzymes Involved in Fungal Cellulose Degradation

Cellulose constitutes 40 percent to 60 percent of plant cell wall material; its biotechnological conversion, initially to glucose and then to ethanol, can provide an alternative source of energy. This application requires a complete understanding of the various enzymes involved in fungal cellulose degradation.

The cellulose-degrading cultures of *Phanerochaete chrysosporium* produce a unique hemoflavoenzyme, cellobiose dehydrogenase (CDH), which oxidizes cellobiose to cellobionolactone. We have purified CDH to homogeneity in high yields. Cellulases bind to crystalline cellulose using a specific cellulose-binding domain. CDH appears to have a similar domain for cellulose binding; the amino acid sequence responsible for cellulose-binding and the binding mechanism are under investigation.

Our recent research suggests that a possible physiological role of CDH is to enhance crystalline cellulose degradation by cellulases, the rate-limiting step in the bioconversion of cellulose to glucose. A detailed study of the structure, function, and mechanism of CDH using spectroscopic, biochemical, and molecular biological methods is in progress. *Renganathan*

Translational and Transcriptional Control in *Neurospora crassa*

A greater understanding of many human health issues relies on increased knowledge of how cells express genetic information. Gene expression can be controlled by regulating the synthesis and stability of functional RNA and protein. The goal of our research is to obtain a greater understanding of how these mechanisms work using the *N. crassa* arg-2 gene as a model. This gene appears to be regulated at both transcriptional and translational levels, and an upstream open reading frame (uORF) in the transcript appears to be important for translational regulation. Mechanisms of eukaryotic translational control are not well understood. Extensive studies of genetics and biochemistry in *N. crassa*, and recent advances in using reverse genetics to study arg-2 expression, make this an excellent model system for studying regulatory control. Because *N. crassa* is a filamentous fungus that is related to fungal pathogens and to fungi used in biotechnology (for example, in antibiotic production), an understanding of transcriptional and control mechanisms in this organism is of practical and fundamental interest. The nuclear gene arg-2, which specifies for the mitochondrially localized small subunit of arginine-specific carbamoyl phosphate synthetase (CPS-A), is regulated by at least three distinct pathways: specific control negatively regulates expression in response to Arg; cross-pathway control positively regulates expression in response to limitation for a variety of amino acids including Arg; and development control regulates arg-2 expression in response to changes in the organism's life cycle. Each of these pathways influences the level of arg-2 transcript. There is evidence that Arg-specific control has a translational component mediated through a 24-codon uORF in the transcript. In addition, intron sequences within this uORF appear to have roles in transcription. The goal of our program is to understand the molecular mechanisms by which these different regulatory pathways interact to control arg-2 expression. *Sachs*

Mechanisms of Chemosensory Responses in Elephants and Sharks

Chemical communication plays a significant role in life strategies for elephants. Our research focuses on chemical identification of pheromones functioning during reproduction. We are studying inter-sexual temporal gland (related to the unique male condition known as musth) and urine signals. We have identified (Z)-7-dodecen-1-yl acetate in female preovulatory urine and demonstrated bioactivity of its synthetic form. This compound is also bioactive in many Lepidoptera, making it a good example of convergent evolution of structure and function. Our new directions include sophisticated assessments of behavior resulting from this and other chemical signals, and molecular biological studies to elucidate pheromonal tissue sources and the nature of specific carrier proteins, allowing the sequence from pheromone to signal transduction in the neuroreceptive cells of the vomeronasal organ.

Male musth signals may have a role in mate choice by female elephants. These include urinary and temporal gland emissions during musth. We are characterizing the moderate and light volatiles emanating from the temporal gland. Ongoing studies include chemical identification of specific chemical communicators, correlation of these chemicals with testosterone levels in males, and delineation of their behavioral components. Such signals may affect males and females, and the effects may partially depend on the hormonal status of an individual elephant.

Inter-hormonal and inter-pheromonal relationships during reproduction are incompletely understood; few specific signals have been identified in vertebrates. Using elasmobranchs as models, this aspect of our research has focused first on characterizing the hormones operational during reproduction in placental sharks. Our studies have demonstrated some unusual hormone attributes. Now we are characterizing whether reproductive pheromones in elasmobranchs are hormonal blends as in teleosts, or whether they are a different group of chemical compounds. *Rasmussen*

Chemistry of Copper-Containing Enzymes

Increasing numbers of important enzymes are known to contain copper at their active sites. Of particular interest are enzymes involved in biogenic amine biosynthesis and metabolism (including important neuroactive amines such as nor-adrenaline and amphetamine); enzymes protecting against oxidative cellular damage caused by reduced oxygen metabolites; and enzymes catalyzing the biosynthesis of neuropeptide hormones. A major goal is to understand the catalytic role of copper and the molecular mechanism of oxygen binding and utilization by these oxidase and oxygenase enzymes. *Blackburn*

Spectroscopy of Copper Proteins

Spectroscopic techniques are used to probe the structures of the copper sites in the native proteins and their complexes with substrates and inhibitors. Since the chemistry of the catalytic processes is generally centered on the Cu(I) forms of the enzymes, we are concentrating on the challenging task of developing spectroscopic probes of the Cu(I) oxidation state, which is transparent to most common spectroscopic techniques. Our work thus includes Fourier transform infrared, X-ray absorption edge, and EXAFS spectroscopies, and emphasizes the use of computer simulation of spectra on our micro SGI Indigo work station. Data for the latter two techniques are collected at national and international synchrotron radiation facilities. Proteins under investigation include dopamine- β hydroxylase, cytochrome c oxidase, hemocyanin, peptide amidating enzyme, Menkes and Wilson proteins, and copper chaperones. *Blackburn*

Radical Copper Oxidases

Radical copper oxidases are a new class of redox metalloenzymes (including the fungal enzymes galactose oxidase and glyoxal oxidase) containing a protein free radical directly coordinated to a copper center. This free radical-coupled Cu complex catalyzes the two-electron oxidation of simple alcohols and aldehydes and the reduction of O₂ to hydrogen peroxide, fueling extracellular peroxidases involved in lignin degradation. In these proteins, the free radical is localized on a

tyrosine residue covalently crosslinked to a cysteinyl side chain (a Tyr-Cys dimer). The catalytically active enzyme is an intense green color, the result of unusual optical spectra arising from electronic transitions within the copper radical complex. Low energy transitions in the near IR result from interligand redox in this metal complex, ligand-to-ligand charge transfer (LLCT) processes that are closely related to the electron transfer coordinate for substrate oxidation. The active site metal complex is surprisingly flexible, twisting through a pseudorotation distortion when exogenous ligands bind, thereby modulating the basicity of a second tyrosine ligand that serves as a general base in catalysis. Many of these aspects of electronic structure and dynamics of the radical copper oxidases are the focus of active research. *Whittaker*

Manganese Metalloenzymes

Manganese is an essential element for life, forming the active site for a large number of metalloenzymes catalyzing hydrolytic or redox reactions, including the photosynthetic oxygen evolving complex. We are interested in the Mn redox sites in Mn superoxide dismutase (MnSD, mononuclear Mn) and Mn catalase (MnC, dinuclear Mn), enzymes that provide protection from toxic oxygen metabolites. The key question is: How do interactions between the protein, metal ion and exogenous ligands tune the redox potential and chemistry of these complexes? We are combining the powerful tools of molecular biology with advanced spectroscopic and computational approaches to explore the structure and dynamics of Mn active sites. For MnSD, we find an unexpected temperature dependence for the structures of anion complexes, which change coordination as the temperature is raised. This thermal transition implies that the stability of the active site structure is determined by dynamical features of the complex and that dynamical excitation may play an important role in controlling the energetics of ligand binding and redox. A wide range of projects relating to the chemistry and biology of Mn are in progress. *Whittaker*

Electronic Spectroscopy of Biological Metal Complexes

Electronic spectroscopy extends structural studies of biomolecules beyond the atomic resolution of X-ray crystallography to a level of structural detail that directly relates to chemistry. The techniques used in these studies span five decades of the electromagnetic spectrum, from microwaves to the ultraviolet and beyond. At the lowest energy, electron paramagnetic resonance (EPR) spectroscopy gives information on the electronic ground state, defining the molecular orbital that contains the unpaired electron in a paramagnetic complex. At higher energy, UV-visible absorption spectroscopy excites orbital transitions between electronic states, giving information on characteristic metal-ligand interaction energies that can be understood in terms of a ligand field or molecular orbital analysis. Polarization spectroscopy (linear dichroism, circular dichroism, and magnetic circular dichroism) can give more detailed information on ground and excited state electronic wave functions using geometric features of light to probe the active site. These experimental approaches can be complemented by spectroscopic modeling and computational biology methods to provide a detailed description of a metalloprotein complex and its interactions. *Whittaker*

Vibrational Spectroscopy of Metalloprotein Active Sites

Many spectroscopic methods are available for the investigation of structural and functional properties of metal ions in enzymes and proteins. We use electronic, vibrational (especially resonance Raman), and EPR spectroscopy to characterize metal-ion active sites. Our laboratory has a sensitive, state-of-the-art Raman instrument: a fast spectrograph with a liquid N₂-cooled CCD detector. We also use a combined FT-IR/FT-Raman instrument for protein and model compound studies.

Our research focuses on the description of the molecular and electronic structures of heme (iron porphyrin), nonheme-iron, and copper enzymes to gain an understanding of the role of the metal ion in enzymatic catalysis. Of particular interest is the biochemistry of O₂. Metalloproteins are involved in O₂ binding (hemoglobin or hemocyanin) and in oxidative chemistry whereby O₂ is reduced and substrates are oxygenated or oxidized. Trapped reaction intermediates and model

compounds help us to unravel these complex processes and to define reaction mechanisms.

Several heme enzymes are under investigation. Lignin and manganese peroxidases are enzymes involved in biodegradation of lignin in wood; these are the central themes of M.H. Gold's research at OGI. Heme oxygenase is a fascinating system that uses the O₂-binding affinity of its heme substrate in the cellular degradation of heme to open-chain biliverdin. These studies are carried out with P.R. Ortiz de Montellano's group at U.C. San Francisco. In collaboration with R.B. Gennis of the University of Illinois, we are studying cytochrome bd oxidase, an *E. coli* terminal oxidase expressed under O₂-limiting conditions. In all projects, modern molecular biology techniques provide site-directed mutants that permit alterations in structures and reactivities. *Loehr*

Heme Oxygenase

The resting heme-heme oxygenase enzyme substrate complex is much like myoglobin: The heme is linked to the enzyme by an iron-histidine bond and the iron exists mainly in a six-coordinate, high-spin state with an additional water ligand. The Fe-NHis bond was identified from its resonance Raman vibration at 216 cm⁻¹ in the Fe(II)-heme complex. Two conserved histidines were targeted as ligands, and both H132A and His25A mutants were prepared. The absence of the fingerprint frequency in only the latter species clearly identified His25 as the axial ligand. Remarkably, when imidazole was added to the inactive H25A preparation, activity was fully restored. Current effort is under way identify specific amino acids implicated in the oxidative catalysis. *Loehr*

Oxygen Intermediates of Dinuclear Iron Enzymes

Several diiron enzymes react with molecular oxygen to form powerful oxidizing agents important in biology. Examples include (i) ribonucleotide reductase protein R2, which oxidizes its Tyr-122 to the catalytically important neutral radical (Tyr-122.); (ii) methane monooxygenase, whose hydroxylase component oxidizes hydrocarbons to alcohols; (iii) plant desaturases, which oxidize fatty acids to olefins, e.g., stearoyl to oleoyl; and (iv) ferroxidase reactions, in which Fe²⁺ is oxidized to Fe³⁺. A common feature of these enzymes appears to be the formation of an initial peroxo intermediate from the reduced enzyme. Recent work in our laboratory has focused on the characterization of such O₂ intermediates by resonance Raman spectroscopy. *Loehr*

Oxygen Activation by Iron Proteins

Proteins under investigation by resonance Raman spectroscopy include the respiratory protein hemerythrin and the enzymes ribonucleotide reductase, methanemonooxygenase, and fatty acid desaturase. Each of these proteins appears to contain a novel Fe-O-Fe complex. In hemerythrin, binding of dioxygen is accomplished by reduction to peroxide in a reaction that is readily reversible. In ribonucleotide reductase, peroxide is similarly produced but decomposes irreversibly to a ferryl intermediate that is capable of carrying out oxidative chemistry. This dichotomy of behavior is reminiscent of the respiratory vs. peroxidase functions of different heme-containing proteins. We are interested in determining common principles that influence the pathways of oxygen utilization. This problem is being approached by structural elucidation of the iron sites in the proteins themselves and in model complexes, as well as by studying mechanisms of their reactions with oxygen-containing substrates. *Sanders-Loehr*

Electron-Transfer Centers in Proteins

Many electron-transfer proteins use metal-sulfur centers to carry out their redox reactions. Examples are the tetranuclear iron-sulfur cluster found in proteins such as ferredoxin, and the mononuclear blue copper center found in proteins such as plastocyanin. In both cases, the metals are ligated to the thiolate moiety of a cysteine residue, which gives rise to intense sulfur-to-metal absorption bands. These chromophores are readily probed by resonance Raman spectroscopy, which is proving to be sensitive to the orientation of the cysteine side chain and the protein backbone, as well as the metal-sulfur coordination geometry. Investigation of new proteins prepared by site-directed mutagenesis is yielding important information about how the environment

of the metal-sulfur cluster affects the redox potentials and electron-transfer functions of these proteins. *Sanders-Loehr*

Regulation of Long Chain Fatty Acid Transport and Oxidation in Mammalian Heart and Liver

The rate-limiting step in β -oxidation is the conversion of long-chain acyl-CoA to acylcarnitine, a reaction catalyzed by the outer mitochondrial membrane enzyme carnitine palmitoyltransferase I (CPTI) and inhibited by malonyl-CoA. The acylcarnitine is then translocated across the inner mitochondrial membrane by the carnitine/acylcarnitine translocase and converted back to acyl-CoA by CPTII. This reaction in intact mitochondria is inhibited by malonyl-CoA, the first intermediate in fatty acid synthesis, suggesting coordinated regulation of fatty acid oxidation and synthesis. Although CPTII has been examined in detail, studies on CPTI have been hampered by an inability to purify CPTI in an active form from CPTII. In particular, it has not been conclusively demonstrated that CPTI is even catalytically active, or whether sensitivity of CPTI to malonyl-CoA is an intrinsic property of the enzyme or is contained in a separate regulatory subunit that interacts with CPTI. To address these questions, the genes for human heart muscle M-CPTI and rat liver L-CPTI and CPTII were separately expressed in *Pichia pastoris*, a yeast with no endogenous CPT activity. High levels of CPT activity were present in purified mitochondrial preparations from both CPTI- and CPTII-expressing strains. Furthermore, CPTI activity was highly sensitive to inhibition by malonyl-CoA while CPTII was not. Thus, CPT catalytic activity and malonyl-CoA sensitivity are contained within a single CPTI-polypeptide in mammalian mitochondrial membranes. My laboratory is the first to describe the kinetic characteristics for the yeast-expressed CPTIs, the first such report for a CPTI enzyme in the absence of CPTII. Both yeast-expressed M-CPTI and L-CPTI are inactivated by detergent solubilization. However, removal of the detergent in the presence of phospholipids resulted in the recovery of malonyl-CoA-sensitive CPTI activity, suggesting that CPTI requires a membranous environment. CPTI is thus reversibly inactivated by detergents. We have isolated and sequenced the promoter region of the gene for the human heart M-CPTI. We are mapping the malonyl-CoA and substrate binding sites in human heart M-CPTI and liver L-CPTI by site-directed mutagenesis and chemical modification studies using residue-specific reagents. We will determine the structural basis for the high malonyl-CoA sensitivity of M-CPTI by constructing chimeras between M-CPTI and L-CPTI and by site-directed mutagenesis. We will prepare the expressed highly purified human heart M-CPTI and liver L-CPTI for structural characterization studies. Finally, we plan to study the regulation of human heart M-CPTI expression by hormonal, developmental and dietary factors. Our goal is to elucidate the molecular mechanism of the regulation of fatty acid transport and oxidation in mammalian cells. *Woldegiorgis*

Biophysics and Molecular Biology of Mitochondrial Carriers and Channels

The mitochondrial membrane contains specific cation porters that regulate mitochondrial volume, pH, and Ca^{2+} , and thereby provide the physiological milieu essential for ATP synthesis and energy metabolism. Our research is directed toward understanding these porters on a functional and molecular level, and ranges from ion transport kinetics to molecular biology of transport proteins. We are studying six channels and carriers from mitochondria: the $\text{K}^{+}/\text{H}^{+}$ antiporter, the ATP-dependent K^{+} channel, the $\text{Na}^{+}/\text{H}^{+}$ antiporter, the $\text{Na}^{+}/\text{Ca}^{2+}$ antiporter, the Ca^{2+} channel, and the uncoupling protein of brown adipose tissue mitochondria. Most of these porters have been partially purified and reconstituted into liposomes loaded with fluorescent probes that are sensitive to changes in concentrations of Na^{+} , K^{+} , Ca^{2+} , or H^{+} . This permits accurate kinetic studies of transport mediated by these membrane proteins. We have prepared polyclonal antibodies to a number of these carriers and have begun to clone the cDNAs that encode the transport proteins. We also are using a yeast expression system for the transport proteins that have been cloned, which allows us to study structure-function using site-directed mutagenesis. *Garlid*

Mitochondrial Bioenergetics

A number of unresolved questions relating to the mechanism of energy conservation in mitochondria are being addressed by theoretical and experimental approaches. A particular issue is whether redox slip in the electron transport chain can account for certain anomalous measurements of proton flux in mitochondria. We have addressed this issue by demonstrating the

proper theoretical framework for studying ion flux at high electrical membrane potentials. Our measurements indicate that the anomalies are not due to redox slip but rather to change in the height of the energy barrier to ion leaks as respiration is turned on and off. These studies also have led to a new mechanism of uncoupling induced by certain amphipathic amine local anesthetics. *Garlid*

Anaerobiosis of *Bacillus subtilis*

A gram-positive soil bacterium *B. subtilis* is highly amenable to genetic analysis and has been used as a model system to study fundamental microbiological research. In addition, *B. subtilis* is medically and industrially important since it produces a variety of antibiotics and extracellular enzymes. Although the organism has been widely used, it has been mistakenly referred to as a strict aerobe until recently. Our studies, together with others, have shown that *B. subtilis* is able to grow under anaerobic conditions by utilizing nitrate or nitrite as an alternative electron acceptor. In the absence of terminal electron acceptors, it undergoes fermentative growth. Our research aims include elucidation of the regulatory mechanisms through which the cells adapt to oxygen limitation. Molecular genetic and biochemical approaches are applied. *Nakano*

Two Physiological Roles of Nitrate and Nitrite Reductases

Nitrate and nitrite reductases have two roles in metabolism of *B. subtilis*: assimilation of nitrate/nitrite and anaerobic respiration. Two genetically- and biochemically distinct nitrate reductases are present to fulfill the dual roles; in contrast, a single nitrite reductase functions in both assimilation and respiration. The functional differences of the enzymes correspond to the difference in gene regulation. We have studied how these nitrate and nitrite reductase genes are regulated in response to nitrogen and oxygen limitation by promoter analysis of these genes and identification of trans-acting factors. The mechanisms of transcriptional activation of the nitrate/nitrite reductase genes are being investigated. *Nakano*

ResD-ResE Two-Component Signal Transduction System

Bacteria often encounter sudden environmental changes. Cells cope with such changes by an elaborate network of adaptive responses. The two-component signal transduction system senses and then processes information derived from environmental changes so that the cell can choose the appropriate adaptive response. This simple signal transduction system is widespread in bacteria and also found in plants and lower eukaryotes. ResE is a histidine kinase and ResD is a response regulator of this large protein family. We have shown that ResD and ResE are indispensable for anaerobic respiration in *B. subtilis*. A specific signal derived by oxygen limitation is recognized by the N-terminal input domain of the ResE kinase leading to autophosphorylation of a conserved histidine residue in the C-terminal transmitter domain. This phosphoryl group is then transferred to aspartate in the conserved N-terminal domain of ResD, altering the activity of its C-terminal domain as a transcriptional activator. The objectives of our studies are to determine how ResE senses oxygen limitation and how anaerobically induced genes are activated by ResD. *Nakano*

Flavohemoglobin (Hmp)

Flavohemoglobin is a ubiquitous protein present in organisms ranging from *Escherichia coli* to *Saccharomyces cerevisiae*. The N-terminal part of the protein has similarity to hemoglobin and the C-terminus is homologous to reductase with a flavin-binding domain. *B. subtilis hmp* was identified among genes, expression of which is induced by oxygen limitation. The anaerobic induction of *hmp* requires the ResD-ResE signal transduction pairs and nitrite. The detailed regulatory mechanism of *hmp* expression and its functional role in anaerobiosis are under investigation. *Nakano*

Peptide antibiotic biosynthesis

Our research is aimed at understanding the mechanism of peptide secondary metabolite biosynthesis. Peptides that are synthesized by the non-ribosomal thiotemplate mechanism in bacteria and fungi include antibiotics and bio-control agents used in medicine and agriculture. Non-ribosomally synthesized peptides also include iron-scavenging siderophores which are required for virulence by some bacterial pathogens and toxins produced by a variety of bacterial and fungal species that infect plants. Knowledge of how these processes are carried out at the molecular level may provide information that can ultimately be used to design ways to control the virulence of certain pathogens or to synthesize peptides with a defined structure and bioactivity. The spore-forming bacterium *Bacillus subtilis* will produce an abundance of peptide antibiotics under conditions of nutritional stress. The subject of study is the lipopeptide biosurfactant, surfactin. The genes encoding the enzymes that catalyze surfactin biosynthesis have been cloned and we are engaged in genetic engineering of the enzymes to understand the thiotemplate mechanism of peptide synthesis. *Zuber*

Regulation of Gene Expression and Signal Transduction in Prokaryotes

Bacteria can respond in variety of ways to a growth-restricting environment. Prolonged exposure to a nutritionally poor environment results in the induction of antibiotic biosynthesis, functions required for cell motility and processes of cellular differentiation that give rise to highly resistant cell types. How cells respond to nutritional stress is profoundly influenced by cell density. Extracellular signal molecules accumulate in the local environment of densely populated cell cultures and trigger antibiotic production and developmental processes such as sporulation and genetic competence. The objective of our research is to understand, in molecular terms, the regulatory networks that cells utilize to choose the most appropriate response to harsh conditions. In the spore-forming bacterium, *Bacillus subtilis*, establishment of genetic competence is co-regulated with peptide antibiotic biosynthesis by a complex network of signal transduction pathways that utilize protein components common to all prokaryotic and most eukaryotic organisms. *Zuber*

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research facilities

The department is well-equipped to carry on a vigorous research program. Instruments and equipment available in the department include:

Gas chromatograph/mass spectrometer with computer data system

High-resolution mass spectrometer

Capillary column gas chromatographs with flame ionization detectors

Fourier transform infrared spectrometers

Fourier transform Raman spectrometer with CW Nd:YAG laser

X-band electron paramagnetic resonance spectrometer

Ultraviolet/visible/near-infrared spectrophotometers

Scanning fluorescence spectrophotometers

Magnetic circular dichroism (MCD) spectrometer

Diode array UV/VIS spectrophotometer

Laser Raman spectrophotometer

Raman spectrograph with CCD detector

Ar, Kr, He-Cd, He-Ne, and dye lasers

High-vacuum lines

Phosphor imager

Controlled atmosphere reaction chamber

Super speed centrifuges

Ultracentrifuges

HPLCs

FPLCs

Fraction collectors

Liquid scintillation systems

Gel electrophoresis systems

Laminar flow hoods for sterile culture

Growth chambers

Constant temperature rooms

Light and electron microscopes

Ultrafiltration systems

Autoclaves

Photographic facilities

Probe type sonicators and extruder

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NINIAN J. BLACKBURN

Professor and Department Head

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RESEARCH INTERESTS

Structure and function of oxidase and oxygenase metalloenzymes; spectroscopy of metal sites in proteins with emphasis on EPR, EXAFS, absorption edge, and FTIR spectroscopies; coordination chemistry and biochemistry of copper.

REPRESENTATIVE PUBLICATIONS

N.J. Blackburn, M. Ralle, D. Sanders, J.A. Fee, S. de Vries, R.P. Houser, W.B. Tolman, M.T. Hay and Y. Lu, "XAS Studies on the CuA Centers of Heme-Copper Oxidases and Loop-Directed Mutants of Azurin. Implications for Redox Reactivity." In Spectroscopic Methods in Bioinorganic Chemistry (E.I. Solomon and K.D. Hodgson, Eds.). ACS Symposium Series, 692, 241 (1998).

W.A. Francisco, D.J. Merkler, N.J. Blackburn, and J.P. Klinman. "Kinetic Mechanism and Intrinsic Isotope Effects for the Peptidyl _-Amidating Enzyme Reaction." Biochemistry 37, 8244 (1998).

H.V. Obias, G.P.F. van Strijdonck, D.-H. Lee, M. Ralle, N.J. Blackburn & K.D. Karlin. "Heterobinucleating Ligand-Induced Structural and Chemical Variations in Oxo Complexes." J. Am. Chem. Soc. 120, 9696 (1998).

H.V. Obias, Y. Lin, N.N. Murthy, E. Pidcock, E.I. Solomon, M. Ralle, N.J. Blackburn, Y.-M. Neuhold, A.D. Zuberbühler & K.D. Karlin. "Peroxo-, Oxo-, and Hydroxo-Bridged Dicopper Complexes: Observation of Exogenous Hydrocarbon Substrate Oxidation." J. Am. Chem. Soc. 120, 12960 (1998).

M. Ralle, M.J. Cooper, S. Lutsenko & N.J. Blackburn. "The Menkes Disease Protein Binds Copper via Novel 2-Coordinate Cu(I)-Cysteineates in the N-Terminal Domain. J. Am. Chem. Soc. 120, 13525 (1998).



COLIN ANDREW
Research Assistant Professor

Research Background

Ph.D., Chemistry University of Newcastle Upon Tyne, 1992
Research Assistant Professor, Oregon Graduate Institute, 2000 - present

Research Interests

Bioinorganic chemistry; structure, function and spectroscopy of metalloenzymes; generation, mobilization and sensing of nitric oxide by metalloproteins; redox-active copper proteins.

Representative Publications

Hannan, J. P., S. L. Davy, G. R. Moore, R. R. Eady, and C. R. Andrew (1998) Effect of nickel(II) substitution on the resonance Raman and NMR spectra of *Alcaligenes xylosoxidans* azurin II: Implications for axial-ligand bonding interactions in cupredoxin active sites. *Biol. Inorg. Chem.* 3, 282-291.

Andrew, C. R., J. Han, T. den Blaauwen, G. van Pouderoyen, E. Vijgenboom, G. W. Canters, and J. Sanders-Loehr (1997) Cysteine ligand vibrations are responsible for the complex resonance Raman spectrum of azurin. *Biol. Inorg. Chem.* 2, 98-107.

Andrew, C. R., R. Fraczkiewicz, R. S. Czernuszewicz, P. Lappalainen, M. Saraste, and J. Sanders-Loehr (1996) Identification and description of copper-thiolate vibrations in the dinuclear CuA site of cytochrome c oxidase. *Am. Chem. Soc.* 118, 10436-10445.

van Pouderoyen, G., C. R. Andrew, T. M. Loehr, J. Sanders-Loehr, S. Mazumdar, H. A. O. Hill, and G. W. Canters (1996) Spectroscopic and mechanistic studies of type-1 and type-2 Cu sites in *Pseudomonas aeruginosa* azurin as obtained by addition of external ligands to mutant His46Gly. *Biochemistry* 35, 1397-1407.

Andrew, C. R., and J. Sanders-Loehr (1996) Copper-sulfur proteins: Using Raman spectroscopy to predict coordination geometry [Review]. *Acc. Chem. Res.* 29, 365-372.



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M.D., The Johns Hopkins University School of Medicine, 1961
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Norwegian Institute of Technology, 1987
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RESEARCH INTERESTS

Understanding specification porters on a functional and molecular level; ion transport kinetics, molecular biology of transport proteins; ATP synthesis and energy metabolism.

REPRESENTATIVE PUBLICATIONS

K.D. Garlid, P. Paucek, V. Yarov-Yarovoy, H.N. Murray, R.B. Darbenzio, A.J. D'Alonzo, N.J. Lodge, M.A. Smith & G.J. Grover. "Cardioprotective Effect of Diazoxide and Its Interaction with Mitochondrial ATP-Sensitive K⁺ Channels: Possible Mechanism of Cardioprotection." *Circ. Res.*, 81, 1072 (1997).

K.D. Garlid, M. Jaburek & P. Jezek. "The Mechanism of Proton Transport Mediated by Mitochondrial Uncoupling Proteins." *FEBS Lett.*, 438, 10 (1998).

P. Jezek & K.D. Garlid. "Mammalian Mitochondrial Uncoupling Proteins." *Int. J. Biochem. Cell Biol.*, 30, 1163 (1998).

P. Jezek, H. Engstova, M. Zackova, A.E. Vercesi, A.D.T. Costa, P. Arruda & K.D. Garlid. "Fatty Acid Cycling Mechanism and Mitochondrial Uncoupling Proteins." *Biochim. Biophys. Acta*, 1365, 319 (1998).

M. Jaburek, V. Yarov-Yarovoy, P. Paucek, W. Li & K.D. Garlid. "State-Dependent Inhibition of the Mitochondrial KATP Channel by Glyburide and 5-Hydroxydecanoate." *J. Biol. Chem.*, 273, 13578 (1998).



MICHAEL H. GOLD

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Ph.D., Biochemistry

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RESEARCH INTERESTS

Biochemistry; molecular biology; genetics of fungi; fungal degradation of lignin and environmental pollutants; structure and function of novel peroxidases; structure expression and regulation of fungal genes; biotechnology.

REPRESENTATIVE PUBLICATIONS

M.D. Sollewijn Gelpke, M. Mayfield-Gambill, G.P. Lin Cereghino & M.H. Gold. "Homologous Expression of Recombinant Lignin Peroxidase in *Phanerochaete chrysosporium*." *Appl. Environ. Microbiol.*, 65, 1670 (1999).

K. Kishi, M. Kusters-van Someren, M.B. Mayfield, J. Sun, T.M. Loehr & M.H. Gold, "Characterization of MnII Binding Site Mutants of Manganese Peroxidase," *Biochemistry*, 35, 8986 (1996).

G.V.B. Reddy & M.H. Gold. "A Two-Component Tetrachlorohydroquinone Reductive Dehalogenase System from the Lignin-degrading Basidiomycete *Phanerochaete chrysosporium*." *Biochem. Biophys. Res. Commun.*, 257, 901 (1999).

M.H. Gold & M. Alic. "Molecular Biology of the Lignin-degrading Basidiomycete *Phanerochaete chrysosporium*." *Microbiol. Rev.*, 57, 605 (1993).

D. Sheng & M.H. Gold. "Oxidative Polymerization of Ribonuclease A by Lignin Peroxidase from *Phanerochaete chrysosporium*: Role of Veratryl Alcohol in Polymer Oxidation." *Eur. J. Biochem.*, 259, 626 (1999).



THOMAS M. LOEHR
Professor
Ph.D., Inorganic Chemistry
Cornell University, 1967
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RESEARCH INTERESTS

Metallobiochemistry; biological role of transition metals; molecular and electronic structures of metalloenzyme active sites; chemistry of O₂ metabolism; metal-oxo intermediates; resonance and FT Raman, FT-IR, and EPR spectroscopy.

REPRESENTATIVE PUBLICATIONS

J.D. Cohen, M.D. Fryzuk, T.M. Loehr, M. Mylvaganam & S.J. Rettig, "Synthesis and Structure of a Zirconium Dinotrogen Complex with a Side-on Bridging N₂ Unit," *Inorg. Chem.*, 37, 112 (1998).

P. Moëne-Loccoz, C. Krebs, K. Herlihy, D. E. Edmondson, E. C. Theil, B. H. Huynh & T. M. Loehr. "The Ferroxidase Reaction of Ferritin Reveals a Diferric μ -1,2 Bridging Peroxide Intermediate in Common with Other O₂-Activating Non-Heme Diiron Proteins." *Biochemistry* 38, 5290 (1999).

Y. Liu, P. Moëne-Loccoz, D. P. Hildebrand, A. A. Wilks, T. M. Loehr & A. Grant Mauk. "Replacement of the Proximal Histidine Iron Ligand by a Cysteine or Tyrosine Converts Heme Oxygenase to an Oxidase." *Biochemistry* 38, 3733 (1999).

J. A. Broadwater, J. Ai, T. M. Loehr, J. Sanders-Loehr & B. G. Fox. "Peroxodiferric Intermediate of Stearoyl-Acyl Carrier Protein Δ 9 Desaturase: Oxidase Reactivity During Single Turnover and Implications for the Mechanism of Desaturation." *Biochemistry* 37, 14664 (1998).

P. Moëne-Loccoz, J. Baldwin, B. A. Ley, T. M. Loehr & J. M. Bollinger, Jr. "O₂ Activation by Non-Heme Diiron Proteins: Identification of a Symmetric μ -1,2 Peroxide in a Mutant of Ribonucleotide Reductase. *Biochemistry* 37, 14659 (1998).



PIERRE MOENNE-LOCCOZ
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RESEARCH INTERESTS

Structure-function relationships within proteins. Metallo- and heme-proteins, photosynthetic reaction centers. Spectroscopic studies of enzyme-active sites and their cofactors.

REPRESENTATIVE PUBLICATIONS

I. Rodríguez-Crespo, P. Moenne-Loccoz, T.M. Loehr & P.R. Ortiz de Montellano, "Endothelial Nitric Oxide Synthase: Modulations of the Distal Heme Site Produced by Progressive N-Terminal Deletions," *Biochemistry*, 36, 8530 (1997).

P. Moenne-Loccoz & S. DeVries, "Structural Characterization of the Catalytic High-Spin Heme b of Nitric Oxide Reductase: A Resonance Raman Study," *J. Am. Chem. Soc.*, 120, 5147 (1998).

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Y. Liu, P. Moenne-Loccoz, D.P. Hildebrand, A. Wilks, T.M. Loehr, A.G. Mauk & P.R. Ortiz de Montellano. "Replacement of the Proximal Histidine Iron Ligand by a Cysteine or Tyrosine Converts Heme Oxygenase to an Oxidase." *Biochemistry*, 38, 3733 (1999).

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RESEARCH INTERESTS

Anaerobiosis of *Bacillus subtilis*; oxygen-controlled gene regulation; two-component signal transduction system; transcriptional activation; nitrate/nitrite reductases; flavohemoglobin; anaerobic electron transport.

REPRESENTATIVE PUBLICATIONS

M.M. Nakano, T. Hoffmann, Y. Zhu & D. Jahn. "Nitrogen and Oxygen Regulation of *Bacillus subtilis* nasDEF Encoding NADH-dependent Nitrite Reductase by TnrA and ResDE." *J. Bacteriol.*, 180, 5344 (1998).

M.M. Nakano, P. Zuber & A.L. Sonenshein, "Anaerobic Regulation of *Bacillus subtilis* Tricarboxylic Acid Cycle Genes," *J. Bacteriol.*, 180, 3304 (1998).

M.M. Nakano & P. Zuber, "Anaerobic Growth of a 'strict aerobe' (*Bacillus subtilis*)," *Annu. Rev. Microbiol.*, 52, 165 (1998).

M.M. Nakano, Y.P. Dailly, P. Zuber & D.P. Clark, "Characterization of Anaerobic Fermentative Growth in *Bacillus subtilis*: Identification of Fermentation End Products and Genes Required for Growth," *J. Bacteriol.* 179, 6749 (1997).

M. LaCelle, M. Kumano, K. Kurita,
K. Yamane, P. Zuber & M.M. Nakano, "Oxygen-Controlled Regulation of the Flavohemoglobin
Gene in *Bacillus subtilis*," J. Bacteriol. 178, 3803 (1996).



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Dr.Rer.Nat., Biophysics and Chemical Physics
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Ph.D., Biological Science
The Academy of Sciences of the Czech Republic, 1991

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RESEARCH INTERESTS

Molecular biophysics of membrane transport with emphasis on two ATP-dependent K⁺ channels of cardiac mitochondria and sarcolemma; their receptor properties, roles in cellular signaling, bioenergetics and cardiac pharmacology.

REPRESENTATIVE PUBLICATIONS

M. Jaburek, V. Yarov-Yarovoy, P. Paucek, W. Li & K.D. Garlid "State-Dependent Inhibition of the Mitochondrial KATP Channel by Glyburide and 5-Hydroxydecanoate." J. Biol. Chem., 273, 13578 (1998).

K.D. Garlid, P. Paucek, V. Yarov-Yarovoy, H.N. Murray, R.B. Darbenzio, A.J. D'Alonzo, N.J. Lodge, M.A. Smith G.J. Grover. "Cardioprotective Effect of Diazoxide and Its Interaction with Mitochondrial ATP-Sensitive K⁺ Channels: Possible Mechanism of Cardioprotection." Circ. Res., 81, 1072 (1997).

P. Paucek, V. Yarov-Yarovoy, X. Sun & K.D. Garlid, "Inhibition of the Mitochondrial KATP Channel by Long-chain Acyl-CoA Esters and Activation by Guanine Nucleotides," J. Biol. Chem., 271, 32084 (1996).

K.D. Garlid, P. Paucek, V. Yarov-Yarovoy, X. Sun & P. Schindler, The Mitochondrial KATP Channel as a Pharmacological Receptor," J. Biol. Chem., 271, 8796 (1996).

K.D. Garlid, X. Sun, P. Paucek & G. Woldegiorgis, "Mitochondrial Cation Transport," Methods Enzymol., 260, 331 (1995).



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University of Bonn, Germany, 1993

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RESEARCH INTERESTS

Metallobiochemistry; structure-function analysis of copper-containing enzymes. Spectroscopic

characterization of copper-transporting proteins such as the Menkes disease protein and its chaperone HAH1. Spectroscopic techniques used are extended X-ray absorption fine spectroscopy (EXAFS), electron paramagnetic resonance, mass spectrometry, and protein crystallography.

REPRESENTATIVE PUBLICATIONS

M. Ralle, M.L. Verkhovskaya, J.E. Morgan, M.I. Verkhovsky, M. Wikstrom & N.J. Blackburn, "Coordination of CuB in Reduced and CO-liganded States of Cytochrome bo3 from *Escherichia coli*. Is Chloride Ion a Cofactor?" *Biochemistry*, 38, 7185 (1999).

N.J. Blackburn, M. Ralle, E. Gomez, M.G. Hill, A. Pastuszyn, D. Sanders & J.A. Fee, "Selenomethionine-substituted *Thermus thermophilus* Cytochrome ba3: Characterization of the CuA Site by Se and Cu K-EXAFS." *Biochemistry*, 38, 7075 (1999).

M. Ralle, M.J. Cooper, S. Lutsenko & N.J. Blackburn. "The Menkes Disease Protein Binds Copper via Novel 2-Coordinate Cu(I)-Cysteineates in the N-Terminal Domain. *J. Am. Chem. Soc.* 120, 13525 (1998).

M. Ralle, J.C. Bryan, A. Habenschuss & B. Wunderlich, "Low-temperature Phase of Tetra-n-ethylammonium Bromide," *Acta Crystall.* C53, 488 (1997).

C.E. Barnes, M. Ralle, S.A. Vierkoetter & J.E. Penner-Hahn, "Temperature-dependent RhRh EXAFS in Dinuclear and Adsorbed Rhodium Species." *J. Am. Chem. Soc.*, 117, 5861 (1995).



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RESEARCH INTERESTS

Mammalian chemocommunication: role of pheromones in sexual reproduction of Asian elephants; ultrastructure of chemoreceptors including vomeronasal organ; temporal gland, chemistry, and function; reproductive aspects of hormones and pheromones in carcharhinoid sharks.

REPRESENTATIVE PUBLICATIONS

L.E.L. Rasmussen. Source and cyclic release pattern of (Z)-7-dodecenyl acetate, the preovulatory pheromone of the female Asian elephant. *Chem. Senses* (2001)

L.E.L. Rasmussen and Krishnamurthy, V. How chemical signals integrate Asian elephant society: the known and the unknown. *Zoo Biology*, 19:405-423. (2000)

H. S. Riddle, S. W. Riddle, L.E.L. Rasmussen, and T. E. Goodwin. The first disclosure and preliminary investigation of a liquid released from the ears of African elephants. *Zoo Biol.*, 19:475-80. (2000)

L.E.L. Rasmussen. "Evolution of Chemical Signals in the Asian Elephant, *Elephas maximus*: Behavioral and Ecological Influences." *J. Bioscience*, 24, 241 (1999).

L.E.L. Rasmussen. "Chemical Communication: An Integral Part of Functional Asian Elephant (*Elephas maximus*) Society." *Ecoscience*, 5, 410 (1998).

L.E.L. Rasmussen, T.D. Lee, A. Zhang, W.L. Roelofs & G.D. Daves, Jr., "Purification, Identification, Concentration and Bioactivity of (Z)-7-dodecen-1-yl acetate:Sex Pheromone of the Female Asian Elephant, *Elephas maximus*." *Chemical Senses*, 22, 775 (1997).



MATTHEW S. SACHS

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Massachusetts Institute of Technology, 1986

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RESEARCH INTERESTS

Signals and mechanisms used by cells to regulate growth and differentiation; mechanisms of transcriptional and translational control that regulate expression of the *Neurospora crassa* arg-2 gene; molecular biology of *Neurospora*'s response to light and its circadian rhythm; evolution of microorganisms.

REPRESENTATIVE PUBLICATIONS

Z. Wang, P. Fang & M.S. Sachs. "The Evolutionarily Conserved Attenuator Peptide Regulates the Movement of Ribosomes that have Translated It." *Mol. Cell. Biol.*, 18, 7528 (1998).

M.S. Sachs. "Posttranscriptional Control of Gene Expression in Filamentous Fungi." *Fungal Genet. Biol.*, 23, 117 (1998).

A.L. Schroeder, H. Inoue & M.S. Sachs, "DNA Repair in *Neurospora*," in *DNA Damage and Repair*, Vol. I: DNA Repair in Prokaryotes and Lower Eukaryotes. Humana Press, pp 503-538 (1997).

Z. Wang & M.S. Sachs, "Arginine-specific Regulation Mediated by the *Neurospora crassa* arg-2 Upstream Open Reading Frame in a Homologous, Cell-free in vitro Translation System," *J. Biol. Chem.*, 272, 255 (1997).

Z. Wang & M.S. Sachs. "Ribosome Stalling is Responsible for Arginine-specific Translational Attenuation in *Neurospora crassa*." *Mol. Cell. Biol.*, 17, 4904 (1997).



JOANN SANDERS-LOEHR

Professor

Ph.D., Biochemistry

Cornell University, 1969

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RESEARCH INTERESTS

Investigation of the role of metal ions in proteins by resonance Raman spectroscopy; oxygen activation and metabolism; active-site structures and redox reactions of iron proteins, copper proteins and quinone-containing proteins.

REPRESENTATIVE PUBLICATIONS

C. R. Andrew & J. Sanders-Loehr, "Copper-Sulfur Proteins: Using Raman Spectroscopy to Predict Coordination Geometry," *Acc. Chem. Res.*, 29, 365 (1996).

C.R. Andrew, J. Han, T. denBlaauwen, G. van Pouderoyen, E. Vijgenboom, G.W. Canters, T.M. Loehr & J. Sanders-Loehr, "Cysteine Ligand Vibrations are Responsible for the Complex Resonance Raman Spectrum of Azurin," *J. Biol. Inorg. Chem.*, 2, 98 (1997).

N. Nakamura, P. Moñne-Loccoz, K. Tanizawa, M. Mure, S. Suzuki, J.P. Klinman & J. Sanders-Loehr, "Topaquinone-Dependent Amine Oxidases: Identification of Reaction Intermediates by Raman Spectroscopy," *Biochemistry*, 36, 11479 (1997).

J.A. Broadwater, J. Ai, T.M. Loehr, J. Sanders-Loehr & B.G. Fox. "Peroxydiferric Intermediate of Stearoyl-Acyl Carrier Protein Δ^9 Desaturase: Oxidase Reactivity During Single Turnover and Implications for the Mechanism of Desaturation." *Biochemistry*, 37, 14664 (1998).

T.M. Loehr & J. Sanders-Loehr, "Techniques for Obtaining Resonance Raman Spectra of Metalloproteins," *Methods Enzymol.*, 226, 431 (1993).



JAMES W. WHITTAKER

Associate Professor
Ph.D., Biochemistry
University of Minnesota, 1983
jim@bmb.ogi.edu

RESEARCH INTERESTS

Electronic structures and dynamics of metalloenzyme active sites; spectroscopic and computational approaches to biomolecular structure; metalloenzyme mechanisms; enzyme engineering; biology of metal ions.

REPRESENTATIVE PUBLICATIONS

J.W. Whittaker & M.M. Whittaker. "Radical Copper Oxidases, One Electron at a Time." *Pure & Appl. Chem.*, 70, 903 (1998).

M.M. Whittaker & J.W. Whittaker. "A Glutamate Bridge is Essential for Dimer Stability and Metal Selectivity in Manganese Superoxide Dismutase." *Biol. Chem.*, 273, 22188 (1998).

R.A. Edwards, H.M. Baker, M.M. Whittaker, J.W. Whittaker, G.B. Jameson & E.N. Baker, "Crystal Structure of Escherichia coli Manganese Superoxide Dismutase at 2.1 Å Resolution," *J. Biol. Inorg. Chem.*, 3, 161 (1998).

M.M. Whittaker, D.P. Ballou & J.W. Whittaker, "Kinetic Isotope Effects as Probes of the Mechanism of Galactose Oxidase," *Biochemistry*, 37, 8426 (1998).

J.W. Whittaker, "The Free Radical Coupled Copper Active Site in Galactose Oxidase," in Metal Ions in Biological Systems, Vol. 30, H. Sigel (Ed.), Marcel Dekker, New York, p. 315 (1995).



GEBRETATEOS WOLDEGIORGIS

Associate Professor
Ph.D., Nutritional Biochemistry
University of Wisconsin-Madison, 1976
gwoldeg@bmb.ogi.edu

RESEARCH INTERESTS

Regulation of long-chain fatty acid transport and oxidation in mammalian cells; regulation of cell metabolism and signaling by long-chain acyl CoA esters; mitochondrial ion transport and bioenergetics.

REPRESENTATIVE PUBLICATIONS

J. Shi, H. Zhu, D.N. Arvidson & G. Woldegiorgis. "A Single Amino Acid Change (Substitution of Glutamate 3 with Alanine) in the N-terminal Region of Rat Liver Carnitine Palmitoyltransferase I Abolishes Malonyl CoA Inhibition and High Affinity Binding." J. Biol. Chem. 274, 9421 (1999).

J. Shi, H. Zhu, D.N. Arvidson, J.M. Cregg & G. Woldegiorgis. "Deletion of the Conserved First 18 N-terminal Amino Acid Residues in Rat Liver Carnitine Palmitoyltransferase I Abolishes Malonyl CoA Sensitivity and Binding." Biochemistry 37, 11033 (1998).

H. Zhu, J. Shi, Y. DeVries, D.N. Arvidson, J.M. Cregg & G. Woldegiorgis, "Functional Studies of Yeast-Expressed Human Heart Muscle Carnitine Palmitoyltransferase I," Arch. Biochem. Biophys., 347, 53 (1997).

H. Zhu, J. Shi, J.M. Cregg & G. Woldegiorgis, "Reconstitution of Highly Expressed Human Heart Muscle Carnitine Palmitoyltransferase I," Biochem. Biophys. Res. Commun., 239, 498 (1997).

Y. DeVries, D.N. Arvidson, H. Waterham, J.M. Cregg & G. Woldegiorgis, "Functional Characterization of Mitochondrial Carnitine Palmitoyltransferase I and II in the Yeast *Pichia pastoris*," Biochemistry, 36, 5285 (1997).



PETER ZUBER

Professor
Ph.D., Microbiology
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RESEARCH INTERESTS

Regulation of prokaryotic gene expression and development in response to stress; signal transduction; regulation and mechanism of peptide antibiotic biosynthesis; regulation of genetic

competence in *Bacillus subtilis*.

REPRESENTATIVE PUBLICATIONS

J. Liu, W.M. Cosby & P. Zuber. "Role of Lon and ClpX in the Post-translational Regulation of a Sigma Subunit of RNA Polymerase Required for Cellular Differentiation of *Bacillus subtilis*." *Mol. Microbiol.*, 33, 415 (1999).

M. Ogura, L. Liu, M. LaCelle, M.M. Nakano & P. Zuber. "Mutational Analysis of ComS: Evidence for the Interaction of ComS and MecA in the Regulation of Competence Development in *Bacillus subtilis*." *Mol. Microbiol.*, 32, 799 (1999).

J. Liu & P. Zuber, "A Molecular Switch Controlling Competence and Motility: Competence Regulatory Factors ComS, MecA, and ComK Control σ^D -Dependent Gene Expression in *Bacillus subtilis*," *J. Bacteriol.*, 180, 4243 (1998).

P. H. Weinreb, L.E.N. Quadri, C.T. Walsh & P. Zuber, "Stoichiometry and Specificity of in vitro Phosphopantetheinylation and Aminoacylation of the Valine-Activating Module of Surfactin Synthetase," *Biochemistry*, 37,1575 (1998)

L.E.N. Quadri, P.H. Weinreb, M. Lei, M.M. Nakano, P. Zuber & C.T. Walsh, "Characterization of Sfp, a *Bacillus subtilis* Phosphopantetheinyl Transferase for Peptidyl Carrier Protein Domains in Peptide Synthetases," *Biochemistry* 37,1585 (1998)

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Department of Biochemistry and Molecular Biology

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course offerings

BMB527 Biochemistry I: Proteins and Enzymes

Primary, secondary, and tertiary structure of proteins; enzyme mechanisms; enzyme kinetics. 4 credits

BMB528 Biochemistry II: Introduction to Molecular Biology

DNA replication, RNA synthesis, and protein synthesis; genetic code; gene regulation. 4 credits

BMB529 Biochemistry III: Metabolism and Bioenergetics

Metabolism of carbohydrates, lipids, and amino acids; bioenergetics; photosynthesis; oxidative phosphorylation. 4 credits

BMB530 Enzyme Structure and Function

Overview of protein structures determined by X-ray crystallography and of the principles of protein folding. Elucidation of the mechanisms of enzymatic reactions from studies of active site structures, kinetics, and the reactions of model systems. 4 credits

BMB531 Enzyme Mechanisms

This course covers enzyme purification and characterization, basic organic reaction mechanisms, and application of organic mechanistic principles to enzyme reactions. Mechanisms of dehydrogenases, oxidases, peroxidases, oxygenases, proteases, and pyridoxal phosphate-dependent enzymes are discussed in detail. 4 credits

BMB532 Bioenergetics and Membrane Transport

Critical evaluation of the chemiosmotic theory with specific reference to oxidative phosphorylation, photophosphorylation, and metabolite transport. Biochemical mechanisms of energy transduction common to bacterial and mitochondrial respiration, and bacterial and plant photosynthesis are reviewed. 4 credits

BMB534 Instrumental Methods in Biophysics I

Theory and application of physical techniques to problems in biochemistry. Optical, fluorescence, circular dichroism, infrared, and Raman spectroscopy of chromophoric groups. Magnetic susceptibility and nuclear magnetic resonance of metalloproteins. 4 credits

BMB535 Instrumental Methods in Biophysics II

Investigation of physical techniques particularly useful for studying metalloproteins. Electron paramagnetic resonance, electron spin echo, magnetic circular dichroism, and X-ray absorption spectroscopy. The course has significant "hands-on" exposure to both instrumentation and computer simulation techniques. 4 credits

BMB537 Metals in Biochemistry

Comprehensive study of the chemistry and biochemistry of metal ions in biological molecules and living systems. Topics include metalloprotein structure, metal ion specificity, biological oxidation mechanisms, metal ion catalysis in enzymes, metal ion transport, and gene regulation. 4 credits

BMB538 Coordination Chemistry

Structures and stabilities of transition metal coordination compounds with mono- and multi-dentate

ligands; coordination compounds as models for biological metal centers; strategies for synthesis of transition metal complexes. 4 credits

BMB539 Chemical Group Theory

Properties of mathematical groups; symmetry properties of molecules; symmetry groups, representations, and character tables. Applications of group theory to the study of structure and spectroscopy of organic and inorganic molecules; Hückel molecular orbital theory; ligand field theory; electronic spectroscopy and vibrational spectroscopy. 4 credits

BMB540 Advanced Molecular Biology

An in-depth study of the molecular mechanisms governing the replication, recombination, transcription, and translation of genetic material. Emphasis is placed on experimental approaches that have led to our understanding of these fundamental processes. 4 credits

BMB541 Molecular Genetics of Development

A focused study of selected topics examining the regulation of gene expression during cellular differentiation. Emphasis is placed on the molecular nature of cell-cell interactions and the genetic control of complex cellular responses to developmental and environmental stimuli. 4 credits

BMB542 Molecular Cell Biology

The techniques of molecular biology have created an explosion in knowledge of cell structure and function. This course examines the following topics: cellular organization; cell signaling; cell differentiation; cell evolution. Knowledge of the cell is obtained through combining core readings and lectures with student-led discussions of primary research papers. 4 credits

BMB543 Current Topics in Proteomics

Proteomics is a new area of molecular biology which aims to identify and map the total protein complement of a genome. It expands the scope of biological investigation from studying single proteins to systematically studying all proteins. Proteomics has broad applications in disease diagnosis, drug discovery, and agriculture. The key technologies used in proteomics are 2-dimensional gel electrophoresis, mass spectrometry (ESI-MS, MALDI-TOF), imaging, and database. This course will focus on electrophoresis, mass spectrometry, and applications, using lectures, student seminars, and literature readings. 3 credits

BMB544 Introduction to Computational Biology

Primary literature of computational biology and hands-on experience in data manipulation from local and remote databases. 3 credits

BMB580 Special Topics in Biotechnology

Examination of current and past research papers in a specific area of biotechnology that is of mutual interest to the student and the faculty member. Requires a written review paper or seminar presentation in one of the Student Seminar series. Variable and repetitive credit.

BMB591 Department Seminar: Biochemistry/ Molecular Biology

1 credit, repetitive

BMB594 Metallobiochemistry Student Seminar

Presentations and discussions of selected topics from the recent literature and of ongoing research projects in the department. 2 credits, repetitive

BMB596 Molecular Biology/Biochemistry Student Seminar

Presentation and discussion of journal articles from the recent literature in molecular biology, genetics, and biochemistry. 2 credits, repetitive

BMB598 Ion Transport Student Seminar

Presentation and discussion of journal articles from the recent literature in bioenergetics and

membrane transport. 2 credits, repetitive

BMB600 Research

Supervised research participation. Variable and repetitive credit.

BMB610 Nonthesis Research

Supervised research as a component of the nonthesis M.S. degree. Variable and repetitive credit.

BMB620 Professional Internship

These courses provide the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers.

Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. Variable credit

BMB700 M.S. Thesis Research

Research toward the thesis for the M.S. degree. Variable and repetitive credit.

BMB800 Ph.D. Dissertation Research

Research toward the dissertation for the Ph.D. degree. Variable and repetitive credit.

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admissions and degree requirements

Admission Requirements

Admission requirements are the same as the general requirements of the institution. General aptitude GRE scores are required, except in cases of advanced placement admission for M.S. students (see below). A candidate must hold a bachelor's degree in computer science, mathematics, engineering, one of the biological or physical sciences, or one of the quantitative social sciences. Candidates with a degree in a field other than computer science must have completed courses in the following subject areas:

- An introduction to programming in a high-level language
- Data structures*
- Discrete mathematics*
- Logic design and computer organization
- Calculus or other college-level mathematics

* OGI515 Data Structures and Discrete Mathematics may be taken to meet the prerequisite.

► [Click here to apply on-line for admission to OGI.](#)



Advanced Placement Admissions for M.S. Students

Students who are currently studying at OGI and have earned 12 credits in computer science classes with a minimum 3.0 GPA are exempt from the GRE and TOEFL requirements. Only two letters of recommendation are required; all other admissions requirements remain the same.

If a student applies to the Computational Finance program through advanced placement, the 12 credits earned may be from any OGI academic department. For Computational Finance applicants, OGI 501 would also count toward this 12-credit total.

Degree Requirements

A Student Program Committee (SPC) that provides academic advising is assigned for each matriculating student. The student's SPC also approves the application of courses toward the degree requirements.

A maximum of 21 credits earned prior to matriculation at OGI may be applied toward the master's degree. This may include up to 12 credits transferred from other institutions (up to 18 from

Portland State University, the University of Oregon or Oregon State University) and credits taken at OGI prior to matriculation.

The program of study for each master's student may be tailored to meet individual needs by the SPC. Students are particularly encouraged to include special-topic courses (CSE 58X) relevant to their interests.

Professional Internship Option

Participation is limited by available industrial internships. Students declaring this option must complete 45 credits of course work and up to an additional 3 credits of a professional internship. (CSE620)

MASTER OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING

All M.S. students must complete the M.S. core of 21 credits.

M.S. CSE CORE

The following courses are required of all M.S. CSE students:

CSE500	Introduction to Software Engineering	3 credits
CSE511	Principles of Compiler Design	3 credits
CSE513	Introduction to Operating Systems	3 credits
CSE514	Introduction to Database Systems	3 credits
CSE521	Introduction to Computer Architecture	3 credits
CSE532	Analysis and Design of Algorithms	3 credits
CSE533	Automata and Formal Languages	3 credits

M.S. THESIS OPTION

Students choosing the thesis option must submit and defend a master's thesis and may apply up to 12 credits of thesis research (CSE 700) toward the 45 credit requirement.

1. M.S. CSE CORE (listed above)
2. CSE 700 M.S. THESIS (maximum 12 credits)
3. ELECTIVES (12 credits), as directed by the thesis advisor or SPC

Please note: Students may not receive credit for both CSE504 and OMSE533.

M.S. NONTHESIS OPTIONS

Students choosing the nonthesis M.S. option must complete 45 credits of course work; up to six credits of nonthesis research (CSE 610) may be included, with the approval of the student's SPC. Students pursuing the non-thesis option may choose one of the nine areas of emphasis defined

below or consult their SPC to define a custom program.

ADAPTIVE SYSTEMS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. ADAPTIVE SYSTEMS CORE (18 credits):

Required:

CSE547	Statistical Pattern Recognition	3 credits
CSE560	Artificial Intelligence	3 credits

Choose four of:

CSE540	Neural Network Algorithms & Architecture	3 credits
CSE545	Advanced Neural Net Algorithms	3 credits
CSE546	Fundamentals of Compression Technology	3 credits
CSE550	Spoken Language Systems	3 credits
CSE562	Natural Language Processing	3 credits
CSE564	Human-Computer Interaction	3 credits
CSE568	Empirical Research Methods	3 credits
CSE576	Modern Applied Statistics	3 credits
ECE554	Adaptive Signal Processing	4 credits

3. SUGGESTED ELECTIVES (6 credits)

CSE563	Multi-Agent Systems	3 credits
CSE569	Scholarship Skills	3 credits
CSE58X	appropriate special topics course (or) any CSE class not already taken	

Please note: Students may not receive credit for both CSE504 and OMSE533.

COMPUTATIONAL FINANCE AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. COMPUTATIONAL FINANCE CORE (18 credits):

Required: (Choose 6 of the following:)

CSE570	Principles of Modern Finance	3 credits
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CSE571	Investment and Portfolio Management	3 credits
CSE572	Global Markets and Foreign Exchange	3 credits
CSE573	Options and Futures	3 credits
CSE574	Options and Futures II	3 credits
CSE575	Risk Management	3 credits
CSE577	Financial Time-Series Analysis	3 credits
CSE578	Financial Markets, Price Behavior and Technical Trading	3 credits
CSE579	Advanced Numerical Computing in Finance	3 credits

3. SUGGESTED ELECTIVES (6 credits)

CSE509	Object-Oriented Programming	3 credits
CSE540	Neural Network Algorithms & Architecture	3 credits
CSE544	Introduction to Probability and Statistical Inference	3 credits
CSE545	Advanced Neural and Adaptive Algorithms	3 credits
CSE546	Fundamentals of Coding & Signal Compression	3 credits
CSE547	Statistical Pattern Recognition	3 credits
CSE548	Modern Applied Statistics	3 credits
CSE549	Applied Business Forecasting	3 credits
CSE555	Mathematical Methods for Science and Engineering	3 credits
CSE564	Human-Computer Interaction	3 credits
CSE568	Empirical Research Methods	3 credits
CSE58X	Special Topics	
ECE525	Analytical Techniques in Process & Communication	4 credits
ECE555	Engineering Optimization	4 credits

COMPUTER SECURITY AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. COMPUTER SECURITY CORE (15 credits)

Required:

CSE503	Software Engineering Processes	3 credits
CSE524	TCP/IP Internetworking Protocols	3 credits
CSE527	Principles and Practices of System Security	3 credits
CSE58X	Cryptography	3 credits
CSE58X	Assurance for Secure Computing Systems	3 credits

3. SUGGESTED ELECTIVES (9 credits)

CSE515	Distributed Computing Systems	3 credits
(or) any CSE class not already taken.		

Please note: Students may not receive credit for both CSE504 and OMSE533

DATA-INTENSIVE SYSTEMS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. DATA-INTENSIVE SYSTEMS CORE (12 credits)

Required:

CSE541	Database Implementation	3 credits
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Choose three of:

CSE515	Distributed Computing Systems	3 credits
CSE526	Modern Operating System Design	3 credits
CSE542	Object Data Management	3 credits
CSE58X	Informational Retrieval and the Internet	3 credits
CSE58X	Any special topics course in the database area	

3. SUGGESTED ELECTIVES (12 credits)

Any course in the Data-Intensive Systems area core, the Systems Software area core, the Software Engineering area core, or any CSE class not already taken. Please note: Students may not receive credit for both CSE504 and OMSE533.

HUMAN-COMPUTER INTERFACES AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. HUMAN-COMPUTER INTERFACES CORE (18 credits)

Required:

CSE560	Artificial Intelligence	3 credits
CSE564	Human-Computer Interaction	3 credits

Choose four of:

CSE547	Statistical Pattern Recognition	3 credits
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CSE551	Structure of Spoken Language	3 credits
CSE552	Hidden Markov Models for Speech Recognition	3 credits
CSE561	Dialogue	3 credits
CSE562	Natural Language Processing	3 credits
CSE563	Multi Agent Systems	3 credits
CSE567	Developing User-Oriented Systems	3 credits
CSE568	Empirical Research Methods	3 credits
CSE58X	Any special topics course appropriate to this area	

3. SUGGESTED ELECTIVES (6 credits)

CSE507	Logic Programming	3 credits
CSE515	Distributed Computing Systems	3 credits
CSE540	Neural Network Algorithms & Architecture	3 credits
CSE569	Scholarship Skills	3 credits

(or) any CSE class not already taken.

Please note: Students may not receive credit for both CSE 04 and OMSE533.

SOFTWARE ENGINEERING AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SOFTWARE ENGINEERING CORE (15 credits)

Required:

CSE503	Software Engineering Processes	3 credits
CSE504	Object-Oriented Analysis and Design	3 credits
CSE509	Object-Oriented Programming	3 credits
MST512	Project Management	3 credits

Choose one of:

CSE564	Human-Computer Interaction	3 credits
CSE567	Developing User-Oriented Systems	3 credits

3. SUGGESTED ELECTIVES (9 credits)

CSE515	Distributed Computing Systems	3 credits
	(or) any CSE class not already taken	

Please note: Students may not receive credit for both CSE504 and OMSE533.

SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS CORE (15 credits)

Required:

OMSE511	Managing Software Development	3 credits
OMSE521	Using Metrics & Models to Support Quantitative Decision Making	3 credits
OMSE531	Requirements Analysis	3 credits
OMSE533	Software Design Techniques	3 credits

Choose one of:

CSE564	Human-Computer Interaction	3 credits
CSE567	Developing User-Oriented Systems	3 credits

3. SUGGESTED ELECTIVES (9 credits)

Any CSE course not already taken. Please note: Students may not receive credit for both CSE504 and OMSE533.

SPOKEN LANGUAGE SYSTEMS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SPOKEN LANGUAGE SYSTEMS CORE (18 credits)

Choose six of:

CSE540	Neural Network Algorithms and Architectures	3 credits
CSE545	Advanced Neural and Adaptive Algorithms	3 credits
CSE547	Statistical Pattern Recognition	3 credits
CSE551	Structure of Spoken Language	3 credits
CSE552	Hidden Markov Models for Speech Recognition	3 credits
CSE560	Artificial Intelligence	3 credits
CSE562	Natural Language Processing	3 credits
CSE564	Human-Computer Interaction	3 credits
CSE568	Empirical Research Methods	3 credits
ECE540	Auditory & Visual Processing by Human & Machine	4 credits
ECE541	Speech Processing	4 credits
ECE544	Introduction to Signals and Systems	4 credits
ECE545	Speech Systems	3 credits
ECE551	Introduction to Digital Signal Processing	4 credits
ECE552	Digital Signal Processing II	4 credits

ECE554	Adaptive Signal Processing	4 credits
ECE58X	Speech Synthesis	variable

3. SUGGESTED ELECTIVES

Any course in the Spoken Language Systems core, or any CSE class not already taken. Please note: Students may not receive credit for both CSE 504 and OMSE 533.

SYSTEMS SOFTWARE AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SYSTEMS SOFTWARE CORE (12 credits)

Choose four of:

CSE515	Distributed Computing Systems	3 credits
CSE526	Modern Operating System Design	3 credits
CSE527	Principles and Practices of System Security	3 credits
CSE541	Database Implementation Technique	3 credits
CSE58X	plus any special topics courses appropriate to this area	

3. SUGGESTED ELECTIVES (12 credits)

Any course in the Systems Software area core or any CSE class not already taken. Please note: Students may not receive credit for both CSE 504 and OMSE 533.

MASTER OF SCIENCE IN COMPUTATIONAL FINANCE

The M.S. in [Computational Finance](#) is an interdisciplinary program offering students the flexibility to learn technical skills directly relevant to quantitative or computational work in the financial securities industry. A professional internship track is available.

1. M.S. IN COMPUTATIONAL FINANCE CORE (24 credits)

Choose eight of :

CSE570	Principles of Modern Finance	3 credits
CSE571	Investment and Portfolio Management	3 credits
CSE572	Global Markets and Foreign Exchange	3 credits
CSE573	Options and Futures I	3 credits
CSE574	Options and Futures II	3 credits
CSE575	Risk Management	3 credits
CSE577	Financial Time-Series Analysis	3 credits
CSE578	Financial Markets, Price Behavior and Technical Trading	3 credits

CSE579	<u>Advanced Numerical Computing in Finance</u>	3 credits
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2. BREADTH REQUIREMENT (21 credits)

Breadth requirement courses must come from at least two of the following tracks. The course lists for each track are representative, not exhaustive. Students with strong backgrounds or special interests may request approval to substitute other OGI courses in place of those listed below:

a. Applied Computing

OGI500	<u>Development with Visual Basic for Applications</u>	3 credits
OGI505	<u>Applications Programming in C++</u>	3 credits
OGI508	<u>Web Development with Java</u>	3 credits
OGI511	<u>Computational Tools for Engineering and Finance</u>	3 credits

b. Computer Science

CSE500	<u>Principles of Software Engineering</u>	3 credits
CSE504	<u>Object-Oriented Analysis and Design</u>	3 credits
CSE509	<u>Object-Oriented Programming</u>	3 credits
CSE514	<u>Introduction to Database Systems</u>	3 credits

c. Applied Mathematics, Statistics, and Machine Learning

CSE540	<u>Neural Network Algorithms and Architectures</u>	3 credits
CSE544	<u>Probability and Statistical Inference</u>	3 credits
CSE547	<u>Statistical Pattern Recognition</u>	3 credits
CSE548	<u>Statistical Computing</u>	3 credits
CSE549	<u>Applied Business Forecasting</u>	3 credits
CSE555	<u>Mathematical Methods for Engineering and Finance</u>	3 credits

d. Engineering

ECE525	<u>Analytical Techniques in Statistical Signal Processing</u>	4 credits
ECE544	<u>Introduction to Signals and Systems</u>	4 credits
ECE550	<u>Linear Systems</u>	4 credits
ECE554	<u>Adaptive Signal Processing</u>	4 credits
ECE555	<u>Engineering Optimization</u>	3 credits

e. Management Science

MST 501	<u>Managerial & Financial Accounting for Science &Technology</u>	4 credits
MST 502	<u>Financial Management for Science &Technology</u>	4 credits
MST 512	<u>Project Management</u>	3 credits
MST 520	<u>Managing in Science and Technology</u>	4 credits
MST 540	<u>International Management in Science &Technology</u>	3 credits

f. Finance

Additional core courses beyond the 8-course core requirement.

OREGON MASTER OF SOFTWARE ENGINEERING (OMSE)

Oregon Graduate Institute, Portland State University, Oregon State University, and the University of Oregon jointly offer the Oregon Master of Software Engineering (OMSE) degree to meet the needs of software professionals. The curriculum emphasizes the technical and leadership aspects of software engineering, teamwork and communication skills, and the business aspects of developing industrial-strength software. Admission requirements include a B.S. with pre-foundation courses in programming, discrete mathematics, data structures, operating systems, and computer architecture as well as two years of working experience. Courses may be taken on non-admitted basis. For additional information, see www.omse.org.

Oregon Master of Software Engineering students will take the following courses:

PART 1: SOFTWARE ENGINEERING FOUNDATIONS (21 credits)

These courses convey the foundation skills of the OMSE program in technical capabilities, personal competencies, and the business context for software development. The foundation courses teach the core technical competencies necessary to understand, adapt and apply the specific techniques, methods and tools covered in the subsequent Software Development in Context courses. OMSE 500 is the first course of the foundation courses. The other foundation courses require only OMSE 500 as a prerequisite.

OMSE500	Principles of Software Engineering	3 credits
OMSE511	Managing Software Development	3 credits
OMSE512	Understanding the Software Business	3 credits
OMSE513	Professional Communication Skills for Software Engineers	3 credits
OMSE521	Using Metrics and Models to Support Quantitative Decision Making	3 credits
OMSE522	Modeling and Analysis of Software Systems	3 credits
OMSE525	Software Quality Analysis	3 credits

PART 2: SOFTWARE DEVELOPMENT IN CONTEXT (12 credits)

The courses on software development in context provide instruction in the basic areas of software development: requirements, architecture, design, implementation, and testing. The course material in each of these areas provides instruction in underlying principles, development methods and tools, and analytic methods and tools with a focus on applying principles, techniques and tools. Course material focuses on applying techniques and skills from the foundation courses to realistic examples of the products of each development phase. Course emphasis is on understanding the application and effect of the techniques covered in the context of real software development.

OMSE531	Software Requirements Engineering	3 credits
OMSE532	Software Architecture and Domain Analysis	3 credits
OMSE533	Software Design Techniques	3 credits
OMSE535	Software Implementation and Testing	3 credits

PART 3: PROGRAM INTEGRATION AND STRATEGIC DEVELOPMENT SKILLS (9 credits)

Courses in this area focus on integrating the skills taught in the OMSE program and on the ability to think abstractly about the processes and products of software engineering. Students must have completed Part 1 and Part 2 of the OMSE program before beginning Part 3. (Exception: A student may begin taking courses in Part 3 in the same term as taking any remaining courses in the first two parts.) In OMSE 551, Strategic Software Engineering students learn the skills necessary to understand, model, and adapt their software engineering processes to meet emerging needs. In OMSE555/556, the Software Development Practicum, students participate in the end-to-end development of a significant software product and apply the personal competencies and development skills learned throughout the program in a development context that includes the essential characteristics of real commercial software development.

OMSE551	Strategic Software Engineering	3 credits
OMSE555	Software Development Practicum I	3 credits
OMSE556	Software Development Practicum II	3 credits

PART 4: ELECTIVES (6 credits)

Any CSE or OMSE class not already taken.

OREGON GRADUATE ENGINEERING INTERNSHIP PROGRAM

Oregon Graduate Institute is one of the partners in the Oregon Graduate Engineering Internship Program (OGEIP) that offers master's-level engineering and computer science students an opportunity for on-the-job experience. For more information and how to apply see www.ogeip.org.

OGI's [Department of Computer Science](#) has an internship program independent of OGEIP. For more information and availability regarding these internships, please contact the department.

COOPERATIVE COMPUTER SCIENCE PROGRAMS

OGI has established undergraduate/graduate cooperative programs with Lewis & Clark College, Pacific University, Reed College, and Willamette University. These programs allow selected undergraduate students to enter the master's program in computer science and engineering at the beginning of their senior year. In two years of residence at OGI, the student can simultaneously fulfill requirements for the bachelor's degree at the undergraduate institution and the master's degree at OGI.

PH.D. PROGRAM

The Ph.D. program is strongly oriented toward preparation for research. Each student has the opportunity to work closely with a faculty research advisor throughout his or her residency at OGI. A student must satisfy the institutional requirements for the Ph.D.

Candidacy is satisfied in three parts:

Foundation requirements: Students are required to take six foundation courses. Particularly well-prepared students can waive some of these courses by passing an examination on the course material.

Distribution requirements: Students choose three courses within one area and three courses out of that area, as outlined below.

Research skills assessment: Students are required to take CSE 569 Scholarship Skills and to pass the research proficiency examination (RPE), which requires a written and oral presentation of a research paper. The RPE normally takes place in the spring quarter of the second year of residence.

Ph.D. students must obtain a grade of 'B' or better on each required course. Required courses should be completed by the end of the second year. The doctoral dissertation will document a significant, original research contribution and must be of publishable quality, both in content and presentation.

The faculty strongly recommends that students prepare a formal thesis proposal between 9 and 18 months before the Ph.D. defense. The proposal is not a candidate screening tool, but instead a means to ensure an acceptable level of intellectual vigor and maturity. Starting in the second year, the faculty strongly recommends that students deliver yearly research talks. The RPE, presentation at the student research symposium, the thesis proposal, and talks at refereed conferences satisfy this requirement. Practice talks for conference papers should be open for commentary.

The program of study for each Ph.D. student is tailored to meet individual needs and interests. Each student's Student Program Committee provides academic advisement and is in direct control of each student's program of study. The SPC will work with the student to set and review goals on a twice-yearly basis. Students must write a progress report for all SPC meetings except the first one.

FOUNDATION REQUIREMENTS (18 credits)

Required:

CSE513	Introduction to Operating Systems	3 credits
CSE521	Introduction to Computer Architecture	3 credits
CSE532	Analysis and Design of Algorithms	3 credits
CSE533	Automata and Formal Languages	3 credits

Choose one programming language course:

CSE502	Functional Programming	3 credits
CSE507	Logic Programming	3 credits
CSE509	Object-Oriented Programming	3 credits
CSE531	Foundations of Semantics	3 credits

Choose one interactive and adaptive systems course:

CSE540	Neural Network Algorithms and Architectures	3 credits
CSE560	Artificial Intelligence	3 credits
CSE564	Human-Computer Interaction	3 credits

DISTRIBUTION REQUIREMENTS (18 credits)

Three courses from one of the following six areas, and three other courses not from that area not already taken:

Adaptive Systems and Applications

CSE540	Neural Network Algorithms and Architectures	3 credits
CSE545	Advanced Neural and Adaptive Algorithms	3 credits
CSE546	Fundamentals of Compression Technology	3 credits
CSE547	Statistical Pattern Recognition	3 credits
CSE568	Empirical Research Methods	3 credits
CSE577	Financial Time Series Analysis	3 credits
ECE540	Auditory and Visual Processing by Human and Machine	4 credits
ECE553	Control Systems: Classical, Neural and Fuzzy	4 credits
ECE554	Adaptive Signal Processing	4 credits

Human-Computer Interactive Systems

CSE550	Spoken Language Systems	3 credits
CSE551	Structure of Spoken Language	3 credits
CSE552	Hidden Markov Models for Speech Recognition	3 credits
CSE560	Artificial Intelligence	3 credits
CSE561	Dialogue	3 credits
CSE562	Natural Language Processing	3 credits
CSE563	Multi-Agent Systems	3 credits
CSE564	Human-Computer Interaction	3 credits
CSE567	Developing User-Oriented Systems	3 credits
CSE568	Empirical Research Methods	3 credits
CSE58X	Special Topics: Computer Graphics	variable
ECE540	Auditory and Visual Processing by Human and Machine	4 credits

Programming Languages and Software Engineering

CSE500	Introduction to Software Engineering	3 credits
CSE502	Functional Programming	3 credits
CSE503	Software Engineering Processes	3 credits
CSE507	Logic Programming	3 credits
CSE509	Object-Oriented Programming	3 credits
CSE511	Principles of Compiler Design	3 credits
CSE512	Compiling Functional Languages	3 credits
CSE518	Software Design and Development	3 credits
CSE530	Introduction to Mathematical Logic	3 credits
CSE531	Foundations of Semantics	3 credits
CSE567	Developing User-Oriented Systems	3 credits

Systems Software

CSE509	Object-Oriented Programming	3 credits
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CSE510	Software Tools	3 credits
CSE514	Introduction to Database Systems	3 credits
CSE515	Distributed Computing Systems	3 credits
CSE524	TCP/IP Internetworking Protocols	3 credits
CSE526	Modern Operating System Design	3 credits
CSE527	Principles and Practices of System Security	3 credits
CSE541	Database Implementation	3 credits
CSE542	Object Data Management	3 credits

Theory

CSE530	Introduction to Mathematical Logic	3 credits
CSE531	Foundations of Semantics	3 credits
CSE534	Computability and Intractability	3 credits
CSE535	Categories in Computer Science	3 credits

RESEARCH SKILLS REQUIREMENT (3 CREDITS)

CSE569	Scholarship Skills Research Proficiency Exam	3 credits
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certificate options

Certificate in Computational Finance

OGI's interdisciplinary [Master of Science in Computational Finance](#) is designed to offer students both breadth and flexibility. Students learn the core concepts of modern quantitative finance, along with the solid mathematical foundations and computational skills needed to understand and successfully apply those concepts.

OGI's MS in Computational Finance is the world's only Master's program in quantitative finance based in a Computer Science department. Most seasoned "quants" on Wall Street view solid computing skills as a critical factor when evaluating job candidates. Relative to other programs, OGI trains students in advanced mathematical methods, with an emphasis on applied, numerical and computational mathematics. Moreover, OGI provides its Computational Finance students with a unique opportunity to gain extensive experience in solving financial problems computationally. OGI's students learn the advanced computing skills that are now considered essential to compete successfully for the best jobs in finance.



Students who are interested in Computational Finance may earn a Certificate in Computational Finance by completing six courses from the finance core curriculum.

- [CSE570](#) Principles of Modern Finance (Fall)
- [CSE571](#) Investment and Portfolio Management (Winter)
- [CSE572](#) Global Markets and Foreign Exchange (Summer)
- [CSE573](#) Options and Futures I (Fall)
- [CSE574](#) Options and Futures II (Winter)
- [CSE575](#) Risk Management (Spring)
- [CSE576](#) Advanced Numerical Computing in Finance (Summer)
- [CSE577](#) Financial Time Series Analysis (Spring)
- [CSE578](#) Financial Markets, Price Behavior, and Technical Trading (Summer)
- [CSE579](#) Topics in Computational Finance (Offered intermittently)

For more information, got to www.cse.ogi.edu/CompFin/certificate.html

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research programs

The specific research projects under way at any given time depend upon current interests and obligations of faculty, students, and research sponsors.

Agent-Based Systems

This project will design a new agent communication language (agenttalk) and multiagent architecture. Unlike DARPA's current language (KQML), the proposed language will offer a true semantics, and provably correct dialogue protocols, based on joint intention theory. The Adaptive Agent Architecture, a successor to our earlier Open Agent Architecture, will offer platform and application interoperability, facilitated communication, proper concurrent operation, dynamic reconfigurability of facilitators, and separation of data and control. Quickset will be reimplemented to use this architecture, gaining a more robust capability for supporting human-human collaboration, multimedia, and dynamic adaptation to processing environments. Quickset will be the primary user interface of the technology integration experiment for this program in March 1999. Cohen, Maier

Application Adaptivity to Enhance Survivability

The Heterodyne Project is seeking to generalize the way in which applications can adapt to unforeseen failures and degradation in resource availability. Although traditional adaptivity has been focused on performance improvement, e.g., through query optimization or quality of service specification, we are focusing here on adaptation in cases where degraded service is preferable to failure. Given the heterogeneous, distributed nature of our computing environment, it is unreasonable to simply fail when certain resources are unavailable (e.g., due to network congestion). Whenever it is possible, within the context of a particular application, to tolerate degraded service then we are working on mechanisms that allow the application to adapt to the degraded level (i.e., to survive) and then to return to full service when the unavailable resources return (i.e., to thrive).

Our work uses a lattice to describe the set of possible adaptations for an application component and how they relate. We call such a lattice an adaptation space, where each adaptation is called an adaptation case. One goal is to generate a transition graph from the adaptation space to support navigation at run time among the various adaptation cases, realized by specific application components. Cowan, Delcambre, Maier, Black, McNamee

Constructing Software from Specifications

Research in formal methods for software engineering has been concerned primarily with software specification. This research explores the next step: given a declarative specification, to generate practical and efficient software by the technologies of program transformation and specialization.

We have demonstrated a new software development method in which software components are

constructed from executable specifications by typed, staged functional programs and a translation directed by an interface specification that determines data representations. Systematic techniques for proving the semantic validity of representations for data types are explored. Kieburtz, Hook, Sheard, Launchbury

Domain Specific Languages

Domain specific languages (DSLs) are a mechanism for the representation, optimization, and analysis of families of programs. Examples include parsers, pretty printers, functional-reactive animations, and hardware specification. Among the benefits to using domain specific languages is user-relevance. A significant advantage is gained by expressing application concepts in a language designed around those concepts. DSL designs are also user-modifiable. User-specified changes can be incorporated into fielded systems without compromising the integrity of the whole system. A DSL design of a component remains directly connected to the executing code. And last, DSLs provide a language with which design ideas can be communicated, and design principles taught. A barrier to the widespread adoption of domain specific languages is the ability to systematically design, develop, and implement domain-specific languages. Good domain specific languages are mathematically sound and are computer-readable. At OGI we investigate principles and techniques used to design sound and useable DSLs. This includes abstraction techniques (such as monads) used to make such designs easy to modify and evolve, and the implementation techniques (such as staging) used to embed them efficiently into underlying systems. Sheard

Functional Programming Languages

Functional languages, in which programs are defined like mathematical functions, allow logical reasoning about properties of programs. These languages are more expressive than are conventional programming languages, and they allow a wider variety of implementation strategies. Current research addresses functional programming methods, partial evaluation, program transformation, formal type systems, and methods for obtaining highly efficient implementations of functional language programs. Black, Consel, Hook, Kieburtz, Launchbury, Sheard

Machine Learning and Adaptive Systems

Machine learning, neural computation and adaptive systems are studied from both theoretical and practical standpoints. Research in theory, architectures, and algorithm design includes learning algorithms (supervised, unsupervised, and reinforcement), generalization theory (including model selection and pruning, invariant learning), deterministic and stochastic optimization, context-sensitive learning, signal processing, time series analysis, and control. Practical application domains include adaptive signal processing, pattern recognition, speech recognition, image processing, medical screening technology, control systems, macroeconomics, and finance. Hermansky, Leen, Moody, Pavel, Song, Wan

Multimodal Systems

Multimodal interfaces enable more natural and efficient interaction between humans and machines by supporting multiple coordinated channels through which input and output can pass. The Center for Human-Computer Communication is engaged in empirical investigation of multimodal interaction. This informs our research and development of architectures for multimodal language

processing, work which draws on a range of fields such as cognitive science, natural language processing, multimedia, user interface design, speech recognition, gesture recognition, and visual parsing. The Quickset system developed at CHCC supports multimodal pen/voice interaction with complex visual/spatial displays such as maps. Cohen, Oviatt

Natural Language Dialogue

The performance of speech recognition systems improves significantly when the spoken language understanding system can predict the next utterance. Accordingly, we are performing perceptual studies of dialogue and building models of human-human and human-computer dialogue in order to develop computational models of conversation that can be used to track and predict spoken language. This work is based on speech-act theory, multi-agent architectures, and models of spontaneous speech. Cohen, Heeman, Johnston, Oviatt

Object-Oriented Database Systems

Object-oriented databases support data-intensive applications that are not well served by conventional record-based database systems, such as engineering design, office information systems, multimedia documents, and scientific computing. OODBs are characterized by support for complex object state, object identity, encapsulation of behavior with data and a hierarchy of types. We are interested in formal models and semantics for OODBs; optimizing and processing query languages for OODBs; application and tool development on commercial systems; concurrency control and atomic transaction mechanisms for OODB systems; and support for new datatypes, especially multi-dimensional arrays and continuous media such as video and audio. Maier, Delcambre, Walpole, Black, McNamee

Operating Systems

Our operating systems-related research focuses primarily on adaptive systems software and its application in distributed, mobile, and multimedia computing environments. Several large projects are currently under way in the areas of quality of service control, adaptive resource management and dynamic specialization for enhanced performance, survivability and evolvability of large software systems. Black, McNamee, Steere, Walpole

Scientific Data Management

Scientific applications are a challenging area for data management support in the wide variety of datatypes they exhibit, the need for extensive metadata, heterogeneous data sources, and large bodies of legacy data. Our research exploits semantic data modeling and object-oriented database systems to craft domain-specific data models that give a uniform interface to datasets with disparate formats. This technology also supports extensible metadata management, querying over "lightly-managed" data (residing in files), and connecting existing scientific codes to the database. Projects involve database support for computational chemistry, materials science, protein structures, environmental monitoring, and microbiology. Maier, Delcambre

Speech Recognition

The goal of Large Vocabulary Continuous Speech Recognition research is to enable normal human speech as an input device in next generation computers alongside today's keyboard and mouse input. This technology can be used for dictation and command control applications when used by itself. It can also form part of a powerful information processing system when used together with information retrieval and natural language understanding systems. The research focuses include accurate acoustic modeling, speaker adaptation, confidence measure and rejection, and modeling spontaneous speech. Yan, Heeman

Spoken Language Systems

Spoken language systems make it possible for people to interact with computers using speech, the most natural mode of communication. A spoken language system combines speech recognition, natural language understanding and human interface technology. It functions by recognizing the person's words, interpreting the words in terms of the context and goals of the task, and providing an appropriate response to the user. We are involved in the analysis and development of various components of such systems, ranging from empirical studies of human dialogues through the construction of interactive systems to the development of abstract models of behavior. Cohen, Oviatt, Heeman, van Santen

Superimposed Information

With the advent of the World Wide Web and related technologies, we increasingly find ourselves with an incredible variety of information sources at our fingertips. Superimposed information supplements existing information sources by highlighting, annotating, linking, and elaborating information from the base layer. In this research we focus on unobtrusive use of existing information sources to support new, unanticipated purposes.

While superimposed information is nothing new, we expect its creation and use will increase markedly in the coming decade, for a variety of reasons. More and more kinds of information are being converted to digital form and placed on line. Moreover, that information is often addressable at a finer granularity than its hardcopy analogs: pages and paragraphs rather than entire books and articles; frames and scenes rather than whole movies and videos. The huge volumes of on-line information demand alternative groupings and organizations of information elements to make it usable and comprehensible by individuals and special interest communities. The low cost with which information can be placed on the Internet means that much of it is inaccurate or of questionable value, creating the need for annotation and evaluations by others. Finally, emerging standards such as RDF, XLink and Topic Navigation Maps will facilitate the creation and exchange of superimposed information.

Why is superimposed information an important topic for future research? At the most basic level, it is an interesting phenomenon with deep historical roots that is being profoundly affected by the digital age. More pragmatically, we think a better understanding of the connection between the structure of superimposed information and the capabilities it supports will have value in designing new superimposed information models and accompanying technology. That understanding can also influence the form and function of standard for the representation and dissemination of superimposed information. Defining the common architectural elements of superimposed information systems can be the basis for frameworks and tools for more easily building such systems. Such architectures can also help understand what is required and desired of an underlying information space to better support creation and maintenance of superimposed information over it. Finally, managing superimposed information presents interesting challenges for traditional data management technology, such as handling dynamically discovered data types, combining structured and semi-structured information, and bi-level query processing. Delcambre,

Maier

Tracking Footprints through an Information Space: Leveraging the Document Selections of Experts

The goal of this project is to help expert problem solvers find needed information in a large, complex information space. The focus is on one example of expert problem solving; the physician seeking to diagnose and treat a patient while using the medical record. Sorting through a heterogeneous collection of electronic and other media materials to find needed information, sometimes under time pressures, can be formidable. This project proposes to capture the trace of information used by experts-to monitor the paths taken and collection resources used by physicians, in moving from observation, to information gathering, to solution of a given health care problem. By capturing the trace information artifacts associated with information seeking and selection, it is hypothesized that greater insight can be gained into behaviors of users and patterns of usage. This knowledge can then be fed-back into the design and development of new information environments. The work is conducted by a cross-disciplinary team comprised of an MD focusing on information seeking behaviors of physicians, and a group of computer scientists focusing on extracting and using regularly structured information. The usefulness of the approaches will be tested in domains other than health care, in particular the aircraft design industry through the active support of the Boeing Corp. Delcambre, Maier, and Dr. Paul Gorman, Oregon Health Sciences University

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research centers and facilities

OGI's [Department of Computer Science and Engineering](#) provides a state-of-the-art computing environment designed to support the needs of research and education. The computing facilities staff has a wide range of skills that allows the computing environment at CSE to be flexible and responsive in meeting the changing needs of the department.

Support for central services such as mail, dial-up access, video conferencing, database access, and file and printer sharing as well as access to Internet services are distributed across a group of Sun computers and a Network Appliance file server that comprise the core support environment.



While Sun computers are highly visible at CSE, other computer systems, notably Intel based machines, (HP and Compaq) running NT or Linux, are mainstays of our research activities. The generous support of our industry and government research partners allows CSE to maintain a high-quality computing infrastructure capable of supporting a high degree of heterogeneity as required for high-quality research.

In all, a facilities staff of seven supports more than 250 computer systems and X terminals spanning multiple networks using a variety of automated techniques, many developed internally, to cope with the high degree of complexity inherent in such a heterogeneous environment.

[Center for Human-Computer Communication](#)

503-748-7806

chcc-admin@cse.ogi.edu

The Center for Human-Computer Communication is dedicated to realizing a vision of transparent information and service access. Research projects are broadly interdisciplinary, and include collaborations with numerous universities, federal research laboratories, and the Data-Intensive Systems Center at OGI.



Research activities focus on:

- Multimodal human-computer interaction that allows people to state their needs using speech, writing, and gestures, and that provides multimedia output.
- User-centered design of next-generation interface technology, including spoken language and multimodal interfaces, and interfaces for mobile and multimedia technology.
- Intelligent agent technologies - software systems that assist users in accomplishing tasks and can reason about how and where to carry out the users' requests in a worldwide distributed information environment.
- Collaboration technologies to support human-human communication, and collaborative decision making among groups of people.

CHCC organizes an annual Distinguished Lecture Series on the Future of Human-Computer Interaction. World-class researchers are invited to share current topics.

Dr. Philip Cohen and Dr. Sharon Oviatt are co-directors of the center. Other center faculty include Dr. Peter Heeman, and Dr. Misha Pavel. For more information, visit CHCC's web pages at www.cse.ogi.edu/CHCC/.

Pacific Software Research Center

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Software is everywhere—in cars, airplanes, telephones, banks, and toys. It is the ubiquitous infrastructure of our technological society. The development of good software is done by virtuosi teams of extraordinary individuals. At the Pacific Software Research Center we study mathematically based techniques for the specification and development of software and complex hardware. Our research goal is to develop ideas, tools, and techniques that moves software-and complex hardware-development from an art form to an engineering discipline.

Pacific Software Research Center

PacSoft's approach to specification and development draws from a foundation in functional programming, semantics, and type theory. Our research extends from the foundational theory of functional programming to supporting key aspects of the functional programming infrastructure to pursuing novel, practical applications of the technology.

Much of our work in the past decade focused on the development of domain-specific languages. This work included studying software engineering processes for language development, developing advanced tools and methods for language implementation, and studying the practical use of these languages. Recently one domain gained particular prominence in our research: the specification of microprocessor microarchitectures.

As microarchitectures become more complex, the problems of design become overwhelming. The Hawk project has exploited abstraction and specification techniques from functional programming languages to develop a new kind of hardware specification language. Hawk specifications of microprocessors are an order-of-magnitude more compact than existing specification technologies. These specifications can be directly executed as simulations, symbolically manipulated as a hardware algebra, or reasoned about directly in an automated theorem prover. Hawk has become the paradigmatic example of a successful domain-specific language and logic.

Dr. Tim Sheard is the center director. Dr. Richard Kieburtz was the founding director. Primary center faculty are Dr. John Launchbury, Dr. James Hook, and Dr. Mark Jones of OGI, and Dr. Andrew Tolmach of Portland State University. Several key staff, including Drs. Sava Kristic, Zino Benaissa, and Nancy Day support research activities.

The center is supported by grants and contracts from the US Air Force, DARPA, the Department of Defense, Intel and Tektronix. For more information, visit the PacSoft web site: www.cse.ogi.edu/PacSoft/.

The Systems GroupData Intensive System Center

Database and Object Technology Laboratory
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Systems Software Laboratory

Cynthia Pfaltzgraff, Center Administrator
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The Systems Group consists of two research laboratories-the [Systems Software Laboratory](#) and the Database and Object Technology Laboratory-and the [Data-Intensive System Center](#), which provides services to member companies in the Portland metropolitan area.

The Database and Object Technology Lab (DOT) conducts theoretical and applied research related to database management and object-oriented systems. Query processing is a long-term focus, particularly query optimization frameworks as well as design, optimization and evaluation of object-oriented query languages. Another area of interest is scientific data management, most recently in support of multi-disciplinary studies in forest canopy science.

DOT research includes conceptual modeling, including semantic and object-oriented database models, models for object-oriented analysis and design, and models for superimposed information. Other topics include data dissemination, focusing particularly on information utility and superimposed information management. Superimposed information enhances the utility and value of existing data sources by layering small amounts of information over them. We are examining superimposed information in connection with improving accessibility of medical records. Finally, we are investigating architectures for adaptable software and middleware support for application building, especially object-oriented approaches.

[Dr. Dave Maier](#) of OGI is the director of DOT. Additional DOT-affiliated faculty members are [Dr. Crispin Cowan](#), [Dr. Lois Delcambre](#), and [Dr. Dylan McNamee](#) of OGI, and [Dr. Leonard Shapiro](#) of Portland State University.

The Software Systems Lab (SySL) is a center for research

spanning the areas of distributed and mobile computing, operating systems, networking, and wide-area-network based information management systems. SySL focuses on the development of adaptive systems that utilize techniques such as feedback-control, specialization, domain-specific languages, and quality of service management to enable them to operate effectively in today's rapidly evolving and widely heterogeneous distributed environments. We emphasize the real-world applicability of our research results and we continue to build distributed and scalable prototype systems for application areas such as multimedia computing and communications, active networks, Internet-based information management, and survivable distributed systems. We collaborate closely with industry sponsors such as Intel and Tektronix, and have strong federal funding from DARPA and NSF. [Dr. Jonathan Walpole](#) is the director of SySL. Additional SySL-affiliated faculty are [Dr. David Steere](#) and Dr. Dylan McNamee of OGI.



The [Data-Intensive Systems Center](#) is a joint center of the Department of Computer Science and Engineering at OGI and the Department of Computer Science at PSU, with an industrial membership program providing services exclusively to member companies.



DISC is in its fifth year providing services to member companies. Current members include Intel Corp., Regence Blue Cross/Blue Shield of Oregon, and Sequent Computer Systems.

DISC provides its member companies with short courses, research and technology seminars, invited speaker lectures, and one-day symposia on topics of interest to member companies. DISC also provides an opportunity for technical exchange whereby member companies meet with one or more faculty to discuss problems of interest, current research activities.

DISC services are provided by faculty from OGI and Portland State University. Dr. Len Shapiro is the DISC director and Dr. Lois Delcambre is associate director. Additional DISC faculty are Drs. Crispin Cowan, Dave Maier, Dylan McNamee, David Steere, and Jonathan Walpole of OGI and Drs. Joseph Albert, Jim Binkley, Warren Harrison, Jingke Li, and Sarah Mocas of Portland State University.

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JAMES HOOK

Associate Professor and Department Head
Ph.D., Computer Science
Cornell University, 1988
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RESEARCH INTERESTS

Domain-specific languages, formal methods, and functional programming.

REPRESENTATIVE PUBLICATIONS

J. Hook, E. Meijer, & D. Leijen, "Client-side web scripting in Haskell", in proceedings of Practical Applications of Declarative Languages, January 1999.

J. Hook, E. Meijer, & D. Leijen, "Haskell as an Automation Controller", in "Advanced Functional Programming", Swierstra, Henriques and Oliveira (Eds.), Springer Verlag, LNCS Vol. 1608.

T. Widen & J. Hook, "Software Design Automation: Language Design in the Context of Domain Engineering," Sere 98 (June 1998).

J. Bell, F. Bellegarde & J. Hook, "Type-driven Defunctionalization," ICFP '97 (June 1997).

R. Kieburtz, F. Bellegarde, et al., "Calculating Software Generators from Solution Specifications," TAPSOFT '95, Springer-Verlag, LNCS (May 1995).

F. Bellegarde & J. Hook, "Substitution: A Formal Methods Case Study using Monads and Transformations," Science of Computer Programming, 22(2-3), 287 (1994).

J. Bell, J. Hook, et al., "Software Design for Reliability and Reuse: A Proof-of-Concept Demonstration," TRI-Ada '94 Proceedings, ACM Press (November 1994).

F. Bellegarde & J. Hook, "Monads, Indexes, and Transformations," Proceedings of the Colloquium on Formal Approaches to Software Engineering (TAPSOFT '93), LNCS (April 1993).



DAVID BASTERFIELD

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Ph.D., Decision Theory
University of Manchester, 1984
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RESEARCH INTERESTS

Optimization techniques, algorithm design and analysis, time series analysis, and the application of these methods to problems in finance

REPRESENTATIVE PUBLICATIONS

D. Basterfield, "Error bounds on Tree methods for Calculating Options Prices", Paper Presented at Computational Finance 2000, June 2000

D. Basterfield, T. Bundt and G. Murphy, "The Stable Paretian Hypothesis and the Asian Currency Crisis", Paper Presented at Computational Finance 2000, June 2000



ANDREW P. BLACK

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RESEARCH INTERESTS

Programming languages; distributed systems; wide-area networking, particularly the World Wide Web; object-oriented languages and systems; types for objects; and the ways in which all of these areas interrelate.

REPRESENTATIVE PUBLICATIONS

C. Pu, A. Black, C. Cowan, J. Walpole, & C. Consel, "Microlanguages for Operating System Specialization," Proc. First ACM SIGPLAN Workshop on Domain-Specific Languages, Paris, France, p. 49-57 (January 1997).

C. Pu, T. Autrey, A.P. Black, C. Consel, C. Cowan, J. Inouye, L. Kethana, J. Walpole & K. Zhang, "Optimistic Incremental Specialization: Streamlining in a Commercial Operating System," Proceedings of the 15th ACM Symposium on Operating Systems Principles (December 1995).

A.P. Black & M.P. Immel, "Encapsulating Plurality," Proceedings of European Conference on Object-Oriented Programming (July 1993).

R.K. Raj, E.D. Tempero, H.M. Levy, A.P. Black, N.C. Hutchinson & E. Jul, "Emerald, A General Purpose Programming Language," Software Practice & Experience, 21(1), 91 (January 1991).

A.P. Black & Y. Artsy, Digital Equipment Corp., "Implementing Location Independent Invocation," IEEE Trans. On Parallel and Distributed Systems, 1(1), 107 (January 1990).



THOMAS BUNDT
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RESEARCH INTERESTS

International monetary theory and finance, empirical models of exchange rate determination, time series analysis and forecasting, pedagogical tools in finance, financial forensics and advanced event study methods. Professor Bundt has also written several forecasting cases and a teacher's manual on applied business forecasting.

REPRESENTATIVE PUBLICATIONS

T. Bundt, T.F. Cosimano & J.A. Halloran, "DIDMCA and Bank Market Risk: Theory and Evidence," Journal of Banking and Finance, 16, 1179-1193 (1992).

T. Bundt & J.H. Bergstrand, "Currency Substitution and Monetary Autonomy: The Foreign Demand for U.S. Demand Deposits," Journal of International Money and Finance, 9, 325-334 (1990).

T. Bundt & R. Schweitzer, "Deregulation, Deposit Markets, and Banks' Costs of Funds," The Financial Review, 24(3), 417-430 (August 1989).

T. Bundt, J.S. Chiesa & B.P. Keating, "Common Bond Type and Credit Union Behavior," Review of Social Economy, 47(1), 27-42 (Spring 1989).

T. Bundt & A. Solocha, "Debt, Deficits and the Dollar," Journal of Policy Modeling, 10(4), 581-600 (October 1988).



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RESEARCH INTERESTS

Multimodal interfaces, human-computer interaction, natural language processing, dialogue, delegation technology, cooperating agents, communicative action, applications to mobile computing, information management, network management, manufacturing.

REPRESENTATIVE PUBLICATIONS

Oviatt, Sharon & Cohen, Philip. "Multimodal Interfaces That Process What Comes Naturally" Communications of the ACM, Vol. 43, No. 3, March, 2000, pp. 45-53.

D. McGee, P. Cohen, & L. Wu, (2000) "Something from nothing: Augmenting a paper-based work practice with multimodal interaction," in Proceedings of the Designing Augmented Reality Environments Conference, ACM Press, pp. 71-80, April 12-14, Copenhagen, Denmark.

S. Kumar, & P. Cohen, "Towards a Fault-Tolerant Multi-Agent System Architecture." To appear in The Fourth International Conference on Autonomous Agents (Agents 2000), Barcelona, Spain, June 3-7, 2000.

L. Wu, S.L. Oviatt, & P. Cohen, "Multimodal Integration -- A Statistical View," IEEE Transactions on Multimedia, Vol. 1, No. 4, December 1999, pp. 334-341.

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P. Cohen, H. Levesque, & I. Smith, "On team formation," Hintikka, J. & Tuomela, R. (Eds.), Contemporary Action Theory, Synthese, 1997.

I. Smith & P. Cohen, "Toward a semantics for an Agent Communications Language," Proceedings of the Annual Meeting of the American Association for Artificial Intelligence, Portland, Oregon (August 1996).

P. Cohen & S.L. Oviatt, "The Role of Voice Input for Human-Machine Communication," Proceedings of the National Academy of Sciences, 92 (1995).

P. Cohen, "Communicative Actions for Artificial Agents," Proceedings of the International Multi-agent Systems Conference, San Francisco (1995).



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Ph.D., Computer Science
University of Western Ontario, 1995
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RESEARCH INTERESTS

System security and survivability, operating systems, distributed systems, computer architecture, optimism, programming languages.

REPRESENTATIVE PUBLICATIONS

C. Cowan, C. Pu, D. Maier, H. Hinton, J. Walpole, P. Bakke, S. Beattie, A. Grier, P. Wagle, & Q. Zhang, "Stackguard: Automatic Adaptive Detection and Prevention of Buffer-Overflow Attacks," Seventh USENIX Security Conference (1998).

C. Cowan, A. Black, C. Consel, C. Pu, E-N Volanschi & J. Walpole, "Specialization Classes: An Object Framework for Specialization," Fifth International Workshop on Object Orientation in Operating Systems (1996).

C. Cowan & H. Lutfiyya, "A Wait-Free Algorithm for Optimistic Programming: HOPE Realized," 16th International Conference on Distributed Computing Systems (ICDCS'96), Hong Kong (1996).

C. Cowan, T. Autrey, C. Krasic, C. Pu, & J. Walpole, "Fast Concurrent Dynamic Linking for an Adaptive Operating System," in The International Conference on Configurable Distributed Systems (ICCDs'96), Annapolis, MD (1996).

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C. Cowan & H. Lutfiyya, "Formal Semantics for Expressing Optimism: The Meaning of HOPE," in Proceedings of the 14th Symposium on Principles of Distributed Computing (PODC'95), Ottawa, Ontario, Canada (1995).



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RESEARCH INTERESTS

Superimposed information, database system data models, object-oriented analysis and design, scientific data management.

REPRESENTATIVE PUBLICATIONS

L. Delcambre & E. Ecklund, "A Behaviorally Driven Approach to Object-Oriented Analysis and Design with Object-Oriented Data Modeling," in Object-Oriented Data Modeling, M. Papazougou, S. Spaccateri, & Z. Tari (Eds), MIT Press, to appear 1999.

L. Delcambre, D. Maier, R. Reddy & L. Anderson, "Structured Maps: Modeling Explicit Semantics over a Universe of Information," Journal of Digital Libraries (1997).

E.F. Ecklund Jr., L. Delcambre & M. Freiling, "Change Cases: Use Cases that Identify Future Requirements," in Proc. Of the 1996 Object-Oriented Programming, Systems, Languages and Applications Conference, San Jose, CA (October 1996).

L. Delcambre, C. Hamon, M. Biezunski, R. Reddy & S. Newcomb, "Dynamic Development and Refinement of Hypermedia Documents," in Proc. Of the Extending Database Technology '96 Conference, Avignon, France (March 1996).

G. Washburn, L. Delcambre & M. Whiting "Queries from Outer Space," in Proc. Of Research Issues in Data Engineering Workshop, IEEE Press, New Orleans, LA (February 1996).



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RESEARCH INTERESTS

All aspects of software engineering, including but not limited to systems engineering of software-intensive systems, software process modeling and process improvement, software requirements engineering, software design, software quality engineering, software metrics, software project management, software cost and schedule estimation, software risk management, and software engineering policies, procedures, standards, and guidelines.

REPRESENTATIVE PUBLICATIONS

"Software Estimation Risk," Encyclopedia of Software Engineering, Volume 2, John Wiley and Sons, 2000.

R. Fairley, "A Process-Oriented Approach to Software Product Improvement," PROFES'99 Conference Proceedings, Oulu, Finland (June 1999).

R. Fairley, "The Concept of Operations-The Bridge from Operational Requirements to Technical Specifications," Annals of Software Engineering, Vol. 3, Baltzer Publishers, Amsterdam, The Netherlands, September (1997).

R. Fairley, "Standard for Concept of Operations Documents," IEEE Standard Vol. 1362, IEEE Computer Society (1997).

R. Fairley, "Standard for Software Project Management Plans," IEEE Standard, Vol. 1058, IEEE Computer Society (1997).

R. Fairley, "Risk-Based Cost Estimation," Proceedings of the 11th COCOMO Users Group, Los Angeles, CA (November 1996).

R. Fairley, "Some Hard Questions for Software Engineering Educators," keynote presentation, CSEE 95 Proceedings, ACM Conference on Software Engineering Education, New Orleans (March 1995).

R. Fairley, "Fifteen Guidelines for Organizing and Leading Software Engineering Teams," International Perspectives on Software Engineering, RMISE, 2(3) (July 1994).

R. Fairley, "Risk Management for Software Projects," IEEE Software (May 1994)



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Assistant Professor
Ph.D., Computer Science
University of Rochester, 1997
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RESEARCH INTERESTS

Spontaneous speech recognition, modeling disfluencies and intonation, dialogue management, collaboration, spoken dialogue systems, natural language processing.

REPRESENTATIVE PUBLICATIONS

P. Heeman & J. Allen, "Improving Robustness by Modeling Spontaneous Speech Events", in J. Junqua and G. van Noord (Ds.), Robustness in language and speech technology, Kluwer Academic Publishers, 2000.

K. Ward & P. Heeman, "Acknowledgments in Human-Computer Interaction," in Proceedings of the 1st Conference of the North American Chapter of the Association for Computational Linguistics, Seattle (May 2000).

P. Heeman, "Modeling Speech Repairs and Intonational Phrasing to Improve Speech Recognition," in IEEE Workshop on Automatic Speech Recognition and Understanding, Keystone, Colorado (December 1999).

P. Heeman & J. Allen, "Speech Repairs, Intonational Phrases and Discourse Markers: Modeling Speakers' Utterances in Spoken Dialog," Computational Linguistics, Vol. 25-4 (1999).

P. Heeman, "POS Tags and Decision Trees for Language Modeling," in Proceedings of the Joint SIGDAT Conference on Empirical Methods in Natural Language Processing and Very Large Corpora, College Park, Maryland (June 1999).

P. Heeman, M. Johnston, J. Denney & E. Kaiser, "Beyond Structured Dialogues: Factoring Out Grounding," in Proceedings of the International Conference on Spoken Language Processing (ICSLP-98), Sydney, Australia (December 1998).

P. Heeman & G. Damnati, "Deriving Phrase-based Language Models," IEEE Workshop on Speech Recognition and Understanding, Santa Barbara, California (December 1997).

D. Traum & P. Heeman, "Utterance Units in Spoken Dialogue," in E. Maier, M. Mast, & S. Luperfoy (Eds.), Dialogue Processing in Spoken Language Systems, Lecture Notes in Artificial Intelligence, Springer-Verlag (1997).

P. Heeman & G. Hirst, "Collaborating on Referring Expressions," Computational Linguistics, Vol. 21-3, 1995.



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Ph.D., Linguistics, University of California at Santa Cruz, 1994

MA, Linguistics with Artificial Intelligence, Edinburgh University, Scotland, 1990

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RESEARCH INTERESTS

Natural language processing, human-computer interaction, multimodal interfaces, spoken dialogue systems, syntax, semantics, and pragmatics of human language, computational models of phonology, morphology, and the lexicon, natural language understanding and computational semantics.

REPRESENTATIVE PUBLICATIONS

M. Johnston, P. Cohen, D. McGee, S.L. Oviatt, J.A. Pittman, I. Smith, "Unification-based Multimodal Integration," Proceedings of the 35th Annual Meeting of the Association for Computational Linguistics, Madrid, Spain, 281-288 (1997).

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M. Johnston, "The Telic/Atelic Distinction and the Individuation of Quantificational Domains," in Empirical Issues in Formal Syntax and Semantics: Selected Papers from the Colloque de Syntaxe et de Sémantique de Paris (CSSP 95), Danièle Godard and Francis Corblin (Eds.). Peter Lang, Bern, 269-290 (1997).

J. Pustejovsky, B. Boguraev, M. Verhagen, P. Buitelaar & M. Johnston, "Semantic Indexing and Typed Hyperlinking," in Proceedings of the AAAI Spring Symposium on Natural Language Processing for the World Wide Web, American Association for Artificial Intelligence (1997).

M. Johnston & F. Busa, "Qualia Structure and the Compositional Interpretation of Compounds," in Proceedings of ACL SIGLEX Workshop 1996: Breadth and Depth of Semantic Lexicons, Association for Computational Linguistics (1996).



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University of Oxford, 1992
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RESEARCH INTERESTS

Programming language design and implementation; programming paradigms; module and component systems; type theory; semantics; program transformation and analysis.

REPRESENTATIVE PUBLICATIONS

M.P. Jones, "First-class Polymorphism with Type Inference," in Proceedings of the Twenty Fourth Annual ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages, Paris, France, Jan. 15-17, 1997.

M.P. Jones, "Using Parameterized Signatures to Express Modular Structure," in Proceedings of the Twenty Third Annual ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages, St. Petersburg Beach, Florida, Jan. 21-24, 1996.

M.P. Jones, "Simplifying and Improving Qualified Types," in proceedings of FPCA '95: Conference on Functional Programming Languages and Computer Architecture, La Jolla, CA, June 1995.

M.P. Jones, "A system of constructor classes: overloading and implicit higher-order polymorphism," Journal of Functional Programming, 5, 1, Cambridge University Press, January 1995.

S. Liang, P. Hudak, & M.P. Jones, "Monad Transformers and Modular Interpreters," in Conference Record of POPL'95: 22nd ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages, San Francisco, CA (January 1995).

M.P. Jones, Qualified Types: Theory and Practice, Cambridge University Press (November 1994).



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Ph.D., Electrical Engineering
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RESEARCH INTERESTS

Functional programming, program transformation, software specification, deriving programs from specifications, semantics of programming languages.

REPRESENTATIVE PUBLICATIONS

R.B. Kieburtz, "Reactive Functional Programming," in proceedings of IFIP Conference on Programming Concepts and Methods, in press (1998).

R.B. Kieburtz, L. McKinney, J. Bell, J. Hook, A. Kotov, J. Lewis, D. Oliva, T. Sheard, I. Smith & L. Walton, "A Software Engineering Experiment in Software Component Generation," in Proceedings of the 18th International Conference on Software Engineering, Berlin (March 1996).

R.B. Kieburtz, F. Bellegarde, J. Bell, J. Hook, J. Lewis, D. Oliva, T. Sheard, L. Walton & T. Zhou, "Calculating Software Generators from Solution Specifications," TAPSOFT '95, Springer-Verlag, series LNCS, 915, 546 (1995).

R.B. Kieburtz, "Programming with Algebras," Advanced Functional Programming, E. Meijer & J. Jeuring (Eds.), Springer-Verlag, Series LNCS, Vol. 925 (1995).

R.B. Kieburtz, "Results of the SDRR Validation Experiment," Pacific Software Research Center Software Design for Reliability and Reuse: Phase I Final Scientific and Technical Report, Vol. VI, CDRL No. 0002.11 (February 1995).



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Ph.D., Computing Science
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RESEARCH INTERESTS

Functional programming languages, semantics-based program analysis, program transformation, and partial evaluation.

REPRESENTATIVE PUBLICATIONS

J. Lewis, M. Shields, E. Maijer, & J. Launchbury, "Implicit Parameters," Implicit Parameters, ACM Principles of Programming Languages (2000).

J. Matthews & J. Launchbury, "Elementary Microarchitecture Algebra," Computer Aided Verification, (1999).

J. Launchbury, J. Lewis, & B. Cook. "On embedding a microarchitecture design language within Haskell," International Conference on Functional Programming. ACM (1999).

J. Launchbury & A. Sabry, "Axiomatization and Type Safety of Monadic State," Proc. ACM International Conference on Functional Programming (1997).

J. Launchbury & R. Paterson, "Parametricity and Unboxing with Unpointed Types," Proc. European Symposium on Programming, Linkoping (1996).

J. Launchbury & S.P. Jones, "State in Haskell," J. Of Lisp and Symbolic Computation, (December 1995).

J. Launchbury & S.P. Jones, "Lazy Functional State Threads," in Proc. SIGPLAN Programming Languages Design and Implementation, Orlando, FL (1994).

A. Gill, J. Launchbury & S.P. Jones, "A Short Cut to Deforestation," in Proc. SIGPLAN/SIGARCH

Functional Programming and Computer Architecture, Copenhagen, Denmark (1993).

J. Launchbury, "A Natural Semantics for Lazy Evaluation," in Proc. SIGPLAN Principles of Programming Languages, Charleston, SC (1993).

J. Hughes & J. Launchbury, "Projections for Polymorphic First-Order Strictness Analysis," in Mathematical Structures in Computer Science, 2, 301, C.U.P. (1992).

J. Hughes & J. Launchbury, "Relational Reversal of Abstract Interpretation," in Journal of Logic and Computation, 2(4), 465, O.U.P. (1992).



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RESEARCH INTERESTS

Machine learning, neural nets, local and mixture models, stochastic approximation, model complexity, invariance, applications to signal coding, sensor fusion, and pattern recognition.

REPRESENTATIVE PUBLICATIONS

R. Sharma, T.K. Leen & M. Pavel, "Probabilistic Image Sensor Fusion", in Advances in Neural Information Processing Systems 11, Kearns, Solla, Cohn (Eds.), The MIT Press, 1999.

W. Wei, T. Leen & E. Barnard, "A Fast Histogram-Based Post-processor that Improves Posterior Probability Estimates," Neural Computation, Vol. 11, No. 5, 1999.

T.K. Leen, B. Schottky, & D. Saad, "Optimal Asymptotic Learning Rates: Macroscopic Versus Microscopic Dynamics," Physical Review, E-59, 985-991, 1999.

T.K. Leen, "Exact and Perturbation Solutions for the Ensemble Dynamics," in Online Learning in Neural Networks, The Newton Institute Series, D. Saad (Ed.), Cambridge University Press, Cambridge 1998.

T.K. Leen, B. Schottky & D. Saad, "Two Approaches to Optimal Annealing," in Advances in Neural Information Processing Systems 10, The MIT Press (1998).

T.K. Leen & J.E. Moody, "Stochastic Manhattan Learning, An Exact Time-Evolution Operator for the Ensemble Dynamics," Physical Review E, 56 (1997).

N. Kambhatla & T.K. Leen, "Dimension Reduction by Local Principal Component Analysis," Neural Computation, 9 (1997).

G.B. Orr & T.K. Leen, "Using Curvature Information for Fast Stochastic Search," in Advances in Neural Information Processing Systems 9, Mozer, Jordan, Petsche (Eds.), The MIT Press, 1997.

T.K. Leen, "From Data Distributions to Regularization in Invariant Learning," Neural Computation 7, 867 (1995).



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RESEARCH INTERESTS

Database systems (including object-oriented database management systems, query processing, scientific information management), scientific computing, object-oriented and logic programming languages, algorithms, survivability of information systems, and health information technology.

REPRESENTATIVE PUBLICATIONS

J. Walpole, C. Krasic, L. Liu, D. Maier, C. Pu, D. McNamee & D. Steere, "Quality of Service Semantics for Multimedia Database Systems," Proceedings of Data Semantics 8: Semantic Issues in Multimedia Systems, Rotorua, New Zealand, (January 1999).

D. Maier, M.E. Meredith, & Shapiro, "Selected Research Issues in Decision Support Databases," Journal of Intelligent Information Systems, 11(2) September/October 1998.

L.M.L. Delcambre, D. Maier, R. Reddy, & L. Anderson, "Structured Maps: Modeling Explicit Semantics over a Univers of Information," International Journal on Digital Libraries, 1 (1) April 1997.

B. Vance & D. Maier, "Rapid Bushay Join-Order Optimization with Cartesian Products," Proceedings of the ACM-SIGMOD International Conference on Management of Data, Montreal, Canada (June 1996).

C.

R. Staehli, D. Maier & J. Walpole, "Quality of Service Specifications for Multimedia Presentation," Multimedia Systems, 3(5/6) (November 1995).

L. Fegaras & D. Maier, "Toward an Effective Calculus for Object Query Languages," Proceedings of the ACM-SIGMOD International Conference on Management of Data, San Jose, CA (May 1995).



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RESEARCH INTERESTS

Operating systems, application/operating system interactions, parallel and distributed systems.

REPRESENTATIVE PUBLICATIONS

D.C. Steere, A. Goel, J. Gruenberg, D. McNamee, C. Pu, & J. Walpole, "A Feedback-driven Proportion Allocator for Real-Rate Scheduling," Operating Systems Design and Implementation (February 1999).

J. Walpole, C. Krasic, L. Liu, D. Maier, C. Pu, D. McNamee, & D.C. Steere, "Quality of Service Semantics for Multimedia Database Systems," to appear in Proceedings Data Semantics 8: Semantic Issues in Multimedia Systems IFIP TC-2 Working Conference, Rotorua, New Zealand, (January 1999).

D. Revel, D. McNamee, D.C. Steere & J. Walpole, "Adaptive Prefetching for Device Independent File I/O," in Proceedings Multimedia Computing and Networking 1998 (MMCN98).

V.R. Narasayya, T.S.E. Ng, D. McNamee, A. Tiwary & H. Levy, "Reducing the Virtual Memory Overhead of Swizzling," The International Workshop on Object Orientation in Operating Systems (1996).

G. Kiczales, J. Lamping, C. Maeda, D. Keppel & D. McNamee, "The Need for Customizable Operating Systems," Fourth Workshop on Workstation Operating Systems (WWOS 4), Napa, CA (October 1993).

P. Barton-Davis, D. McNamee, R. Vaswani & E.D. Lazowska, "Adding Scheduler Activations to Mach 3.0," Third USENIX Mach Symposium, Santa Fe, NM (May 1993).

D. McNamee & K. Armstrong, "Extending the Mach External Pager Interface to Accommodate User-Level Page Replacement Policies," USENIX Mach Workshop, Burlington VT (October 1990).



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RESEARCH INTERESTS

Computational finance, time-series analysis, and statistical learning theory and algorithms. Foundations of neural networks, machine learning, and nonparametric statistics, and the application of these methods to problems in finance, economics, and time-series analysis.

REPRESENTATIVE PUBLICATIONS

J.E. Moody & T. Rognvaldsson, "Smoothing Regularizers for Networks of Projective Basis Functions," Neural Computation, Vol. 11, 1999. To appear.

J.E. Moody, L. Wu, Y. Liao & M. Saffell, "Performance Functions and Reinforcement Learning for Trading Systems and Portfolios," Journal of Forecasting, Vol. 17, pp. 441-470, 1998.

J.E. Moody & M. Saffell, "Reinforcement Learning for Trading Systems and Portfolios: Immediate vs. Future Rewards," Knowledge Discovery and Datamining, Proceedings of the 1998 New York

Conference, AAAI Press, 1998.

J.E. Moody & L. Wu, "High Frequency Foreign Exchange Rates: Price Behavior Analysis and 'True Price' Models," Chapter 2 of Nonlinear Modelling of High Frequency Financial Data, Christian Dunis and Bin Zhou (Eds.), Wiley Financial Publishing, London, 1998.

J.E. Moody, M. Saffell, Y. Liao & L. Wu, "Reinforcement Learning for Trading Systems and Portfolios," Decision Technologies for Computational Finance, Proceedings of the London Conference, A.N. Refenes, N. Burgess and J. Moody (Eds.), Kluwer Financial Publishing, 1998.

T.K. Leen and J.E. Moody, "Stochastic Manhattan Learning: Time-evolution Operator for the Ensemble Dynamics," Physical Review E, 1997.

M.C. Mozer, M.I. Jordan & T. Petsche (Eds.), "Multi-Effect Decompositions for Financial Data Modeling," L. Wu and J.E. Moody, in Advances in Neural Information Processing Systems 9, MIT Press, Cambridge, 1997.



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RESEARCH INTERESTS

Multimodal and spoken language systems, modality effects in communication (speech, writing, keyboard, etc.), communication models, telecommunications and technology-mediated communication, mobile and interactive systems, human-computer interaction, empirically based design and evaluation of human-computer interfaces, cognitive science, and research methodology.

REPRESENTATIVE PUBLICATIONS

S. L. Oviatt & B. Adams, "Designing and Evaluating Conversational Interfaces with Animated Characters," in Embodied Conversational Agents, ed. Cassell, Justine, et al. Cambridge: The MIT Press, 2000. pp. 319-343.

S. L. Oviatt & P. Cohen, "Multimodal Interfaces That Process What Comes Naturally" Communications of the ACM, Vol. 43, No. 3, March, 2000, pp. 45-53.

L. Wu, S. L. Oviatt, & P. Cohen, "Multimodal Integration -- A Statistical View," IEEE Transactions on Multimedia, Vol. 1, No. 4, December 1999, pp. 334-341.

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S.L. Oviatt, "Mutual disambiguation of recognition errors in a multimodal architecture," Proceedings of Conference on Human Factors in Computing Systems: CHI '99, New York, N.Y.: ACM Press,

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S.L. Oviatt, M. Maceachern, & G. Levow, "Predicting hyperarticulate speech during human-computer error resolution," Speech Communication, 1998, Vol. 24, 2, 1-23.

S.L. Oviatt, A. Deangeli & K. Kuhn, "Integration and Synchronization of Input Modes during Multimodal Human-Computer Interaction," in Proceedings of Conference on Human Factors in Computing Systems: CHI '97, New York, ACM Press, pgs. 415-422.

S.L. Oviatt, "User-Centered Design of Spoken Language and Multimodal Interfaces," IEEE Multimedia, 3(4), 26-35 (Winter 1996) to be reprinted in Morgan-Kaufmann Readings on Intelligent User Interfaces, M. Maybury & W. Wahlster (Eds.).

S.L. Oviatt, "Multimodal Interfaces for Dynamic Interactive Maps," in Proceedings of Conference on Human Factors in Computing Systems: CHI '96, New York, ACM Press, 95-102 (1996).

S.L. Oviatt, "Predicting Spoken Disfluencies during Human-Computer Interaction," Computer Speech and Language, 9, 19 (1995).



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RESEARCH INTERESTS

Transaction processing, distributed databases, scientific databases, parallel and distributed operating systems.

REPRESENTATIVE PUBLICATIONS

L. Liu & C. Pu, "An Adaptive Object-Oriented Approach to Integration and Access of Heterogeneous Information Sources," International Journal on Distributed and Parallel Databases, 5(2) (April 1997).

K.L. Wu, P.S. Yu & C. Pu, "Divergence Control for Epsilon-Serializability," IEEE Transactions on Knowledge and Data Engineering, 9(2) (March/April 1997).

J. Biggs, C. Pu, A. Groeninger & P.E. Bourne, "pdbtool: An Interactive Browser and Geometry Checker for Protein Structures," Journal of Applied Crystallography, 29(4) (1996).

L. Liu, C. Pu, R. Barga & T. Zhou, "Differential Evaluation of Continual Queries," Proceedings of the 16th International Conference on Distributed Computing Systems, Hong Kong (May 1996).

K. Ramamrithan & C. Pu, "A Formal Characterization of Epsilon Serializability," IEEE Transactions on Knowledge and Data Engineering, 7(6) (December 1995).

C. Pu, T. Autrey, A.P. Black, C. Consel, C. Cowan, J. Inouye, L. Kethana, J. Walpole & K. Zhang, "Optimistic Incremental Specialization: Streamlining a Commercial Operating System," Proceedings of the Fifteenth Symposium on Operating Systems Principles (December 1995).

R. Barga & C. Pu, "A Practical and Modular Implementation Technique of Extended Transaction Models," Proceedings of the 21st International Conference on Very Large Data Bases, Zurich, Switzerland (September 1995).

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RESEARCH INTERESTS

Functional programming, software specification, program generation, reflection, automatic theorem proving, and partial evaluation.

REPRESENTATIVE PUBLICATIONS

T. Sheard, Z. Benaissa, & E. Pasalic. "DSL Implementation Using Staging and Monads," Usenix, Second Conference on Domain Specific Languages. Austin, Texas. October 3-5, 1999.

W. Taha, Z. Benaissa, & T. Sheard. "Multi-Stage Programming: Axiomatization and Type Safety," 25th International Colloquium on Automata, Languages and Programming. July 1998.

M. Shields, T. Sheard, & S. Peyton Jones, "Dynamic Typing as Staged Type Inference," ACM-SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL '98), San Diego, CA (January 1998).

T. Sheard, "A Type-Directed, On-Line, Partial Evaluator for a Polymorphic Language," ACM-SIGPLAN Conference on Partial Evaluation and Semantics-Based Program Manipulation, Amsterdam (June 1997).

W. Taha & T. Sheard, "Multi-Stage Programming with Explicit Annotations," ACM-SIGPLAN Conference on Partial Evaluation and Semantics-Based Program Manipulation, Amsterdam (June 1997).

J. Launchbury & T. Sheard, "Warm Fusion: Deriving Build-Catas from Recursive Definitions," Proceedings of the Conference on Functional Programming and Computer Architecture, La Jolla, CA (June 1995).

T. Sheard & L. Fegaras, "A Fold for All Seasons," Proceedings of the Conference on Functional Programming and Computer Architecture, Copenhagen (June 1993).

T. Sheard, "Automatic Generation and Use of Abstract Structure Operators," ACM Transactions on Programming Languages and Systems, 13(4), 531 (October 1991).

T. Sheard & D. Stemple, "Automatic Verification of Database Transaction Safety," ACM Transactions on Database Systems, 14(3), 322 (1989).



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RESEARCH INTERESTS

Operating systems, mobile computing, distributed information systems.

REPRESENTATIVE PUBLICATIONS

D.C. Steere, A. Goel, J. Gruenberg, D. McNamee, C. Pu, & J. Walpole, "A Feedback-driven Proportion Allocator for Real-Rate Scheduling," Operating Systems Design and Implementation (February 1999).

J. Walpole, C. Krasic, L. Liu, D. Maier, C. Pu, D. McNamee, & D.C. Steere, "Quality of Service Semantics for Multimedia Database Systems," to appear in Proceedings Data Semantics 8: Semantic Issues in Multimedia Systems IFIP TC-2 Working Conference, Rotorua, New Zealand (January 1999).

D. McNamee, D. Revel, D.C. Steere, & J. Walpole, "Adaptive Prefetching for Device Independent File I/O," in Proceedings of Multimedia Computing and Networking 1998 (MMCN98) (January 1998).

D.C. Steere, "Exploiting the Non-Determinism and Asynchrony of Set Iterators to Reduce Aggregate File I/O Latency," in Proceedings of the 16th acmsymposium on Operating Systems Principles (October 1997).

D.C. Steere & J. Wing, "Specifying Weak Sets," in Proceedings of the 15th International Conference on Distributed Computing Systems, 414-421, Vancouver, BC (June 1995).

M. Satyanarayanan, H.H. Mashburn, P. Kumar, D.C. Steere & J.J. Kistler, "Lightweight Recoverable Virtual Memory," ACM Transactions on Computer Systems, 12(1), 33-57 (February 1994).
Corrigendum: ACM Transactions on Computer Systems, 12(2), 165-172 (May 1994).

M. R. Ebling, L.B. Mummert & D.C. Steere, "Overcoming the Network Bottleneck in Mobile Computing," in Proceedings of the First Workshop on Mobile Computing Systems and Applications, 34-36, Santa Cruz, CA (December 1994).



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RESEARCH INTERESTS

Adaptive systems software and its application in distributed, mobile, and multimedia computing environments and environmental observation and forecasting systems. Quality of service specification, adaptive resource management and dynamic specialization for enhanced performance, survivability and evolvability of large software systems.

REPRESENTATIVE PUBLICATIONS

D. McNamee, J. Walpole, C. Cowan, C. Pu, C. Krasic, P. Wagle, C. Consel, G. Muller & R. Marlet, "Specialization Tools and Techniques for Systematic Optimization of Systems Software," in submission to ACM Transactions on Computer Systems, 2000.

C. Krasic & J. Walpole, "QoS Scalability for Streamed Media Delivery," in submission to Multimedia Systems Journal, Springer Verlag, 2000.

J. Walpole, C. Krasic, L. Liu, D. Maier, C. Pu, D. McNamee, & D. Steere, Database Semantics: Semantic Issues in Multimedia Systems, Edited by Robert Meersman, Zahir Tari and Scott Stevens, "Quality of Service Semantics for Multimedia Database Systems," Kluwer Academic Publishers, 1999. Also available as OGI CSE Technical Report 98-010, July 1998.

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S. Cen, C. Pu, & J. Walpole, "Flow and Congestion Control for Internet Streaming Applications," Proceedings Multimedia Computing and Networking 1998 (MMCN98).

J. Inouye, S. Cen, C. Pu, & J. Walpole, "System Support for Mobile Multimedia Applications", Proceedings of the 7th International Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV 97), St. Louis, Missouri, May 1997.

R. Konuru, S. Otto, & J. Walpole, "A Migratable User-Level Process Package for PVM", Journal of Parallel and Distributed Computing, 40, Special Issue on Workstation Clusters and Network-Based Computing, Kai Hwang (Editor), pages 81-102, February, 1997.

C. Pu, T. Autrey, A. Black, C. Consel, C. Cowan, J. Inouye, L. Kethana, J. Walpole, & K. Zhang, "Optimistic Incremental Specialization: Streamlining a Commercial Operating System", Proceedings of the 15th ACM Symposium on Operating Systems Principles (SOSP'95), December 3-6, 1995, Copper Mountain, Colorado.

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Department of Computer Science and Engineering

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course offerings

CSE500 Introduction to Software Engineering

Software engineering is concerned with the ways in which people conduct their work activities and apply technology to produce and maintain software products and software-intensive systems. Issues of concern include specification, design, implementation, verification, validation, and evolution of software artifacts. Related topics include software metrics, project management, configuration management, quality assurance, peer reviews, risk management, and process improvement. This course presents an integrated view of these topics and related issues. It is an essential course for anyone working in development, maintenance, management, or related areas in a software organization. 3 credits

CSE502 Functional Programming

In functional programming, we shift our focus from data objects and their representations to functions that act on data. Programs are formulated as compositions of functions, rather than as sequences of statements. This leads to a programming methodology that is quite different from that learned in using statement-oriented languages. This course introduces the student to functional notation, recursion, higher-order functions, reasoning about functions, and polymorphic type systems. Functional programming languages are known for their increased productivity and reliability, due in part to the higher levels of abstraction provided by functional languages. Course is taught by lecture with small weekly programming assignments. Experience is gained by programming in the functional language Haskell or one of its close derivatives. Recent advances in functional programming languages allow them to use updatable state in a safe manner and to cause effects on the real world. Students gain experience by writing programs using these features to program interactive window-based programs using an embedded "widget" library. 3 credits

CSE503 Software Engineering Processes

This course is concerned with examining and improving the software development processes, including the technical, managerial, and cultural processes, used by organizations to develop and maintain high quality software systems in a timely and economical manner. Various process models, including the SEI Capability Maturity Models, the ISO SPICE model, the Team Software Process, and the Personal Software Process are studied and contrasted. Tailoring of process models to fit local situations and various approaches to software process improvement are presented. Students select and complete term projects that address topics in software process improvement. 3 credits

CSE504 Object-Oriented Analysis and Design

This course presents an integrated set of techniques for software analysis, and design based on object-oriented concepts. The techniques focus on producing the artifacts and work products, expressed in UML, appropriate for each phase of the software development life cycle with an emphasis on analysis and high-level design. We adopt a use case model for requirements and a responsibility-driven approach for the development of object models. This course includes a brief introduction to object-oriented programming. Note that CSE 509 Object-Oriented Programming is

intended as a follow-on course for CSE 504. 3 credits

CSE507 Logic Programming

Logic programming is an attempt to construct computer languages with completely declarative semantics: The programmer only states "what" should be done; the interpreter or compiler must decide "how." This course examines existing logic programming languages, notably Prolog; provides the foundations in logic and theorem proving for such languages; and covers implementation of logic programming languages. Other topics may include an introduction to modal logic and intuitionistic logic. 3 credits

CSE509 Object-Oriented Programming

This course provides a rigorous introduction to the concepts behind object-oriented programming. It is for students who are already familiar with the concept of object-orientation and with object-oriented analysis and design techniques. One way to learn this background material is by taking CSE 504 Object-Oriented Analysis and Design. In CSE 509, students gain a thorough understanding of incremental programming, type-safety, polymorphism, encapsulation, and set-based abstraction, and apply these concepts through a variety of programming projects. We study several programming languages, including Java and Smalltalk, so students are exposed to different realizations of these concepts and gain an appreciation for the programming language design space. We also look at published object-oriented design patterns and see how they can be implemented in different object-oriented programming languages. Students are required to read appropriate research papers, complete several short programming assignments, complete a substantial programming project, and write some short essays. Prerequisite: CSE 504 or equivalent. 3 credits

CSE510 Software Tools

An introduction to the use of advanced software tools available within the UNIX operating system. The emphasis is on tools for creating graphical interfaces, compiler writing tools, and general programming. The course covers X and the X Toolkit, Motif, some aspects of Java, Tcl/Tk, and lex/yacc. The material is taught through programming exercises and a term project. This course is designed for students who wish to build programs with graphical user interfaces and sharpen their skills with C and OO languages (Java). Both industrial students and Ph.D. research students have found the course helpful. Prerequisite: Knowledge of C. Experience with OOP and X is helpful, but not required. 3 credits

CSE511 Principles of Compiler Design

This course introduces the student to the basics of building a compiler using a multi-phase translation process. It covers lexical analysis, parsing, and translation to abstract syntax using modern parser generator technology. It discusses binding of identifiers and symbol table organization, and a variety of intermediate representations that are suitable for back end analysis. It investigates back end transformations and optimizations for a number of languages. Other topics include type checking, attribute grammar representations, and printing from abstract syntax. Compiling is essentially a process of symbolically manipulating program representations represented by tree and graph-like data structures. Because of this, we will use a modern tool that facilitates symbolic manipulation and definition of such structures as parser and lexical generators, and tools for generating code from pattern-based descriptions. Prerequisite: CSE 533. 3 credits

CSE512 Compiling Functional Languages

A project-oriented course on the theory and design of a compiler for a typed, functional programming language. Topics include understanding a formal definition of programming language semantics, compiling pattern analysis, lifting abstractions, continuation-passing style of

implementation, abstract machines, code generation and address assignment, register allocation and assignment on general-register machines, run-time storage administration, data-flow analysis, and code improvement. Prerequisite: CSE 511. 3 credits

CSE513 Introduction to Operating Systems

A study of the design and implementation of modern operating systems. The course concentrates on operating system kernel design, and includes the following topics: concurrent processes, interprocess communication, synchronization, scheduling, resource allocation, memory management, the concept of virtual memory and the required underlying hardware support, secondary storage management, file systems, and security. We will use the Linux operating system to ground the discussion of abstract concepts. Interested students will be encouraged to read the Linux source code for discussions in class. 3 credits

CSE514 Introduction to Database Systems

A survey of database fundamentals emphasizing the use of database systems. Topics include database design, data dependencies and normalization, database design, system architecture, secondary storage structures, query languages and processing, query optimization transactions, and recovery. This course focuses on relational database systems. Students participate in a project to design, implement, populate, and query a database. Prerequisite: Data structures, discrete mathematics, and mathematical logic. 3 credits

CSE515 Distributed Computing Systems

A selection of research topics in distributed computing systems. This course concentrates on distributed computing systems from a systems software perspective. Major topics include distributed operating systems, distributed file systems, distributed transaction processing, load balancing, distributed programming languages and systems, fault-tolerance and replication algorithms, distributed timing issues, and primitives for distributed computing (e.g., Remote procedure call and causal broadcast). Prerequisites: CSE 513 or equivalent and a basic understanding of computer communications problems and protocols. 3 credits

CSE518 Software Design and Development

Techniques of contemporary software design, including component-based design, component integration, encapsulation, composition, software architectures, software specification, software prototyping, design reuse, abstraction and modularity, design before implementation, and design refinement. Principles are applied in a class project of modest complexity. Tasks of design, design inspection, and design documentation are assigned to student teams. 3 credits

CSE521 Introduction to Computer Architecture

This course provides a broad introduction to computer architecture. The course covers a large amount of material in moderate depth, giving the student a good understanding of the basic issues in computer system design. Specifically, the course covers instruction set design, pipelining, the memory hierarchy, I/O systems, networking issues, and multiprocessors. Example systems include the Intel x86, MIPS, and DEC Alpha processors. Prerequisites: Experience writing software, preferably with some C or assembler programming. NOTE: Computer architecture has become a quantitative science, so there will be considerable algebraic manipulation involved in the performance analysis component of the course. 3 credits

CSE522 Advanced Computer Architecture

This course examines advanced topics in computer architecture. Topics include detailed examination of issues relating to instruction-level parallelism, memory latency and bandwidth, and

other current research topics. Prerequisite: CSE 521. 3 credits

CSE524 TCP/IP Internetworking Protocols

This course provides an overview of the structure and algorithms used in the TCP/IP networking protocols that make up the foundation of the Internet. Protocols and technologies covered will include an introduction to the link layer, ARP, IP, ICMP, UDP, TCP, routing protocols, and application protocols and systems like the DNS, NFS, SMTP, FTP, HTTP, and multicasting protocols and applications. To provide architectural insight into protocol design issues and operating system implementation techniques, typically in terms of the Berkeley UNIX socket programming model. To provide socket programming experience with the client/server model. To provide experience reading Internet RFC's and/or drafts. Prerequisites: familiarity with the functions of a modern multiuser operating system such as is covered in CSE 513 or in PSU's CS 533; familiarity with C programming on modern UNIX computers 3 credits

CSE526 Modern Operating System Design

This course includes an in-depth study of modern operating system design. The course is based on a collection of recent research papers, and includes an emphasis on evaluating the papers in addition to understanding the systems they describe. Topics include micro-kernel operating systems, lightweight interprocess communication, extensible operating systems, file systems, mobile computing, workstation clusters, adaptive resource management, and OS support for multimedia systems. Prerequisites: CSE 513 and CSE 521. 3 credits

CSE527 Principles and Practices of System Security

In the Internet age, host system security is essential and difficult. This course will educate students in the principles and practices of securing host systems. Students learn the principles of how to build secure systems and how various real systems succeed and fail in living up to these principles. We will study various security enhancing technologies, in each case relating the security enhancement to the principles of secure systems. Prerequisite: CSE 513. 3 credits

CSE530 Introduction to Mathematical Logic

Provides a theoretical foundation for the logic of computation. Propositional and first-order predicate calculi, soundness and completeness, incompleteness and incomputability, the Church-Turing thesis, term-rewriting systems, and application to program verification. 3 credits

CSE531 Foundations of Semantics

Formal semantics aims to answer two important questions: 1) when are two programs equal? And 2) when does a program faithfully implement a mathematical specification? The course explores denotational semantics, operational semantics, and program logic, studying how they are related and how they can answer the motivating questions. Programming language concepts, such as imperative programming, functional programming, call-by-name, call-by-value, and continuations, are contrasted and explained in terms of their semantic foundations. Key concepts include full abstraction and the use of least fixed point constructions to solve recursive equations. The course is designed for students interested in the mathematical foundations of programming languages and programming logics. Prerequisite: Discrete mathematics. 3 credits

CSE532 Analysis and Design of Algorithms

An introduction to the design and analysis of algorithms. The course covers design techniques, such as dynamic programming and greedy methods, as well as fundamentals of analyzing algorithms for correctness and time and space bounds. Topics include advanced sorting and searching methods, graph algorithms and geometric algorithms. Other areas vary from year to

year, and may include matrix manipulations, string and pattern matching, set algorithms, polynomial computations, and the fast Fourier transform. Prerequisite: Data structures and discrete mathematics. 3 credits

CSE533 Automata and Formal Languages

Automata theory introduces fundamental models that are used over and over again in computer science for programming languages, in compiler construction, and in algorithms. These models are a valuable part of the repertoire of any computer scientist or engineer. This course introduces progressively more powerful models of computation, starting with finite automata and moving through counter, stack, and Turing machines. It also presents the regular, context-free, recursive, and recursively enumerable languages, and shows how they correspond to the various models of computation and to generation mechanisms such as regular expressions and grammars. The emphasis is on understanding the properties of these models, the relationships among them, and how modifications such as nondeterminism and resource bounds affect them. The course includes application of these concepts to problems arising in other parts of computer science. Prerequisite: Discrete mathematics. 3 credits

CSE534 Computability and Intractability

Computability and complexity theory identify classes of languages based on characteristics of machines that recognize them. The course presents elementary results from recursive function theory, including recursive and recursively enumerable sets, and degrees of undecidability. Using recursion theory as a model, it develops the classical results of complexity theory, including time and space complexity classes, hierarchy theorems, and elementary results from parallel complexity. The course concludes by studying classes of problems that are provably intractable, with a particular emphasis on NP-complete problems. Prerequisites: CSE 532 or CSE 533. 3 credits

CSE535 Categories in Computer Science

Category theory provides a powerful and concise notation for abstract properties of functions. Originally developed for algebraic topology, it has found widespread application in computer science. This course introduces the basic notions of category theory, including functors, natural transformations, products, sums, limits, colimits, monads, and adjunctions. These concepts are illustrated with examples from computer science and mathematics, including the relationship between cartesian closed categories and the lambda-calculus. Familiarity with discrete mathematics is an essential prerequisite. 3 credits

CSE540 Neural Network Algorithms and Architectures

This course introduces the fundamentals of connectionist and neural network models. Paradigms for both unsupervised and supervised learning are covered. Topics include introduction to neural processing elements, Hebbian learning, LMS and back propagation algorithms, competitive learning, computational capability, and elements of statistical pattern recognition. Specific architectures covered include Hopfield nets, single and multilayer Perceptrons, and Kohonen maps. Programming projects involve network simulations and application problems. Prerequisites: Some knowledge of linear algebra and calculus is required. Programming experience is necessary. 3 credits

CSE541 Database Implementation

This course provides hands-on experience implementing high-performance database management systems. The goal of the course is to implement database software and to understand techniques used to provide maximum performance and functionality on modern architectures. Typical topics discussed include benchmarking, transaction processing, file and

index implementation, buffer management, concurrency control, recovery, query optimization, and a variety of query processing algorithms. The data model to be implemented, and the computer architecture to be used, will change between offerings. Prerequisite: CSE 514. This course is offered at Portland State University as CS 545. 3 credits

CSE542 Object Data Management

A variety of products for managing object data have emerged in the marketplace. Object-oriented database systems and persistent programming languages have been joined by object-relational databases and middleware component technologies, such as Enterprise Java Beans. Other storage engines, such as LDAP and XML servers, have an object flavor. This course begins with the concepts in types, data models, and languages that underlie object data management. It then looks at example prototype and commercial systems, and examines design dimensions such as data model, persistence, encapsulation, hierarchies, query languages, and transactions. It touches on application development and data management issues and concludes with treatment of software architecture and implementation techniques. Students will do a project using one of several commercial products. 3 credits

CSE544 Probability and Statistical Inference

This course provides a comprehensive introduction to probability, statistical inference and stochastic processes. The topics include the elements of exploratory data analysis, sampling distribution theory, confidence intervals, hypothesis testing, linear regression, goodness-of-fit, ANOVA, maximum likelihood estimation, Bayesian inference, cross-validation, nonparametric tests, random walks, martingales, stochastic processes and stochastic differential equations. The goal of the course is to provide a comprehensive review of essential concepts in probability and statistics. The primary analysis tools for this course are S-PLUS and MATLAB. 3 credits

CSE545 Advanced Neural and Adaptive Algorithms

An advanced treatment of architectures and algorithms for pattern recognition, regression, timeseries prediction, and datamining. Typical topics include convergence, effects of noise, optimization methods, probabilistic framework (including Bayesian estimation), generalization ability and regularization and pruning, Hebbian learning, and clustering and density modeling. Prerequisites: CSE 540 or instructor permission. 3 credits

CSE546 Fundamentals of Compression Technology

This course covers fundamental theory and techniques of compression technology, establishing the base from which practical audio and video compression systems can be designed. Topics include loss-less entropy-based coding, including Huffman and Lempel-Ziv, lossy compression techniques, including scalar quantization, Karhunen-Loeve and DCT coding, linear predictive coding, vector quantization and its variants (tree, finite-state, multistage, and predictive quantizers), and wavelet representations. Applications to audio and video compression include JPEG, MPEG, and vocoder technologies. Prerequisites: Calculus, introductory probability theory, programming experience. 3 credits

CSE547 Statistical Pattern Recognition

Theory and practice of statistical pattern recognition. Students will develop familiarity with statistical tools for developing and assessing pattern recognition systems, and apply principles to real-world examples. Emphasis is on broadly applicable fundamental analysis and modeling tools, rather than on specific recognition technologies. The course will benefit those whose work may use any of a variety of recognition technologies in broad-ranging applications. Topics include random vectors, likelihood ratio tests, ROC curves, parametric and non-parametric density estimation, parametric and nonparametric classification models, classification error bounds and

cross-validation. Maximum likelihood and Bayesian parameter estimation. Feature extraction for dimensionality reduction, and for classification. Prerequisites: Familiarity with probability and statistics. 3 credits

CSE548 Statistical Computing

This course provides an introduction to modern applied statistics. The topics include distributions and data summaries, density estimation, generalized linear models, modern nonlinear regression, robust statistics, factor analysis, linear and nonlinear classifiers, Bayesian classifiers, cluster analysis, decision trees, ensemble learning methods, validation techniques and Bootstrap and Monte Carlo methods. The goal of the course is to provide a solid understanding of practical statistical inference methods and proficiency in using modern statistical tools. The primary analysis tool for this course is S-PLUS. Prerequisite: CSE544 Introduction to Probability and Statistical Inference or equivalent. 3 credits

CSE/MST549 Applied Business Forecasting

This course is taught over the World Wide Web using WebCT; enrollment limitations may apply. An applied course in business forecasting, the course emphasizes generating and implementing business forecasts. Designed for those wishing to understand the basics of modern forecasting, the course emphasizes modern statistical methods widely used to generate business forecasts. Specific applications to business include forecasting sales, production, inventory, macroeconomic variables such as interest rates and exchange rates, and other applications related to business planning, both short- and long-term. Topics include data considerations and model selection, applied statistics, moving averages and exponential smoothing, regression analysis, time-series decomposition, Box-Jenkins (ARIMA) models, bootstrapping, optimal forecast combination, and forecast implementation. The course is based upon the SORITEC integrated econometric and statistical analysis language for Windows 95 and NT, which accompanies Wilson and Keating's Business Forecasting, McGraw Hill-Irwin, 3rd Edition. Knowledge of basic statistics and regression analysis is highly recommended, but not required. 3 credits

CSE550 Spoken Language Systems

In the not too distant future, spoken language systems will revolutionize human-computer interaction by enabling natural conversations between people and machines. In addition to telephony applications, such as voice browsing of the web, these systems also will support face-to-face communication with intelligent animated agents. These animated human-like agents will combine acoustic information with the speaker's facial cues and gestures to understand speech, and produce natural and expressive speech with accurate facial movements and expressions. This course reviews the state of the art in human language technology, and explains how key technologies are combined to produce spoken language systems. The course combines lectures by experts in the field with hands-on experience using and building spoken language systems using the CSLU Toolkit. The course materials are included in <http://www.cse.ogi.edu/CSLU/hltsurvey/hltsurvey.html>. 3 credits

CSE 51 Structure of Spoken Language

This course provides a foundation for subsequent learning and research in computer speech recognition. We examine the structure of spoken English through selected readings in speech perception and acoustic phonetics and examination of visual displays of speech. The goals are to understand the acoustic cues for each major phonetic category, understand how these cues are affected by context, understand the perceptual strategies that listeners use to understand speech, and evaluate the assumption that speech can be described as an ordered sequence of phonetic segments. 3 credits

CSE552 Hidden Markov Models for Speech Recognition

Hidden Markov Model-based technology is used widely in today's speech recognition systems. This course is an introduction to speech recognition using HMM technology. Topics include the theory of Hidden Markov Models (discrete, semi-continuous, and continuous) and their applications to speech recognition, along with the basic mathematics (probability theory, statistics, stochastic process, information theory, and signal processing) that are necessary for speech recognition. The course is focused on understanding the theory behind these fundamental technologies, and applying the technology to develop speech recognition systems. Prerequisite: Some knowledge of engineering mathematics (calculus and linear algebra) is required; C programming experience is necessary. 3 credits

CSE555 Mathematical Methods for Engineering and Finance

This course explores the essential mathematical methods required for quantitative analysis in engineering and finance. The course examines a selection of topics from multivariate calculus, differential equations, stochastic calculus and mathematical optimization. Advanced topics include partial differential equations, Ito calculus, martingales, stochastic control and constrained optimization. The focus is on explaining the key Mathematical results and, by means of examples and assignments, showing how they may be applied in engineering and finance. Prerequisites: Knowledge of calculus, linear algebra and basic differential equations. 3 credits

CSE560 Artificial Intelligence

This course surveys the foundations and applications of symbolic approaches to artificial intelligence. The approach emphasizes the formal basis of automated reasoning and includes an introduction to programming in Prolog. Fundamentals covered include search, knowledge representation, automated inference, planning, nonmonotonic reasoning, and reasoning about belief. Applications include expert systems, natural language processing and agent architectures. 3 credits

CSE561 Dialogue

This course provides an in-depth treatment of the major theories of dialogue, including finite-state, plan-based, and joint action theories. Dialogue is examined at a level general enough to encompass conversations between humans, between human and computer, and among computers, while at the same time being precise enough to support implementations. The course introduces basic speech act theory, planning, and reasoning through a number of classic papers. Plan-based theories are examined in detail, including their incorporation into spoken dialogue systems, and their potential effects upon speech recognition components. Students will develop dialogue components and integrate them into working systems. Prerequisite: CSE 560. 3 credits

CSE562 Natural Language Processing

An introduction to artificial intelligence techniques for machine understanding of human language. The course introduces key aspects of natural language, along with the analyses, data structures and algorithms developed for computers to understand it. Computational approaches to phonology, morphology, syntax, semantics, and discourse are covered. Programming assignments are written in Prolog. Prerequisite: CSE 560 or equivalent. 3 credits

CSE563 Multi-Agent Systems

This course covers the emerging theory and practice of multi-agent systems: semi-autonomous, semi-intelligent distributed computing systems that can be organized ad hoc to meet the immediate needs of a user. The course covers a variety of individual and multi-agent architectures, including the Contract Net protocol, distributed blackboard systems, and mobile agents. Also discussed are principles for building networks of heterogeneous agents, ranging from simple rule-based systems to databases and humans. In order to collaborate to solve a user's

problem, agents need to communicate. We examine agent communication languages, including KQML and FIPA, as well as the underlying general speech act theories. Students learn how to model these systems formally, and will develop and program individual agents that can participate in a multi-agent system. 3 credits

CSE564 Human-Computer Interaction

This course emphasizes the experience of computing, which centers on an understanding of real users and the specific tasks they need to accomplish when computing. In the pursuit of optimal user support, an interdisciplinary approach to system design and evaluation is stressed. The course reviews current research viewpoints and activities in the field of human-computer interaction, surveys key research challenges that exist, and discusses trends in next-generation system design. Students gain hands-on experience by critiquing existing interfaces, as well as hearing reports from experts in industry on the state of the field. An introduction to this topic is essential for everyone working in the field of computer science. 3 credits

CSE567 Developing User-Oriented Systems

This course explores a range of issues and methods needed to design and evaluate user-oriented software applications. Topics focus on field and ethnographically based design studies, participatory design methods, user laboratory studies, and usability testing. The purpose is to have access to a range of methods that help uncover opportunities, breakdowns, and interactions that affect the design and use of developing systems. Students are challenged to evaluate the underlying perspectives of the approaches and decide which approach or combination of approaches works best for particular problems. They apply the methods in field and classroom exercises and produce a real-world project or paper using course methods. The intended result is to make students more effective not only at gathering relevant user-based information, but also at integrating it into the development process. 3 credits

CSE568 Empirical Research Methods

This course introduces principles of experimental design and data analysis for empirical research. Topics include the goals and logic of experimental design, hypothesis formation and testing, probability and sampling theory, descriptive statistics, correlation and regression, basic parametric and nonparametric tests of statistical significance (e.g., Binomial, t-test, chi-square, analysis of variance), standard designs for single- and multi-factor experiments, and strategies of scientific investigation (e.g., Exploratory vs. Directed). The course is fundamental for anyone who plans to conduct independent research in the future or needs to critically evaluate the research of others. Students participate in designing and analyzing data in order to answer scientific questions and present the results of these activities both orally and in writing. 3 credits

CSE569 Scholarship Skills

Scientific results have little value if they are not communicated clearly or are disconnected from prior work in a field. This course teaches students to research, write, present, and review effectively for the computer sciences. It emphasizes learning by doing, and students have frequent writing and presentation assignments. Students learn how to locate and organize background materials, how to write clearly about technical topics, the structure and stylistic conventions of scientific documents (such as conference abstracts, journal papers, theses, and proposals), how to prepare and deliver short and long presentations, the refereeing process, and how to prepare and respond to a review. This course is required for Ph.D. students and strongly recommended for master's students, especially those pursuing the thesis option. It also is useful for professionals who must write or speak to a technical audience. 3 credits

CSE570 Principles of Modern Finance

This course surveys the concepts and principles underlying the modern theory of finance. Specifically, the course reviews the seven most important concepts in finance: net present value, conservation of value, capital structure theory, efficient markets, capital asset pricing, agency theory, and option pricing theory. Topics covered include bond and stock valuation, fundamental analysis, mean-variance portfolio theory, Sharpe-Lintner capital asset pricing model, arbitrage pricing theory, Modigliani/Miller capital structure theory, and Black-Scholes option pricing. Course assignments make use of MATLAB and BARRA On Campus. 3 credits

CSE571 Investment and Portfolio Management

This course provides students with an overall introduction to practical and theoretical aspects of investment analysis and portfolio management. Specifically, the course surveys various models of asset valuation and their use in constructing effective investment portfolios. Topics include investment vehicles and asset classes, market structure and market efficiency, security valuation models, financial statement analysis, setting investment goals and policies, designing investment portfolios, equity and fixed-income portfolio strategies, measuring investment performance, and managing investment risk. To help students integrate the course knowledge into their actual investment practice, the course includes team projects to analyze actual investment securities and design investment portfolios. Students have access to investment data and analytics provided by Barra and Standard and Poor's Micropal. 3 credits

CSE572 Global Markets and Foreign Exchange

This course surveys the modern paradigms in international finance. Specifically, the course examines the theory linking the world's various foreign exchange, money, and securities markets, emphasizing global investment and risk management. Topics include spot and forward FX markets, FX options, interest rate parity, purchasing power parity, exchange rate theory, global investing, global FX risk management, and emerging markets and currency crises. Course assignments make use of MATLAB, S-PLUS, and BARRA On Campus. 3 credits

CSE573 Options and Futures I

This course introduces the trading, pricing and risk-management applications of financial derivatives including futures, swaps, and option contracts. Emphasis is given to pricing models including arbitrage pricing theory, risk-neutral valuation, and Black-Scholes analysis. Topics covered include futures and swap pricing, methods for pricing American style options, hedging and speculation using derivatives, Ito calculus, portfolio insurance, option trading strategies, dynamic hedging strategies, and numerical models. Course assignments require use of MATLAB. 3 credits

CSE574 Options and Futures II

A continuation of CSE573 Options and Futures I, this course examines derivative pricing models since Black-Scholes, models for the term structure of interest rates and relevant numerical methods. The course begins with a review of stochastic calculus and stochastic differential equations. Specific topics include arbitrage pricing, equivalent martingale measures, risk neutrality, and optimal stopping times as applied to American options. Equilibrium and no-arbitrage term structure models are presented, from Vasicek through Heath-Jarrow-Morton. In addition, emphasis is given to pricing fixed-income derivatives, credit derivatives, and exotics using numerical solution methods such as the Crank-Nicholson, finite difference methods, and Monte Carlo search. Prerequisite: CSE573 Options and Futures I or permission from instructor. 3 credits

CSE575 Risk Management

This course explores various aspects of management of risk associated with operating a

multinational enterprise. Emphasis is on evaluating and hedging financial risks (fixed-income, equity, commodity, and foreign exchange risk exposures), with emphasis on value-at-risk (VAR) models. Topics include sources and measurement of risk and exposure, value at risk, hedging linear and nonlinear derivatives risk, delta-normal VAR, historical simulation VAR, Monte Carlo approaches to VAR, and implementation and evaluation of risk management systems. Course assignments make use of MATLAB and BARRA On Campus.3 credits

CSE577 Financial Time-Series Analysis

This course reviews advanced time-series techniques and their application to the analysis and forecasting of financial time-series. Emphasis is given to multivariate and nonlinear methods applied to high-frequency financial data. Topics covered include ARIMA models, GARCH models, martingales and random walks, stochastic trends, co-integration and error-corrections models. The primary analysis tool for this course is S-PLUS. Prerequisite: [CSE548 Modern Applied Statistics](#). 3 credits

CSE578 Financial Markets, Price Behavior and Technical Trading

This course provides a survey of the structure and dynamics of financial markets, the behavior of financial price series, and trading techniques. Topics include market microstructure, market efficiency and documented anomalies, noise traders and bounded rationality, properties of high frequency data, nonlinear price behavior, speculative bubbles and crashes, market psychology, and technical trading systems. The course draws upon the academic literature and the practitioners' lore. Students use MATLAB, S-PLUS, and extensive data resources to analyze price behavior and build and test simple technical trading systems. Prerequisites: [CSE570 Principles of Modern Finance](#) and [CSE577 Financial Time-Series Analysis](#).3 credits

CSE579 Advanced Numerical Computing in Finance

This course introduces the major numerical methods needed for quantitative work in finance, focusing on derivatives pricing and fixed income applications. Topics include binomial and trinomial methods, finite difference solution of partial differential equations, Crank-Nicholson methods for various exotic options, treatment of discrete dividends, projected- SOR method for American options, numerical methods for stochastic differential equations, random number generators, Monte-Carlo methods for European and least-squared Monte-Carlo methods for American options. The course is lab oriented. Prerequisite: [CSE574 Options and Futures II](#) or permission from instructor.3 credits

CSE58X Special Topics

Under this number, we offer courses of particular relevance to the research interests of faculty or in state-of-the-art subjects of interest to the community.

CSE600 Research

Supervised research activity. Variable and repetitive credit.

CSE610 Nonthesis Research

Supervised research for up to six credits as a component of the nonthesis master's degree. Students are required to produce concrete research deliverables, including a final report equivalent to a CSE technical report.

CSE620 Professional Internship

These courses provide the student with an opportunity to earn credit for relevant work experience

in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers in computer science. A written report must be submitted to the CSE faculty advisor at the end of the experience.

Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. 1 to 3 credits per quarter

CSE621 Professional Internship in Finance

This course provides the student with an opportunity to earn credit for relevant work experience in finance and related industries. It enables students to enhance their understanding of the practical realities of modern finance, including such areas as corporate treasury operations, investment analysis, portfolio management, risk management, derivatives pricing, forecasting and trading. Students gain valuable industrial experience that both allows them to learn to apply their knowledge gained in the classroom and to better prepare for their future careers in finance.

Enrollment requires the permission of the instructor and is limited by the number of internship opportunities available. 1 to 3 credits per quarter

CSE700 M.S. Thesis Research

Research toward the thesis for the M.S. degree. Variable and repetitive credit.

CSE800 Ph.D. Dissertation Research

Research toward the dissertation for the Ph.D. degree. Variable and repetitive credit.

APPLIED COMPUTING COURSES

OGI500 Development with Visual Basic for Applications

This course introduces Visual Basic for Applications as a tool for rapid application development, customization and system integration in Windows environments. The course focuses on combining VBA with Microsoft Office. Topics covered include the structure of the VBA programming language and built-in functions, enhancing recorded macros using VBA code, applying the MS Office object models and accessing relational databases using ActiveX Data Objects (ADO). Students will gain expertise in advanced analysis and data manipulation, developing and customizing applications, and integrating them with existing systems. Prerequisites: experience with MS Excel and Access, and knowledge of a programming language. 3 credits

OGI501 Accelerated Development with Visual Basic

This course uses Visual Basic 6.0 and Visual Basic for Applications as tools to introduce the concepts of rapid application development, systems integration and customization on Windows platforms. While studying Visual Basic, students will gain an understanding of the architecture of Windows applications and create COM components, ActiveX controls and executable programs. Students will also learn how to apply basic analysis and design techniques, and how to make their user interfaces friendly and efficient. Assignments involve practical work with these software tools, using applications from industry/business as case studies. This fast-paced course is intended for experienced programmers wishing to augment their skills with knowledge of Visual Basic. Prerequisites are programming experience with C, C++ or Java. OGI500 is not a prerequisite for this course. 3 credits

OGI503 Web Development with Perl 5

This course uses "Perl 5" technology to introduce the essential concepts needed to develop web applications with server side scripting. Topics include the structure and elements of the Perl 5 language (variables, control structures, file I/O, regular expressions, objects and built-in functions), important Perl libraries, writing CGI scripts, building dynamic web pages and extracting data from databases using basic SQL queries. Important issues, such as the security of web applications, will be addressed and additional topics, such as XML, may be introduced, time permitting. On completion, students will understand the conceptual architecture of web applications with server side automation and be in a position to contribute to their design and development. Assignments include writing programs and a project to develop a web application. Prerequisites: knowledge of a programming language and basic HTML. 3 credits

OGI505 -- Applications Programming in C++

This course provides an introduction to programming in C++, which is used widely for developing engineering and business applications. This course introduces students to C++ language constructs, data structures and classes. The student will also be shown how access class and template libraries, including the standard template library (STL). The course is suitable for students in engineering, management and finance who wish to gain an understanding of the language. On completion, students will be in a position to contribute to the design and development of systems using C++. Assignments include writing programs and a programming project. Prerequisites are knowledge of a programming language. 3 credits

OGI506 Advanced Applications Programming in C++

This course explores advanced topics concerning applications programming in C++. The course will focus on writing efficient, extensible and reusable programs, and introduce concepts in software engineering, program analysis and design, and data modeling. Students will develop class libraries, and learn how to apply design patterns. The course is suitable for students in science, engineering and finance who wish to further their understanding of the language. On completion, students will be in a position to the design and develop systems using C++. Assignments include writing programs and a programming project. Prerequisites: OGI 505 or equivalent knowledge of C++. 3 credits

OGI508 Web Development with Java

This course uses "Java 2" technology to introduce the essential concepts needed to develop web applications with client side scripting. Topics include the structure and elements of Java, Java Foundation Classes (JFC), Java applets and servlets, Java Beans and Remote Method Invocation (RMI). Other topics, such as JDBC and XML may be introduced, time permitting. On completion, students will understand the conceptual architecture of web applications with client side automation and be in a position to contribute to their design and development. Assignments include writing programs and a project to develop a web application. Prerequisites: knowledge of a programming language. 3 credits

OGI511 Computational Tools for Engineering and Finance

This course provides an introduction to essential programming skills needed for engineering and finance. The course reviews key topics in linear algebra, explores basic numerical methods, and provides a comprehensive introduction to computing in Matlab. Mathematical topics include vector spaces, matrix computation, solution of linear systems, interpolation, regression, approximation, numerical precision, convergence and algorithm complexity. Matlab topics include language features, handling vectors, matrices and cells, programming in Matlab (functions and script files), 2D and 3D graphics, using key toolboxes, developing a graphical user interface, and other advanced features. The course is lab oriented. Programming assignments focus on the practical use of Matlab. Prerequisites: knowledge of a programming language. 3 credits

OGI515 Data Structures and Discrete Math

This course covers fundamental topics in data structures and discrete mathematics. The topics are presented in an integrated manner that provides the discrete math foundations for data structures and computing applications of discrete mathematics concepts. Topics covered include stacks, queues, linked lists, trees, algorithms for searching and sorting, finite state automata, and concepts of computability and decidability. Topics from discrete math include sets and various types of relations (functions, graphs, trees, lattices), recursion and inductive proofs, boolean logic, relational algebra, predicate calculus, series and limits, and asymptotic behavior of searching and sorting algorithms. Programming exercises are assigned throughout the course. Prerequisites: OGI 505 or equivalent knowledge of C or C++. 3 credits

OMSE COURSE OFFERINGS**OMSE500 Principles of Software Engineering**

This course serves as an introduction to software engineering. The course's focus is on understanding the software engineering process and its attendant problems as manifest in real development projects. The course compares and contrasts different models of the software engineering process and approaches to process improvement. It includes the analysis of where and how things go wrong motivated by case studies. This course is intended as a leveling course for entering students who have not had prior instruction in software engineering and may be waived for students with an equivalent senior-level or master's-level course or equivalent work experience. Prerequisite: Knowledge of programming. Relevant work experience recommended but not required. 3 credits

OMSE 511 Managing Software Development

This course provides the knowledge and skills needed to plan, organize, lead, and control software projects. Topics include planning and estimating, measuring and controlling, and achieving results in environments that include a great deal of ambiguity and contradictory information. Quantitative measures and risk management will be emphasized throughout the course. Students will prepare project plans for real or hypothetical software projects, to include effort, cost, and schedule estimates and risk management plans. Prerequisite: OMSE 500. 3 credits

OMSE512 Understanding the Software Business

This course provides a familiarity with the business and economic aspects of software companies and other high-technology companies that develop software. Topics include fundamental macro-economic concepts, basic accounting and financial principles and methods, basic business law, and the functions and role of marketing in enterprises that develop software products or products that include software. Prerequisite: OMSE 500. 3 credits

OMSE513 Professional Communication Skills for Software Engineers

This course covers the skills necessary for appropriate professional conduct and effective communication in a professional setting. It includes technical writing, making effective presentations, conducting effective meetings, conflict resolution, team and decision-making skills, and professional ethics. Prerequisite: OMSE 500. 3 credits

OMSE521 Using Metrics and Models to Support Quantitative Decision Making

This course provides the knowledge and skills needed to apply quantitative tools based on metrics and models of the software product and development process to make decisions under uncertainty. Topics covered will include measurement concepts, decision-making under uncertainty, and model and metric development for the software development enterprise. Prerequisite: OMSE 500. 3 credits

OMSE522 Modeling and Analysis of Software Systems

Abstract models are used to formalize specifications of software systems. Formalized reference specifications serve as a basis for the design of software implementations and for validating critical properties of software systems. This course provides the fundamental mathematical concepts needed to understand abstract models of software and to reason about them as well as examples showing how they are applied. Prerequisite: OMSE 500. 3 credits

OMSE525 Software Quality Analysis

This course covers processes, methods, and techniques for developing quality software, for assessing software quality, and for maintaining the quality of software. Course material emphasizes the tradeoffs between software cost, schedule time, and quality; the integration of quality into the software development process; formal review and inspection methods; principles of testing and test planning; module design for testability; and maintaining quality while supporting existing software. Prerequisite: OMSE 500. 3 credits

OMSE531 Software Requirements Analysis

This course covers the principles, tools, and techniques for requirements elicitation, specification, and analysis. The course focus is on understanding the role of requirements in system development and maintenance, goals of the requirements phase, essential difficulties of specifying requirements for real systems, and effective methods tools and techniques. The course covers techniques for formally modeling and specifying software requirements with hands-on experience as well as the role of prototyping in validating requirements. Prerequisites: OMSE 500, OMSE 522, and the Formal Inspections part of Quality Analysis. 3 credits

OMSE532 Software Architecture and Domain Analysis

This course covers the principles and methods of the architectural design of complex software systems. It includes a survey of the major architectural styles, strengths and weaknesses of each style, and trade-offs among them; application of domain analysis to identifying and capturing common architecture in software domains (e.g., Product lines); the impact of platform dependence and independence on architectural decisions; and the relation of software architecture to requirements and its effects on downstream design. Students will examine domain analysis and the architectural design process and products in context including the effect of decisions on function, quality, cost, and schedule. Prerequisites: OMSE 500, OMSE 522. 3 credits

OMSE533 Software Design Techniques

This course covers the principles of software design and a survey of design methods, techniques, and tools. In-depth and hands-on study of at least one method such as object-oriented design as applied to a realistic industrial problem. It examines the effects of design decisions on the functional and nonfunctional properties of the software (e.g., Ease of understanding, maintainability, reuse) and how software engineering principles are applied to make appropriate trade-offs. Students also examine the design process and products in context including the effect of design decisions on function, quality, cost, and schedule. Prerequisites: OMSE 500, OMSE 522. CSE students may not receive credit for both CSE 504 and OMSE 533 because there is significant overlap in content. 3 credits

OMSE535 Software Implementation and Testing

This course covers the principles of implementing and verifying computer software. Implementation topics include coding style, packaging principles, reuse, testability, and maintainability. Verification topics include structural (white box) testing and techniques for code verification. Also included will be verification and integration of foreign code, testing techniques and how to apply them, including code-based and specification-based testing, hands-on application of the testing process, including test case generation, and test adequacy, test validation, test execution, and automation. Prerequisites: OMSE 500, OMSE 522, OMSE 525. 3 credits

OMSE551 Strategic Software Engineering

Where traditional software engineering focuses on the development and maintenance of individual systems strategic software engineering addresses the development of multiple systems over time. Recent work has shown that significant gains in productivity, cost, and schedule can result from systematic improvement of a company's overall software development process and systematic reuse of life-cycle products over multiple developments. This course covers the principles, methods, and tools for such strategic software development including long-term process modeling and improvement, developing programs as instances of families of systems, and systematic approaches to code generation and the reuse of non-code products including requirements and design. Prerequisites: OMSE Foundation and Context courses. 3 credits

OMSE555 Software Development Practicum I

3 credits

OMSE556 Software Development Practicum II

The development practicum provides an opportunity for students to apply the knowledge and skills gained in other courses as they synthesize a solution to a significant, realistic, and practical problem. Students work in teams to analyze a problem, develop a software concept, plan a software development effort, define requirements, and implement a solution. Each offering of the practicum will include at least one hour of lecture per week. Students will work closely with OMSE program faculty and, where possible, reviewers from industry to apply advanced software engineering techniques to a disciplined development of a realistic product and evaluate the results. Software development artifacts created as part of the practicum will become part of the student's professional portfolio. Contents of the portfolio include such products as the concept definition, cost estimate, project plan and schedule, formal requirements specification, test plan, software quality assurance plan, software architecture, software design, implementation artifacts, test results, and metrics collected. The portfolio contents provide examples of the student's professional capabilities. 3 credits

[Click here to register for courses...](#)

Department of Electrical and Computer Engineering

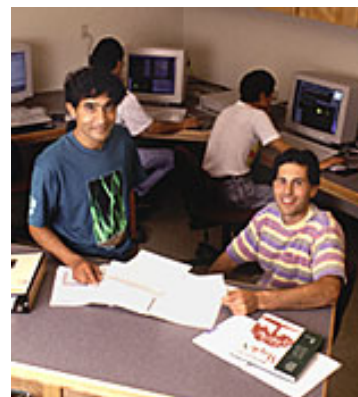
| [admissions](#) | [degree requirements](#) | [research](#) | [centers & facilities](#) | [faculty](#) | [courses](#) |

admissions and degree requirements

Admission Requirements

Admission requirements are the same as the [general requirements of the institution](#). The GRE is not required for the part-time program, special cooperative programs, or the twelve-month M.S. program. It is recommended for M.S. students who may want to apply for the Ph.D. at a later date. The TOEFL is required of all international student applicants for both the MS and Ph.D. programs.

Prerequisite: B.S. or M.S. in physics, applied physics, engineering physics, electrical engineering, or equivalent. Since modern electrical engineering programs are broad and diverse, students with undergraduate degrees in applied mathematics as well as other branches of engineering are encouraged to apply.



OGI offers the Ph.D. in Electrical Engineering. Students must have a Master of Science degree acceptable to the ECE Department to be acceptable into the Ph.D. program. This M.S. degree may be from OGI or another institution of higher education.

► [Click here to apply on-line for admission to OGI.](#)

Degree Requirements

M.S. PROGRAM

OGI's M.S. in Electrical Engineering is designed to enable professionals or recent graduates to adapt quickly to the changing needs of their fields.

Courses and M.S. non thesis research must be taken for graded credit to be counted towards the ECE degree. A minimum grade point average of 3.0 must be maintained. The course of study should be approved by a faculty advisor. Students are limited to 12 credits per quarter unless a waiver is obtained from their advisor. The M.S. degree requires successful completion of 48 credits.

THESIS OPTION

The M.S. thesis option requires successful completion of 48 credits, of which 32 are course work and a minimum of 16 are research resulting in a written thesis. In addition, an oral defense of the thesis is required. Significantly more than the minimum number of research credits may be required for completion of a satisfactory thesis project. Research credits earned toward an M.S. degree must be graded.

NON THESIS OPTION

The M.S. non thesis option requires completion of at least 48 credits of graded course work. Up to eight credits of course work may be replaced by graded research leading to a written research paper if approved by the advisor. The non thesis M.S. can be completed in a 12-month, full-time format or on a part-time basis. Research credits earned toward an M.S. degree must be graded.

TRANSFER CREDITS

Up to 12 credits from accredited institutions may be transferred to OGI; students may petition for transfer of up to 18 credits. from Portland State University, Oregon State University, and the University of Oregon. Upon approval from the department head, students may apply to their ECE degree a maximum of 21 credits from other OGI departments towards their ECE degree. Students seeking an M.S. degree from the ECE Department must take a minimum of 24 credits from ECE's curriculum.

AREAS OF EMPHASIS

By selecting 16 credits from one of the following areas of emphasis, students may select a specialization. Students may combine two or more of these specializations into a broad course of study, or concentrate exclusively within one area of emphasis.

- [Communication and Signal Processing](#)
- [Computational Finance](#)
- [Computer Engineering](#)
- [Electronic Circuit Design](#)
- [Electronic Packaging](#)
- [Information Processing](#)
- [Multimedia Systems](#)
- [Semiconductor Processing and Device Physics](#)
- [VLSI Design.](#)

Students should refer to ECE Department's 12 month Curriculum Plan for the scheduled offering of courses in the 2000/2001 academic year.

COMMUNICATIONS AND SIGNAL PROCESSING AREA OF EMPHASIS

Job opportunities in communications and signal processing are exploding. This field is enjoying a renaissance due to the rapid progress of optical fiber technology and digital signal processing techniques, and the need to move larger and larger amounts of information on a global basis.

ECE525	Analytical Techniques in Statistical Signal Processing & Communications	4 credits
ECE526	Analog and Binary Digital Communications Systems	4 credits
ECE527	M-ary Digital Communication Systems, Information Theory, and Coding	4 credits
ECE541	Speech Processing	4 credits
ECE542	Introduction to Image Processing	4 credits
ECE543	Introduction to Digital Video Processing	4 credits
ECE544	Introduction to Signals and Systems	4 credits
ECE545*	Speech Systems	4 credits

ECE550	Linear Systems	4 credits
ECE551	Introduction to Digital Signal Processing	4 credits
ECE552	Digital Signal Processing II	4 credits
ECE554	Adaptive Signal Processing	4 credits
ECE555	Engineering Optimization	4 credits
ECE557	Computer-Aided Analysis of Circuits	4 credits
ECE58X	Design of Digital Communication Circuits	4 credits
ECE58X	Digital Control Systems	4 credits

* May be offered in alternating years

COMPUTATIONAL FINANCE AREA OF EMPHASIS

The level of technical proficiency required for state-of-the-art quantitative analysis in finance has increased dramatically in the past decade. Advances in computing technology, mathematical modeling techniques, and in the quantitative methods of information processing of electrical engineering have opened up new possibilities for portfolio management, market analysis, asset allocation, hedging, derivative instruments pricing, global risk management, time series analysis, and real-time decision making.

The CSE department offers an M.S. in Computational Finance as well as a certificate program. A higher rate of tuition applies to certain CSE Computational Finance courses. ECE students with a general interest in Computational Finance may elect a concentration of courses within the ECE curriculum, as follows:

ECE525	Analytical Techniques in Statistical Signal Processing & Communications	4 credits
ECE527	M-ary Digital Communications Systems, Information Theory, and Coding	4 credits
ECE544	Introduction to Signals and Systems	4 credits
ECE545*	Speech Systems	4 credits
ECE551	Introduction to Digital Signal Processing	4 credits
ECE552	Digital Signal Processing II	4 credits
ECE553	Control Systems: Classical, Neural and Fuzzy	4 credits
ECE554	Adaptive Signal Processing	4 credits
ECE555	Engineering Optimization	4 credits
CSE510	Software Tools	3 credits
CSE540	Neural Network Algorithms and Architectures	3 credits
CSE544	Introduction to Probability and Statistical Inference	3 credits
CSE545	Advanced Neural Net Algorithms	3 credits
CSE546	Fundamentals of Compression Technology	3 credits
CSE547	Statistical Pattern Recognition	3 credits
CSE548	Modern Applied Statistics	3 credits

CSE549	Applied Business Forecasting	3 credits
CSE555	Mathematical Methods for Science and Engineering	3 credits

* May be offered in alternating years

Note: A higher rate of tuition applies to individual Computational Finance courses. The CSE department offers an M.S. in Computational Finance, as well as a certificate program.

COMPUTER ENGINEERING AREA OF EMPHASIS

Computer engineering is a hybrid program utilizing electrical engineering and computer science courses. It involves the engineering aspects of hardware and software as well as the underlying theory of computation.

ECE525	Analytical Techniques in Statistical Signal Processing & Communications	4 credits
ECE526	Analog and Binary Digital Communications Systems	4 credits
ECE527	M-ary Digital Communication Systems, Information Theory, and Coding	4 credits
ECE542	Introduction to Image Processing	4 credits
ECE543	Introduction to Digital Video Processing	4 credits
ECE551	Introduction to Digital Signal Processing	4 credits
ECE552	Digital Signal Processing II	4 credits
ECE559	Introduction to Application Specific IC (ASIC) Design	4 credits
ECE572	Digital Integrated Circuit Design	4 credits
ECE573	Introduction to Computer Logic Design	4 credits
ECE574	CMOS Digital VLSI Design I	4 credits
ECE575	CMOS Digital VLSI Design II	4 credits
CSE500	Introduction to Software Engineering	3 credits
CSE513	Introduction to Operating Systems	3 credits
CSE514	Introduction to Database Systems	3 credits
CSE515	Distributed Computing Systems	3 credits
CSE521	Introduction to Computer Architecture	3 credits
CSE522	Advanced Computer Architecture	3 credits
CSE533	Automata and Formal Languages	3 credits
CSE546	Fundamentals of Compression Technology	3 credits

ELECTRONIC CIRCUIT DESIGN AREA OF EMPHASIS

There is a continuing demand in high-tech industries for engineers knowledgeable in the design of electronic circuits. We have a comprehensive program in which students learn practical techniques in the design of analog and digital integrated circuits, GaAs high-speed circuits, VLSI design, and high frequency circuits for optics and semiconductors. In addition, students are exposed to

computer-aided analysis and optimization of electronic circuits. This program aims to produce competent circuit designers with skills required for broad job opportunities.

ECE500	<u>Electronics and Instrumentation</u>	4 credits
ECE507	<u>Introduction to Electromagnetic Fields and Waves</u>	4 credits
ECE508	<u>Electromagnetic Fields and Waves II</u>	4 credits
ECE514	<u>MOSFET Modeling for VLSI Circuit Design</u>	4 credits
ECE520	<u>Introduction To Transmission Line Theory</u>	4 credits
ECE521	<u>Introduction to Microwave Engineering</u>	4 credits
ECE544	<u>Introduction to Signals, Systems and Information Processing</u>	4 credits
ECE554	<u>Adaptive Signal Processing</u>	4 credits
ECE555	<u>Engineering Optimization</u>	4 credits
ECE557	<u>Computer-Aided Analysis of Circuits</u>	4 credits
ECE559	<u>Introduction to Application specific IC (ASIC) Design</u>	4 credits
ECE570	<u>Gallium Arsenide MESFET Integrated Circuit Design</u>	4 credits
ECE571	<u>Analog Integrated Circuit Design</u>	4 credits
ECE572	<u>Digital Integrated Circuit Design</u>	4 credits
ECE573	<u>Introduction to Computer Logic Design</u>	4 credits
ECE574	<u>CMOS Digital VLSI Design I</u>	4 credits
ECE575	<u>CMOS Digital VLSI Design II</u>	4 credits

ELECTRONIC PACKAGING AREA OF EMPHASIS

With the rapid growth of the semiconductor industry and the concomitant increase in the demands for methods of reliably and inexpensively packaging integrated circuit dies, and for providing electronic packaging at the board level and higher, associated educational needs also have grown. Electronic packaging engineers need interdisciplinary knowledge involving electrical engineering, mechanical engineering, and materials science.

ECE507	<u>Introduction to Electromagnetic Fields and Waves</u>	4 credits
ECE508	<u>Electromagnetic Fields and Waves II</u>	4 credits
ECE512	<u>Operation of Semiconductor Devices: Basics and Bipolar</u>	4 credits
ECE514	<u>MOSFET Modeling for VLSI Circuit Design</u>	4 credits
ECE520	<u>Introduction to Transmission Line Theory</u>	4 credits
ECE521	<u>Introduction to Microwave Engineering</u>	4 credits
ECE556	<u>Principles of Electronic Packaging</u>	4 credits
ECE558	<u>High Speed Interconnect Design</u>	4 credits
ECE560	<u>Microelectronic Fabrication I</u>	4 credits
ECE561	<u>Microelectronic Fabrication II</u>	4 credits
ECE562	<u>Microelectronic Fabrication III</u>	4 credits
ECE562	<u>Microelectronic Fabrication III</u>	4 credits
ECE565	<u>Analytical Scanning Electron Microscopy</u>	4 credits
ECE566	<u>Focused Ion Beam Technology</u>	4 credits

ECE567	Transmission Electron Microscopy	4 credits
ECE568	Failure and Reliability in Microelectronics	4 credits

INFORMATION PROCESSING AREA OF EMPHASIS

With rapid advances in technology, we are experiencing a paradigm shift toward information-intensive systems for sophisticated multimedia telecommunication and human-machine interaction. This master-level program represents a unique combination of traditional engineering signal processing with human information processing that prepares students for the information-intensive society of the coming century. Students benefit from exposure to real problems through partnerships with industry and government.

ECE525	Analytical Techniques in Statistical Signal Processing & Communications	4 credits
ECE526	Analog and Binary Digital Communications Systems	4 credits
ECE527	Optimal Communication Systems, Information Theory, and Coding	4 credits
ECE540	Auditory and Visual Processing by Human and Machine	4 credits
ECE541	Speech Processing	4 credits
ECE542	Introduction to Image Processing	4 credits
ECE543	Introduction to Digital Video Processing	4 credits
ECE544	Introduction to Signals, Systems and Information Processing	4 credits
ECE545*	Speech Systems	4 credits
ECE550	Linear Systems	4 credits
ECE551	Introduction to Digital Signal Processing	4 credits
ECE552	Digital Signal Processing II	4 credits
ECE553	Control Systems: Classical, Neural and Fuzzy	4 credits
ECE554	Adaptive Signal Processing	4 credits
ECE555	Engineering Optimization	4 credits
ECE58X	Speech Synthesis	4 credits
ECE58X	Digital Control Systems	4 credits
CSE540	Neural Network Algorithms and Architectures	3 credits
CSE547	Statistical Pattern Recognition	3 credits

* May be offered in alternating years

MULTIMEDIA SYSTEMS AREA OF EMPHASIS

Multimodal Communication and multimedia systems is an emerging engineering area that comprises multiple disciplines extending from human factors and algorithm development to network protocols and designing electronic devices. Existing and future multimedia applications combine audio and video (and possible other modalities) to extend the capabilities of a human operator. Multimedia systems range from the simple incorporation of text, audio, and synchronized video to creation of virtual environments. The multimedia track is an interdisciplinary specialization involving

computer engineering and computer science. Students taking courses from this track are expected to range from novices to practicing engineers desiring retraining to become multimedia professionals.

ECE525	<u>Analytical Techniques in Statistical Signal Processing & Communications</u>	4 credits
ECE526	<u>Analog and Binary Digital Communications Systems</u>	4 credits
ECE540	<u>Auditory and Visual Processing by Human and Machine</u>	4 credits
ECE541	<u>Speech Processing</u>	4 credits
ECE542	<u>Introduction to Image Processing</u>	4 credits
ECE543	<u>Introduction to Digital Video Processing</u>	4 credits
ECE545*	<u>Speech Systems</u>	4 credits
ECE551	<u>Introduction to Digital Signal Processing</u>	4 credits
ECE552	<u>Digital Signal Processing II</u>	4 credits
ECE554	<u>Adaptive Signal Processing</u>	4 credits
CSE509	<u>Object-Oriented Programming</u>	4 credits
CSE513	<u>Introduction to Operating Systems</u>	4 credits
CSE514	<u>Introduction to Database Systems</u>	4 credits
CSE515	<u>Distributed Computing Systems</u>	4 credits
CSE516	<u>Computer Graphics: Theory and Application</u>	4 credits
CSE521	<u>Introduction to Computer Architecture</u>	4 credits
CSE522	<u>Advanced Computer Architecture</u>	4 credits
CSE526	<u>Modern Operating System Design</u>	4 credits
CSE550	<u>Spoken Language Systems</u>	4 credits
CSE564	<u>Human-Computer Interactions</u>	4 credits

* May be offered in alternating years

SEMICONDUCTOR PROCESSING AND DEVICE PHYSICS AREA OF EMPHASIS

We offer a broad spectrum of courses in semiconductor synthesis, processing, device physics, and integrated circuits. Courses are designed to prepare the student for growth areas in semiconductor-based technology. Specific groups of courses are designed to provide a strong, cohesive, and marketable body of knowledge in device processing, device physics and design, and integrated circuit design. Course selections can be tailored to create unique specializations that will prepare students for careers in this important technology field.

ECE507	<u>Introduction to Electromagnetic Fields and Waves</u>	4 credits
ECE508	<u>Electromagnetic Fields and Waves II</u>	4 credits
ECE510	<u>Introduction to Quantum Mechanics for Electrical Engineers</u>	4 credits
ECE512	<u>Operation of Semiconductor Devices: Basics and Bipolar</u>	4 credits
ECE513	<u>Operation of Semiconductor Devices: MOS</u>	4 credits
ECE514	<u>MOSFET Modeling for VLSI Circuit Design</u>	4 credits
ECE516	<u>Fundamentals of Semiconductor Device Design and Processing</u>	4 credits
ECE517	<u>Semiconductor Device Design and Processing II</u>	4 credits

ECE535	<u>Thin Film Deposition and Applications in Semiconductor Fabrication</u>	4 credits
ECE536	<u>Surface Science for Semiconductor Technology</u>	4 credits
ECE537	<u>Characterization of Thin Films for Semiconductor Technology</u>	4 credits
ECE555	<u>Engineering Optimization</u>	4 credits
ECE558	<u>High Speed Interconnect Design</u>	4 credits
ECE560	<u>Microelectronic Fabrication I</u>	4 credits
ECE561	<u>Microelectronic Fabrication II</u>	4 credits
ECE562	<u>Microelectronic Fabrication III</u>	4 credits
ECE563	<u>Plasma Processing of Semiconductors I</u>	4 credits
ECE564	<u>Plasma Processing of Semiconductors II</u>	4 credits
ECE565	<u>Analytical Scanning Electron Microscopy</u>	4 credits
ECE566	<u>Focused Ion Beam Technology</u>	4 credits
ECE567	<u>Transmission Electron Microscopy</u>	4 credits
ECE568	<u>Failure and Reliability in Microelectronics</u>	4 credits
ECE569	<u>Electronic Materials and Device Characterization</u>	4 credits
ECE570	<u>Galium Arsenide MESFET Integrated Circuit Design</u>	4 credits
ECE571	<u>Analog Integrated Circuit Design</u>	4 credits
ECE572	<u>Digital Integrated Circuit Design</u>	4 credits

VLSI DESIGN AREA OF EMPHASIS

Modern very large scale integrated (VLSI) circuits are so complex that designing them by hand is virtually impossible. Consequently, VLSI design is accomplished using computer aided design tools that automate the design process and check the completed design by using simulation. There is already a strong demand for professionals trained in VLSI design and as the density of devices on a chip and device speeds increase, demand will be even more intense.

ECE513	<u>Operation of Semiconductor Devices: MOS</u>	4 credits
ECE514	<u>MOSFET Modeling for VLSI Circuit Design</u>	4 credits
ECE515	<u>Introduction to Device Physics</u>	4 credits
ECE517	<u>Semiconductor Device Design and Processing II</u>	4 credits
ECE555	<u>Engineering Optimization</u>	4 credits
ECE557	<u>Circuit Analysis</u>	4 credits
ECE560	<u>Microelectronic Device Fabrication I</u>	4 credits
ECE561	<u>Microelectronic Device Fabrication II</u>	4 credits
ECE562	<u>Microelectronic Device Fabrication III</u>	4 credits
ECE571	<u>Analog Integrated Circuit Design</u>	4 credits
ECE572	<u>Digital Integrated Circuit Design</u>	4 credits
ECE573	<u>Introduction to Computer Logic Design</u>	4 credits
ECE574	<u>CMOS Digital VLSI Design I</u>	4 credits

ECE575	CMOS Digital VLSI Design 11	4 credits
ECE58X	Introduction to Design with Programmable Logic	4 credits
CSE521	Introduction to Computer Architecture	3 credits
CSE532	Analysis and Design of Algorithms	3 credits
CSE533	Automata and Formal Languages	3 credits

COOPERATIVE M.S. PROGRAMS

Joint degree program options are available through Reed College, Lewis and Clark College and Pacific University. In these programs, the student spends three and a half years in the bachelor's program and one and a half years at OGI and receives a bachelor's degree from the undergraduate institution and a master's degree from OGI. Students interested in these special programs should contact the department for further information.

PH.D. PROGRAM

OGI offers a PhD degree program in Electrical Engineering. Admission to the PhD program generally requires a prior M.S. in Electrical Engineering, Computer Engineering or related field, whether from OGI or from another institution.

Upon entry into the program a Student Program Committee (SPC) of three faculty members is formed. The student discusses feasible research areas and eventual research directions with the committee, and together they chart an individualized course of study to prepare the student for the Qualifying Exam.

The Qualifying Exam may be written or oral or both, at the discretion of the SPC, and may additionally involve a formal research proposal. It is normally taken within 12 months of enrolling in the program, and is schedulable at any time during the year. The amount of coursework to be completed before taking the Qualifying Exam is dependent on the individual's level of preparation at entry. At minimum, 3 graded courses in ECE at OGI must be successfully completed before taking the exam.

After the qualifying exam is passed, student and Committee then work closely together to develop a research plan specifically for the dissertation. PhD students are required to make annual reports to the SPC on the status of their research, and may be called upon to deliver timely research presentations as the work progresses. The dissertation itself must constitute a significant research contribution and must be of publishable quality. The Ph.D. degree is granted following the presentation of an acceptable dissertation and successful oral defense.

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Department of Electrical and Computer Engineering

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research programs

Synthesis, Processing and Characterization of Semiconductor Materials and Devices

Synthesis facilities include state-of-the-art organometallic vapor phase epitaxy systems for growth of thin film device structures in III-V, II-VI and group IV semiconductor materials. Processing facilities include photolithography and focused ion beam lithography, rapid thermal and laser annealing and oxidation, metal and insulator deposition (physical, and RF and DC sputtering), wet and reactive ion etching, mechanical procedures (dicing, lapping and polishing), and bonding and packaging. Characterization facilities include dek-tak, ellipsometry, C-V and I-V to 1 GHz (300K to 900K) photovoltage and photoconductivity (UV to IR at 10K to 300K), X-ray (diffraction, rocking curve and von Laue), FTIR, fully equipped Zeiss 960 SEM and Hitachi 800 TEM. Present research programs are focused on III-V lasers, HEMTs and HBTs; (HgCd)Te photodiodes and (HgCd)Te/Si monolithically integrated focal plane arrays; and solid state device technology R&D (includes basic transport property measurements, device processing technology and development of power diodes and MESFETs). *Parsons, Solanki*

Modification of Semiconductor Materials

Research is under way on the processing and characterization of semiconductor materials as affected by localized transient heating, plasma passivation, and thermal annealing. The recrystallization of polysilicon is studied using various laser sources and rapid thermal annealing. *Solanki*

Speech Synthesis

Speech is the most natural and efficient means by which individuals may access most information, and the need for speech-based interfaces is growing as computing gradually moves off of the desktop and into mobile devices. Since most on-line information is represented as ASCII text, the automatic conversion of text to speech provides a critical component in voice-based systems. Text-to-speech synthesis (TTS) has the further advantage of providing textual information to people who are visually impaired or functionally illiterate. The current trend in TTS research is to develop algorithms that rely on automatic training of models from labeled data, rather than hand-tuned rules as used historically. This strategy leads to systems that can be itrainedi rapidly to speak in a new language or speaking style. Our work has been focused on signal processing models of the human voice and their use in data-driven speech synthesis algorithms. This is an interdisciplinary field that draws elements from linguistics, computer science, machine learning, human perception, and digital signal processing. *Macon*

Semiconductor Compounds and Alloys

Research is being conducted in III-V, II-VI, and group IV semiconductor synthesis, materials, devices, and monolithically integrated optoelectronic circuits. Metal Organic Chemical Vapor Deposition (MOCVD) is employed for synthesis research. Materials research includes metal/semiconductor interface and transport property studies, 3C-SiC and selective Si epitaxy. 3C-SiC research is focused on high-power, high-temperature devices and nonthermionic emitters for CRT flat panel displays. *Parsons*

Advanced Lithography

Lithography is the key technology pacing the evolution of microelectronics. Research is ongoing in developing a viable patterning technology for use in large scale manufacturing of semiconductor devices. By using either semiconductor technology or new cathode materials, it should be possible to generate arrays with significantly enhanced speed and improved pattern fidelity. *Berglund*

VLSI Architecture for Intelligent Computing

Some of the most fundamental problems in computing involve teaching computers to act in a more intelligent manner. Key to this is the efficient representation of knowledge or contextual information. In this project a variety of highly parallel algorithms are studied, including neuromorphic structures, with the intent of implementing knowledge representation and manipulation in silicon. *Hammerstrom*

Flat Panel Displays

The video screen is becoming an indispensable link between information processing electronics systems and human beings. Although the cathode ray tube (CRT) remains the dominant display technology, its size, weight, and power requirements become unsuitable for many applications. As a replacement for CRTs, several flat panel display technologies are being explored due to their compactness, light weight and low power consumption. A flat panel display research group has been established to develop research capabilities and to work closely with the emerging display companies to assist them in overcoming technological hurdles. At present, research is directed towards electroluminescent, field emission, and liquid crystal displays. *Berglund, Bell, Solanki, Rananavare*

Light-Tissue Interaction

Conventional light sources and lasers are widely used in medicine, and their efficacy is largely determined by the transport of light in the targeted tissue. Research is directed towards developing new noninvasive techniques for monitoring light propagation using reflectance spectroscopy, fluorescence, and pulsed-photothermal radiometry. Close ties with the Cardiac Laser Center at St. Vincent Hospital facilitate the transfer of this basic light-tissue research to new clinical devices and techniques. Collaborative efforts include laser angioplasty of coronary arteries and noninvasive spectral identification of chromophore concentrations. *Prahl, Jacques*

Atmospheric Optics

The use of laser systems to transmit signals through the atmosphere for purposes of communication, radar, recognition, and designation is severely limited by scattering due to turbulence and particulates such as water droplets or dust. Turbulence, which causes shimmer on a hot day and makes stars seem to twinkle, results in the random steering, spreading and breaking-up (scintillation) of a laser beam. Particulate scattering that severely attenuates the received signal also causes depolarization and multiple path effects such as pulse stretching and scrambling of the signal. Experimental studies which, in conjunction with concurrent theoretical work, are contributing significantly to fundamental understanding of the effects of atmospheric turbulence on laser beam, speckle propagation and its application to optical remote sensing. *Holmes*

Optical Remote Sensing

Analytical and experimental studies are being made on the use of the interaction of electromagnetic radiation and turbulence to measure winds and turbulence. Recent efforts include analytical, numerical and experimental work on a CO₂, optical heterodyne system for remote measurement of atmospheric cross winds and strength of turbulence. *Holmes*

Speech Analysis for Adverse Communication Environments

Biological signals such as speech carry large amounts of information from different information sources. Typical engineering applications such as automatic speech recognition, speaker verification, or low bit-rate coding of speech may require information from only one particular source, and all other information introduces undesirable and harmful variability into the signal. Humans appear to be able to partially separate the various information sources in the speech signal. This ability spurred interest in modeling human-like processing of speech by modern discrete signal processing techniques. The anthropomorphic signal processing techniques could, in principle, yield improved performance of man/machine I/O technologies in real practical environments. Our research project on speech analysis, carried on jointly with the International Computer Science Institute, Berkeley, Calif., focuses on human-like processing of speech in realistic telecom-munications environments to ensure reliable recognition of speech in adverse conditions such as the current mobile cellular telephone. *Hermansky*

Neural Networks and Adaptive Systems

Neural computation and adaptive systems are studied from both theoretical and practical standpoints. Current research in theory, architecture, and algorithm design includes deterministic and stochastic network dynamics, learning algorithms (supervised, unsupervised, and reinforcement), generalization theory (including model selection and pruning, invariant learning), context-sensitive learning, signal processing, time series analysis, and control. Practical application domains include adaptive signal processing, pattern recognition, speech recognition, image processing, control systems, macroeconomics, and finance. *Wan, Pavel, Leen, Moody, Song*

Image Processing & Image Recognition

The main research interests of our group are twofold. One thrust is image processing and image recognition. One of the techniques we are working on is incorporating contextual information into recognition. In the real world there are cases where the identity of an object is ambiguous due to the noise in the measurements or the incompleteness of information based on which the

classification should be made. It is helpful to reduce the ambiguity by utilizing extra information referred to as context. Context appears in many forms in different applications. It can be the identities of adjacent characters in character recognition, the identities of neighboring pixels for remote sensing images, the frequency of other cell types in white blood cell image recognition, or the presence of accompanying analytes in urinalysis, to name a few. Probabilistic or statistical models can be developed for context incorporation, and it has been demonstrated that utilizing contextual information is crucial for improving recognition accuracy. Another research thrust is on machine learning and data mining. We are interested in a fundamental understanding of learning, and in the development of learning systems that achieve state of the art performance. *Song*

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research centers and facilities

Research Centers

Center for Information Technologies

The mission of the Center for Information Technology (CIT) is to support the development and deployment of complex information- and signal-processing systems. The broad field of information technologies has become a vital driving force in the United States economy, both regionally and nationally. Industries are in the process of shifting emphasis from instrumentation and manufacturing to multimedia and communications services. CIT activities complement this growing movement by focusing on the "human-like," or anthropic, processing side of information systems. The general approach of this newly established center is based on anthropic signal processing, which is the synthesis of robust signal-processing techniques that exceed the performance of standard classical signal-processing methods by appealing to human-like processing strategies and capabilities.

Center For
Information
Technology



Digital signal processing has made a significant impact on human lives since its introduction several decades ago. A wide array of technologies- ranging from digital telephones to the ability to accurately predict the behavior of complex systems- rely on elegant mathematical concepts and on the power of digital computers. Even the most advanced techniques, however, fail to carry out many tasks that are effortlessly performed by humans.

The center complements traditional digital signal-processing techniques with engineering knowledge of human information processing. The center's efforts focus on several target engineering systems, including robust feature extraction for speech recognition systems, speech quality enhancement in cellular communications, automatic target detection and identification, and a forward visibility system for aviation. These projects are supported by basic research on several key supporting technologies, including neural networks, prediction, image and speech representation, information fusion and the incorporation of prior knowledge in adaptive systems.

Within OGI, CIT provides a natural complement to existing and proposed centers, including the Department of Computer Science and Engineering's Center for Spoken Language Understanding and its Center for Human-Computer Communication. CIT provides support to CSLU in the development and analysis of adaptive techniques, thereby supporting signal analyses for speech recognition. In a similar way, CIT is developing solutions to a variety of signal-processing problems in natural communication using images, sound and gestures. CIT is an important component in the ECE department's focus on intelligent signal processing. For more information, consult our World Wide Web pages at www.ece.ogi.edu/CIT/.

Center for Spoken Language Understanding

The research program of the Center for Spoken Language Understanding (CSLU) encompasses a broad range of technologies critical to advances in the development of interactive conversational systems. Such research is inherently multidisciplinary, and the center brings together a team with expertise in signal processing, speech recognition, speech synthesis, dialogue modeling, natural language processing, multimodal systems, linguistics and human-computer interaction. Within CSLU there are five collaborating research groups:



- Neural Speech Enhancement Lab
- Anthropic Signal Processing Group
- Speech Recognition Group
- Speech Synthesis Research Group
- Natural Dialog Group

These focus on specific problem areas such as: robust methods for enhancing speech in noisy environments; large vocabulary recognition of continuous speech, as in broadcast news; unit selection and voice conversion for more realistic speech synthesis; robust parsing and interpretation of spoken and multimodal input; modeling of disfluencies in spontaneous speech; and effective methods for dialog management. CSLU research projects incorporate and evaluate these research advances. For example, one project involves the development of an animated conversational agent for learning and language training with profoundly deaf children. The center is also highly active in the development and distribution of a wide variety of language resources, including corpora of transcribed telephone and cellular speech data for over 20 languages.

[Professor Jan van Santen](#) is the director of OGI's Center for Spoken Language Understanding. The center is co-directed by Professors Peter Heeman, Mike Macon and Eric Wan. Other center faculty includes Professors Todd Leen, Hynek Hermansky, Xubo Song, Pieter Vermeulen and Howard Yang. The center receives support from a broad range of government and industrial sources, including NSF, DARPA, ONR, Boeing, Intel, L&H, Microsoft, Motorola, Qualcomm, SpeechWorks, Texas Instruments, Voice Control Systems and Southwest Bell Technology. For additional information, visit the CSLU web site: www.cslu.ece.ogi.edu.

Research Programs

[Oregon Medical Laser Center](#)

[Anthropic Signal Processing Group](#)

[Flat Panel Display Group](#)

[Neural Speech Enhancement Lab](#)

[Speech Synthesis Research Group](#)

Research Facilities

The department has a complete complement of electronic measuring, recording, amplifying, signal generating, data processing, and servicing gear with associated power supplies and component stocks. Additional facilities and equipment include:

NT/PC Computer Lab

Solaris Servers with X-terminal access

DTV Lab

Intel Semiconductor Educational Lab

Embedded Computer Lab

High-end PCs & workstations

Far-infrared Fourier spectrometer

Parallel field-vibrating sample magnetometer

Mossbauer spectrometer

Field electron and ion microscopes

Ultra-high vacuum systems

Thin-film evaporation equipment

Electron energy analyzers for Auger and field electron spectroscopy

Micromachining capabilities

Scanning electron microscope and transmission electron microscope

High-resolution electron and ion microprobes

Work function analysis instrumentation

Quadrupole mass spectrometers for surface desorption studies

Arc zone refinement system for single crystal specimen preparation

Wire bonder

Die attach system

X-ray diffraction generator and cameras

Facility for electronic transport and luminescence measurements as a function of temperature

Visible, ultraviolet, and infrared gas, solid state, and dye lasers

MOCVD crystal growth reactors

1.25 meter visible and IR spectrometer

High-performance optical microscope

Depth profiling ellipsometer

Photolithography and semiconductor metallization

Sputter etching

Device interconnect and packaging

C-V, I-V measurement facilities

Pulsed uv-laser processing system

Electrical characterization (Hall)

Sputtering machine

Atomic layer epitaxy

Liquid crystal display lab with pretilt, rubbing, and single-cell electro-optic characterization facilities.

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DAN HAMMERSTROM

Doug Strain Professor and Department Head
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RESEARCH INTERESTS

Highly parallel computer architecture and microarchitecture. Silicon structures optimized for image processing, digital video, intelligent and neuromorphic computing. VLSI design. Technology transfer.

REPRESENTATIVE PUBLICATIONS

D. Hammerstrom, "Computational Neurobiology Meets Semiconductor Engineering," Invited Paper MultiValued Logic 2000, May 2000.

S. Rehfuess & D. Hammerstrom, "Comparing SFMD and SPMD Computation for On-Chip Multiprocessing of Intermediate Level Image Understanding Algorithms," Proceedings of the conference for Computer Architectures for Machine Perception 1997, Boston, MA (October 1997).

D. Hammerstrom & D. Lulich, "Image Processing Using One-Dimensional Processor Arrays," The Proceedings of the IEEE, 84(7), 27-43 (July 1996).

S. Rehfuess & D. Hammerstrom, "Model Matching and Single Function Multiple Data Computation (SFMD)," NIPS Proceedings (November 1995).

D. Hammerstrom, "Digital VLSI for Neural Networks," Handbook of Brain Theory and Neural Networks, M. Arbib (Ed.), Bradford Books/MIT Press (1995).

D. Hammerstrom, "A Digital VLSI Architecture for Real World Applications," An Introduction to Neural and Electronic Networks, S.F. Zornetzer, J.L. Davis, C. Lau & T. McKenna (Eds.), Academic Press (1995).



ANTHONY E. BELL

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RESEARCH INTERESTS

Development of liquid metal field ion sources; field ionization, surface physics, and chemistry; field emission microscopy and energy distribution measurements. Selected area processing for microcircuit fabrication using focused electron beams. Direct-write electron-beam lithography for both mask making and IC fabrication using multiple photo-emitted electron beams. Plasma processing for thin film deposition and etching.

REPRESENTATIVE PUBLICATIONS

A.E. Bell & D.F. Barofsky, "Field Emission and Field Ionization," in Encyclopedia of Applied Physics, 6, 379 (1993).

A.E. Bell, K. Jousten & L.W. Swanson, "High Field Ion Sources," Rev. Sci. Instr., 61(1) Part II, 363 (1990).

S. Rao, A.E. Bell, G.A. Schwind & L.W. Swanson, "Angular Distribution of Ions from a AuSi Liquid Metal Source," J. Vac. Sci. Technol., A8(3), 2258 (1990).

S. Rao, A.E. Bell, G.A. Schwind & L.W. Swanson, "A Combination Electron/Ion Field Emission Source," J. Vac. Sci. Technol., B7, 1793 (1989).

L.W. Swanson & A.E. Bell, "Liquid Metal Ion Sources," I.G. Brown (Ed.), The Physics and Technology of Ion Sources, John Wiley & Co., 313 (1989).



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RESEARCH INTERESTS

Management of technology, and advanced lithography for semiconductor fabrication.

REPRESENTATIVE PUBLICATIONS

J. Ye, M. Takac, C.N. Berglund, G. Owen & R.F.W. Pease, "An Exact Algorithm for the Self-Calibration of Precision X-Y Stages," Conference on Electron, Ion & Photon Beam Technology and Nanofabrication (May 1996).

M.T. Takac, J. Ye, M.R. Raugh, R.F.W. Pease, C.N. Berglund & G. Owen, "Self-Calibration in Two Dimensions: The Experiment," 1996 SPIE International Symposium on Microlithography (March 1996).

W. Wang, J. Ye, A.B. Owen, C.N. Berglund & R.F.W. Pease, "Adaptive Metrology: An Economical Strategy for Judging the Acceptability of a Mask Pattern," J. Vac. Sci. Technol., B13(6) (November/December 1995).

J. Ye, C.N. Berglund & R.F.W. Pease, "Field Distortion Characterization Using Linewidth or Pitch Measurement," J. Vac. Sci. Technol. B13(6) (November/December 1995).

J. Ye, C.N. Berglund, J. Robinson & R.F.W. Pease, "A Review of Mask Errors on a Variety of Pattern Generators," IEEE Transactions on Semiconductor Manufacturing, 8(3), 319-325 (August 1995).

J. Ingino, G. Owen, C.N. Berglund, R. Browning & R.F.W. Pease, "Workpiece Charging in Electron Beam Lithography," J. Vac. Sci. Technol., B12(3), 1367-1371 (May/June 1994).



JOHN L. FREEOUF

Professor

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RESEARCH INTERESTS

The large and growing semiconductor industry has clearly established that to control something you must be able to measure it. A major thrust of my research efforts is to determine how to measure the specific parameters required to best understand and improve our semiconductor materials and devices. Typically, these measurements will involve incident photons; the output may be either photons or some electrical response.

REPRESENTATIVE PUBLICATIONS

Todd Holden, P. Ram, Fred H. Pollak, J. L. Freeouf, B. X. Yang and M. C. Tomargo, Spectral Ellipsometry Investigation of Zn Cd Se Lattice Matched to InP, Physical Review B56, 4037 (1997).

M. Leibovitch, P. Ram, L. Malikova, Fred H. Pollak, J. L. Freeouf, L. Kronik, B. Mishon, Yoram Shapira, A. R. Clawson, and C. M. Hanson, Reflection Anisotropy Spectroscopy, Surface Photovoltage Spectroscopy, and Contactless Electroreflectance Investigation of the InP/In_{0.53}Ga_{0.47}As (001) Heterojunction System, J. Vac. Sci. Technol. B14, 3089 (1996).

J. L. Freeouf, N. Braslau, and M. Wittmer, Lifetime Measurements on Silicon on Insulator Wafers, Appl. Phys. Lett. 63, 198 (1993).

M. Wittmer and J. L. Freeouf, Ideal Schottky Diodes on Passivated Silicon, Phys. Rev. Lett. 69, 2701 (1992).

J. L. Freeouf, D. A. Buchanan, S. L. Wright, T. N. Jackson, and B. Robinson, Accumulation Capacitance for GaAs SiO₂ Interfaces With Si Interlayers, Appl. Phys. Lett. 57, 1919 (1990).



KENTON GREGORY

Associate Professor
M.D., School of Medicine
University of Southern California, 1980

RESEARCH INTERESTS

Application of laser energy for the treatment of atherosclerotic vascular disease, laser thrombolysis in acute myocardial infarction and stroke, vascular smooth muscle response to light, Elastin biomaterials for tissue replacement and repair, and dye-targeted laser-tissue fusion.

REPRESENTATIVE PUBLICATIONS

M.J. Girsky, K.W. Gregory, A. Shearin & S.A. Pahl, "Photoacoustic Drug Delivery to Arterial Thrombus: A New Method for Local Drug Delivery," American Heart Association, 69th Annual Scientific Session, New Orleans, LA (November 1996).

K.W. Gregory, "Laser Thrombolysis in Acute Myocardial Infarction," Current Review of Interventional Cardiology (D. Holmes Jr. & P. Serruys), 3rd Edition (August 1996).

E.N. LaJoie, A.D. Barofsky, K.W. Gregory & S.A. Pahl, "Welding Artificial Biomaterial with a Pulsed Diode Laser and Indocyanine Green," SPIE, Laser Tissue Interaction VI (S.L. Jacques, Ed.), San Jose, CA (1995).

H. Shangguan, L.W. Casperson, A. Shearin, K.W. Gregory & S.A. Pahl, "Photoacoustic Drug Delivery: The Effect of Laser Parameters on Spatial Distribution of Delivered Drug," SPIE, Laser Tissue Interaction VI (S.L. Jacques, Ed.), San Jose, CA (1995).

K.W. Gregory & J.M. Grunkemeier, "Arterial Reconstruction using an Elastin-based Biopolymer with Dye Targeted Diode Laser Fusion," American Society for Laser Medicine and Surgery, 15th Annual Meeting, San Diego, CA (April 1995).



HYNEK HERMANSKY

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Dr. Eng., Electrical Engineering
University of Tokyo, 1983
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RESEARCH INTERESTS

Communication between human and machine; human perception and its computer simulation; speech production and perception; automatic recognition of speech, speech coding, synthesis and enhancement; identification and extraction of linguistic information in realistic communication environments.

REPRESENTATIVE PUBLICATIONS

H. Hermansky, "Should Recognizers Have Ears?" Speech Communication, , Publishers, Holland, (June 1998).

H. Hermansky, "Modulation Spectrum in Speech Processing, in Signal Analysis and Prediction," Prochazka, Uhler, Rayner, Kingsbury, Eds., (1998).

H. Hermansky & N Malayath, "Speaker Verification using Speaker-Specific Mappings," Proceedings of Speaker Recognition and its Commercial and Forensic Application, France, (1998).

C. Avendano & H. Hermansky, "On the Properties of Temporal Processing for Speech in Adverse Environments," Proceedings of 1997 Workshop on Application of Signal Processing to Audio and Acoustics, Mohonk Mountain House, New Paltz, New York, (October 1997).

S. Tibrewala & H. Hermansky, "Multi-band and Adaptation Approaches to Robust Speech Recognition," to appear in Proceedings of EUROSPEECH '97, Rhodes, Greece, (September 1997).

S. van Vuuren & H. Hermansky, "Data-driven Design of RASTA-like Filters," Proceedings of EUROSPEECH 97, Rhodes, Greece, (September 1997).

H. Hermansky, C. Avendano, S. van Vuuren, & S. Tibrewala, "Recent Advances in Addressing Sources of Non-Linguistic Information," Proceedings of ESCA-NATO Tutorial and Research Workshop on Robust Speech Recognition for Unknown Communication Channels, 103-106, Pont-a-Mousson, France (April 1997).



J. FRED HOLMES

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RESEARCH INTERESTS

Speckle propagation through turbulence, optical remote sensing of wind and turbulence, electro-optic systems, instrumentation signal processing, and biomedical optics..

REPRESENTATIVE PUBLICATIONS

J. Fred Holmes, Steven L. Jacques, and John M. Hunt, "Adapting atmospheric lidar techniques to imaging biological tissue", SPIE, Bios 2000 Conference, San Jose, California, (January 22 - 28, 2000).

M. Becker, J.F. Holmes, & L. Meekisho, "Interdisciplinary Curriculum Development in Electronics Packaging Using Course Segmentation," ASEE 1998 Frontiers in Education Conference, Tempe, Arizona (November 4-7, 1998).

J.F. Holmes & B. J. Rask, "Range Resolved, 3-D Optical Remote Sensing of Atmospheric Winds Using a CW Lidar," Advances in Atmospheric Remote Sensing with Lidar, A. Amsmann, R. Neuber, P. Rairoux, and U. Wandinger (eds.), Springer-Verlag, Berlin (1997).

J. F. Holmes & C. Zhou, "Path Resolved, Optical Remote Sensing of the Strength of Turbulence Using a Pseudo Random Code Modulated CW Lidar and Coherent Optical Processing," 9th

Conference on Coherent Laser Radar, Linkoping, Sweden (June, 1997).

J.F. Holmes & B.J. Rask, "The Effect of Aerosol Speckle Phase Decorrelation on the Allowable Signal Averaging Time for Coherent Optical Receivers," SPIE Annual Meeting (August 1996).

J.F. Holmes & B.J. Rask, "Range Resolved, 3-D, Optical Remote Sensing of Atmospheric Winds Using a CW Lidar," 18th International Laser Radar Conference, Berlin, Germany (July 1996).

J.F. Holmes & B.J. Rask, "Optimum, Optical Local Oscillator Levels for Coherent Detection Using Photodiodes," Appl. Opt., 34 (February 1995).



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Sc.D., Electrical Engineering
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RESEARCH INTERESTS

Electronic and photonic device design for microsensor applications with a current concentration on materials. Applications in genetic algorithms and programs as applied to electronic materials and devices as well as human organizations. System dynamics modeling of human organizations for public policy development. The role early engineering education processes have in retention and attraction of female engineering students.

REPRESENTATIVE PUBLICATIONS

James Hines, Jody Lee House, Richard Wu, "Representing Learning within System Dynamics Models: An agent-based, genetic algorithm approach", proceedings of International System Dynamics Conference, Bergen, Norway, August, 2000.

Jody Lee House, Alex Kain, James Hines, "Evolutionary Algorithm: Metaphor for Learning," proceedings of Genetic and Evolutionary Computing Conference 2000, Las Vegas, Nevada, July 2000.

James Hines, Jody Lee House, "Policy Evolution Within an Organization," proceedings of the 1999 NSF Design & Manufacturing Conference, Vancouver, B.C., January 1999.

Hines, J, and J.L. House, 'Harnessing evolution for organizational management,' proceedings of the International Conference on Complex Systems, Nashua, NH, October 1998.

J. House, G. Petrich, L. Kolodziejski, & E. Ippen, "Growth and Characterization of ZnSe/GaAs Single Quantum Well Structures," Surface Science, 104(105),472-478 (1996).

D.J. Dougherty, S.B.F., E.L. Warlick, J. House, G.S. Petrich, E. Ho, L.A. Kolodziejski, Investigation of electric fields, interface charges, and conduction band offsets at ZnSe/GaAs heterojunctions with a novel photoreflectance technique. MRS Proceedings, 1996.

Dougherty, D.J., S.B. Fleischer, E. Warlick, J.L. House, G.S. Petrich, L.A. Kolodziejski, E.P. Ippen, "Ultrafast carrier dynamics and intervalley scattering in ZnSe," Applied Physics Letters, vol. 71, no. 21, pp. 3144-6, November 24, 1997., September 17-19, 1993, in Journal of Vacuum Science Technology, B12(2), pp. 1153-1155, 1994.



MARWAN JABRI

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Ph.D., Electrical Engineering University of Sydney, 1988

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RESEARCH INTERESTS

Integrated circuits and systems; computer architecture; understanding the principles by which humans and other organisms perceive the environment, process sensory signals, reason, make decisions and learn

REPRESENTATIVE PUBLICATIONS

M.A. Jabri, R. Coggins & B. Flower, "Adaptive Analog Neural Systems," Chapman and Hall, UK, 1996.

M.A. Jabri, "An Artificial Intelligence Approach to Integrated Circuit Floorplanning," Springer-Verlag, Lecture Notes in Engineering, Vol. 1.66, 1991.



STEVEN L. JACQUES

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Ph.D., Biophysics and Medical Physics

University of California, Berkeley, 1984

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RESEARCH INTERESTS

Biomedical optics and laser-tissue interactions. Development of diagnostic and therapeutic devices for medicine and biology using optical technologies.

REPRESENTATIVE PUBLICATIONS

S. L. Jacques, "Light distributions from point, line, and plane sources for photochemical reactions and fluorescence in turbid biological tissues," Photochem. Photobiol. 67:23-32 (1998)

S. L. Jacques, S. J. Kirkpatrick, "Acoustically modulated speckle imaging of biological tissues," Optics Letters, 23:879-881 (1998)

S. L. Jacques, "Path integral description of light transport in tissue," Ann N Y Acad Sci. 9;838:1-13 (1998)

S. L. Jacques, J. R. Roman, K. Lee, "Imaging superficial tissues with polarized light," Lasers Surg. Med. 26:119-129 (2000)

L. V. Wang, S. L. Jacques, "Source of error in calculation of optical diffuse reflectance from turbid

media using diffusion theory," Comput Methods Programs Biomed. 61(3):163-170 (2000)

S. L. Jacques, "Modeling photon transport in transabdominal fetal oximetry," J Biomed. Optics, in press (2000)



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Robert S. Jaffe is a full time instructor in ECE. He teaches in the areas of signals and systems, applied mathematics and mathematical systems theory. His area of specialization is linear systems and robust control. He received a Ph.D. in Electrical and Computer Engineering from Portland State University in 1988. During an earlier career phase he was a Professor of Philosophy and a researcher in the philosophy of education.



MICHAEL MACON

Assistant Professor

Ph.D., Electrical Engineering

Georgia Institute of Technology, 1996

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RESEARCH INTERESTS

Speech synthesis, speech and audio coding, music synthesis, human auditory perception, and digital signal processing.

REPRESENTATIVE PUBLICATIONS

F. Kossentini, M.W. Macon & M.J.T. Smith, "Audio Coding Using Variable-Depth Multistage Quantization," IEEE Transactions on Speech and Audio Processing, Vol. 6, No.2, 186-188, (March 1998).

M.W. Macon & M.A. Clements, "Sinusoidal Modeling and Modification of Unvoiced Speech," IEEE Transactions on Speech and Audio Processing, Vol. 5, No. 6, 557-560, (November 1997).

M. W. Macon and M. A. Clements, "An Enhanced ABS/OLA sinusoidal model for waveform synthesis in TTS," in Proceedings of EUROSPEECH, volume 5, pp. 2327-2330 (1999).

M.W. Macon, L. Jensen-Link, J. Oliverio, M. Clements & E.B. George, "Concatenation-based MIDI-to-singing voice synthesis," 103rd Meeting of the Audio Engineering Society, New York (1997).

M.W. Macon & M.A. Clements, "Speech Concatenation and Synthesis Using An Overlap-add Sinusoidal Model," Proceedings of the International Conference on Acoustics, Speech, and Signal Processing, Vol.1, 361-364 (May 1996).

J. Wouters and M. W. Macon, "A Perceptual Evaluation of Distance Measures for Concatenative

Speech Synthesis," Proc. of International Conference on Spoken Language Processing, November 1998.

A. Kain & M.W. Macon, "Spectral Voice Conversion for Text-to-Speech Synthesis," Proceedings of International Conference on Acoustics, Speech, and Signal Processing, 1, 285-288 (1998).



JACK McCARTHY

Assistant Professor

Ph.D., Materials Science and Engineering

Oregon Graduate Institute of Science and Technology, 1996

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RESEARCH INTERESTS

Mechanisms of change in metallization and insulator thin films used in microelectronic applications, in-situ testing of these films in transmission and scanning electron microscopes to develop better processing techniques and more reliable thin films. The development of focused ion beam processes for the fabrication of structures on the micron and sub-micron scales to produce sensors and electro-mechanical devices for testing the physical properties of sub-micron thin films. Thin film transmissive photocathodes for use in multi-beam electron lithography and surface reactions at the emission site. Materials characterization techniques using analytical electron microscopy and focused ion beam technology.

REPRESENTATIVE PUBLICATIONS

F.Radulescu, J.M.McCarthy, "The Effect of Stress in the PdGe Mediated Solid Phase Epitaxial Growth of Ge on GaAs", MRS Symposium Proceedings, Substrate Engineering for Epitaxy, 587(1999)

F.Radulescu, J.M.McCarthy, E.Stach "In-Situ Annealing Transmission Electron Microscopy of Pd/Ge/Pd/GaAs Interfacial Reactions" MRS Symposium Proceedings, Advances in Materials Problem Solving with the Electron Microscope, 589(1999)

J.McCarthy, Z. Pei, M.Becker, D.Atteridge "FIB Micromachined Submicron Thickness Cantilevers for the Study of Thin Film Properties" Thin Solid Films 358 (2000) p146-151. accepted 8/31/99.

S.Gosavi, J.M.McCarthy, C.N.Berglund, W.A.Mackie, L.A.Southall "Practical Gold Thin Film Photocathodes for Advanced Electron Beam Lithography" BACUS Symposium on Photomask Technology, SPIE Vol.3873, Sept (1999).

Z.Pei, J.McCarthy, C.N.Berglund, T.H.P.Chang, M.Mankos, K.Y.LEE and M.L.Yu, "Thin Film Gated Photocathode for e-Beam Lithography", J.VAC.Sci.Technol.B 17(6), p2814(1999).

J.M. McCarthy , SEM and TEM Characterization of Materials Using a Focused Ion Beam Milling Workstation, IMS Conference Proceedings in Materials Characterization accepted (1997).



MISHA PAVEL

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Experimental Psychology New York University, 1980

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RESEARCH INTERESTS

Multimodal communication between humans and machines. Analysis and modeling of complex human-like (anthropic) behaviors, including visual and auditory processing, pattern recognition, information fusion and decision making. Development of systems with anthropic abilities for speech and video communication, machine vision, visually guided vehicular control, and virtual reality.

REPRESENTATIVE PUBLICATIONS

R.Sharma & M. Pavel, "Adaptive and Statistical Image Fusion," Society for Information Display International Symposium: Digest of Technical Papers, Vol. XXVII, San Diego, CA (May 1996).

M. Pavel & H.A. Cunningham, "Eye Movements and the Complexity of Visual Processing," in M.S. Landy (Eds.), Exploratory Vision: The Active Eye, 101-120 New York, NY, Springer-Verlag (1996).

H. Hermansky & M. Pavel, "Psychophysics of Speech Engineering Systems," invited paper, Proceedings of the 13th International Congress on Phonetic Science, Stockholm, Sweden (August 1995).

P. Suppes, M. Pavel & J. Falmagne, "C. Representations and Models in Psychology," Annu. Rev. Psycho., 45, 517 (1994).

M. Pavel, J. Larimer & A. Ahumada, "Sensor Fusion for Synthetic Vision," Society for Information Display (SID), 92, 475 (1992).

M. Pavel, H. Cunningham & V. Stone "Extrapolation of Linear Motion," Vision Research, 32(11), 2177 (1992).

M. Pavel, "Predictive Control of Eye Movement," in E. Kowler (Eds.), Eye Movement and Their Role in Visual and Cognitive Processes, 71-114, Amsterdam, Elsevier (1990).



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Ph.D., Biomedical Engineering

University of Texas at Austin, 1988

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RESEARCH INTERESTS

Interaction of light with tissue, pulsed photothermal radiometry, laserangioplasty, optical properties of biological materials, noninvasivemedical diagnostics.

REPRESENTATIVE PUBLICATIONS

S.A. Prael, "Pulsed Photothermal Radiometry of Inhomogeneous Tissue," in A. Mandelis & P. Hess (Eds.), Progress in Photothermal and Photoacoustic Science and Technology Series, Life and Earth Sciences: SPIE Press, 3, (1996).

U.S. Sathyam, A. Shearin & S.A. Prael, "Visualization of Microsecond Laser Ablation of Porcine

Clot and Gelatin Under a Clear Liquid," R.R. Anderson & A. Katzir (Eds.), Proceedings of Lasers in Surgery: Advanced Characterization, Therapeutics, and Systems VI, San Jose, CA, Vol. 2671, 28-35 (1996).

U.S. Sathyam, A. Shearin, A. Chasteney & S.A. Prahl, "Threshold and Ablation Efficiency Studies of Microsecond Ablation of Gelatin Under Water," Lasers Surg. Med, 19 (1996).

H. Shangguan, L.W. Casperson, A. Shearin & S.A. Prahl, "Investigation of Cavitation Bubble Dynamics Using Particle Implications for Photoacoustic Drug Delivery," in R.R. Anderson & A. Katzir (Eds.), Proceedings of Lasers in Surgery: Advanced Characterization, Therapeutics, and Systems VI, San Jose, CA, Vol. 2671, 104-115 (1996).

S.A. Prahl, "Charts for Rapid Estimation of Spatial and Temporal Distribution of Temperature Following Laser Irradiation," SPIE, 2391A (1995).

E.N. La Joie, A.D. Barofsky, K.W. Gregory & S.A. Prahl, "Welding Artificial Biomaterial with a Pulsed Diode Laser and Indocyanine Green," SPIE, 2395D (1995).

S.L. Jacques, L. Buckley, S. Prahl & K. Gregory, "Quantifying Psoralen in Tissues by Fluorescence: Dosimetry for PUVA to Block Restenosis," SPIE, 2130 (1994).



SHANKAR RANANAVARE

Associate Research Professor

Ph.D., Physical Chemistry

University of Missouri, St. Louis, 1983

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RESEARCH INTERESTS

Nanotechnology: Nanoparticles and Photoresists, Dynamics of complex systems, Ferroelectric, Antiferroelectric and Amphitropic Liquid Crystals, Flat Panel Displays, Phase Transitions and Critical Phenomena.

REPRESENTATIVE PUBLICATIONS

Ciro Di Meglio, S. B. Rananavare, S. Sorenson, D. H. Thompson, " Bolaamphiphilic Phosphocholines: Structure and Phase Behavior in Aqueous Media," Langmuir, 16, 128 (2000).

V. G. K. M. Pisipati and S. B. Rananavare, "Interdigitated Smectic A and B Mesophases in Higher Homologues of 50.m Series," Liquid Crystals, 13,757-764 (1993).

V.G.K.M. Pisipati & S.B. Rananavare, "X-Ray Diffraction Studies of 10O.14 and 10O.8," Mol. Cryst. Liq. Cryst.,238,, 207-214 (1994).

J.H. Freed, A. Naveem & S.B. Rananavare, "ESR and Liquid Crystals: Statistical Mechanics and Generalized Smoluchowski Equations," Chapter 4, 71-84, "ESR and Molecular Motions in Liquid Crystals," "Thermodynamics of Liquid Crystals and the Relation to Molecular Dynamics: ESR Studies," "ESR Studies of Molecular Dynamics at Phase Transitions in Liquid Crystals," "ESR and Slow Motions in Liquid Crystals," Chapters 12-15, 271-402, The Molecular Dynamics of Liquid Crystals, (G. R. Luckhurst and C. A. Veracini eds.), NATO ASI Series, Kluwer Academic Publishers, Netherlands (1994).

S.B. Rananavare, V.G.K.M. Pisipati & E.W. Wong, "The ACC Multicritical Point in Ferroelectric Liquid Crystals," Phys. Rev. Lett, 72, 3558 (1994).

S.B. Rananavare, V.G.K.M. Pisipati & E.W. Wong, "A Lifshitz Point in Ferroelectric Liquid Crystals", Liquid Crystal Materials, Devices and Applications III, (R. Shashidhar, ed.), 2175, 108-119, SPIE-94, San Jose, CA, Feb. 8-10 (1994).



MILTON R. SCHOLL

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Ph.D., Materials Science and Engineering

Oregon Graduate Institute of Science and Technology, 1987

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RESEARCH INTERESTS

Micro-mechanical systems and their design and use, particularly the mechanics, the materials, and interaction of contacting surfaces, i.e. tribology of microsystems. Tribological systems ranging from chemical mechanical polishing, to fiber-plate interactions in chip refining and wood cutting, to wheel-rail interactions. Tribological performance of materials including abrasive and erosive wear, sliding behavior, rolling / sliding conditions and the interactions of the phenomena with the working environment, focussing on surface response to external stimuli and mitigation techniques to reduce or eliminate surface damage.

REPRESENTATIVE PUBLICATIONS

M. Scholl, "Abrasive wear of titanium nitride coatings," Wear, Vol. 203-204, 57- 64 (1997).

M. Scholl, "Unique Thermal Spray Coatings by High Energy Plasma Spraying," Proceedings of the International Conference on Advances in Welding Technology: Joining of High Performance Materials, Columbus, Ohio, Nov. 6-8, 1996.

D. Christensen, Y. Jia, M. Scholl, P. Clayton, & S. Abubakr, "Surface Deterioration of Refiner Plates for Thermo-Mechanical Pulping," Proceedings of the 1994 Pulping Conference, Nov. 6-10, 1994, San Diego, California, pub. by TAPPI Press, Atlanta, 1994, pp. 193-203.

M. Scholl, "Plasma Spraying with Wire Feedstock," Proceedings of the 1994 National Thermal Spray Conference, Boston, MA (June 1994).

M. Scholl, C. Steinkamp & W.E. Wood, "Acoustic Emission Monitoring of Plasma Sprayed Tubes," EWI Research Report (1994).

M. Scholl & P. Clayton, "Surface Texture and Abrasive Wear Resistance of Some High Velocity Air Plasma Sprayed Coatings," Proceedings of the 1991 National Thermal Spray Conference, Pittsburgh, PA (May 1991).



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Colorado State University, 1982
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RESEARCH INTERESTS

Multilevel metallization, gate dielectrics, inorganic and organic electroluminescent devices, thin film transistors, bioengineering.

REPRESENTATIVE PUBLICATIONS

H. Zhang, R. Solanki, B. Roberds, G. Bai, and I. Banerjee, " High Permittivity Thin Film Nanolaminates", J. Appl. Phys. 87, 1921 (2000).

A.T. Voutsas, M.A. Marmorstein, and R. Solanki, " The Effect of Laser Annealing Ambient on the Performance of Excimer Laser Annealed Thin Film Transistors", J. Electrochemical Soc. 146 , 3500 (1999).

R. Engelmann, J. Ferguson, and R.Solanki, "Quantum Well Activated Phosphors-A New Concept for Electroluminescent Displays", Appl. Phys. Lett. 70, 411(1997).

A.T. Voutsas, A.M. Marmorstein, and R. Solanki, "Study of Parameters Affecting Material Characteristics Of XeCl Excimer Laser Annealed Polysilicon Thin Films" J. Applied Phys.

W. Kong, S. Ahmed, J. Ferguson, and R. Solanki, "Violet Light Emission from SrS:Eu Thin Film Electroluminescent Devices", Appl. Physics Lett.67, 7(1995).

J. Fogarty, W. Kong, and R. Solanki, "Monte Carlo Simulation of High Field Electron Transport in ZnS," Solid-State Electronics,38, 653 (1995).

W. Kong and R. Solanki, "The Effect of Ultraviolet Radiation on a ZnS:Tb Thin Film Electroluminescent Device," J. of Appl. Phys.75, 3311 (1994).

D. M. Kim, J. W. Lee, T. Dosluoglu, and R. Solanki, "High Speed Lateral Polysilicon Photodiode," Semicond. Sci. Technol. 9,1276 (1994).

T. Dosluoglu and R. Solanki, "Self-Consistent Calculations of Carrier Distribution and Energy Bands in InGaAs/InP PIN Diodes," Solid State Comm., 85, 243 (1993).

T. Dosluoglu, R. Gudimetla, and R. Solanki, "The Generalized Steady State Diode Equation: The State Equations Approach," Solid-State Electronics, 36, 273 (1993).



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1999, California Institute of Technology
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RESEARCH INTERESTS:

Digital Image/Video Processing; Sensor Fusion; Computer Vision; Pattern Recognition; Machine Learning; Information Theory and Coding; Biomedical Engineering.

REPRESENTATIVE PUBLICATIONS

Xubo Song, Yaser Abu-Mostafa, Joseph Sill, Harvey Kasdan, "Image Recognition in Context: Application to Microscopic Urinalysis", in Advances in Neural Information Processing Systems, S.A. Solla, T.K. Leen and K.-R.Muller, Editors, MIT Press, 2000, Pages 963-969.

Xubo Song, Yaser Abu-Mostafa, Joseph Sill, Harvey Kasdan, "Incorporating Contextual Information into White Blood Cell Recognition", in Advances in Neural Information Processing Systems 10, Jordan, Kearns and Solla (eds), MIT Press, 1998. pp. 950-956.

Yaser Abu-Mostafa, Xubo Song, "Bin Model for Neural Networks", in Proceedings of the International Conference on Neural Information Processing, Amari, Xu, Chan, King and Leung (eds), Springer, 1996, pp. 169-173.

Xubo Song, "Contextual Pattern Recognition with Applications to Biomedical Image Identification", PhD Thesis, California Institute of Technology, 1999.

Yaser Abu-Mostafa, Xubo Song, Alexander Nicholson, Malik Magdon-Ismael, "The Bin Model", submitted to IEEE Transactions on Information Theory, 1999.

Xubo Song, "Pattern Recognition in Context", to be submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence, 2000.

Xubo Song, "Contextual Biomedical Image Recognition", to be submitted to IEEE Transactions on Biomedical Engineering, 2000.

Malik Magdon-Ismael, Xubo Song, "Effective Choice of Weight Decay Parameters", to be submitted to Neural Computation, 2000.



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Carnegie Mellon University, 1989
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RESEARCH INTERESTS

Pattern recognition, automatic recognition of speech and speakers, real-time and embedded systems.

REPRESENTATIVE PUBLICATIONS

R.A. Cole, D.G. Novick, P.J.E. Vermeulen, S. Sutton, J.H. de Villiers & L.F.A. Wessels, "Experiments With a Spoken Dialogue System for Taking the U.S. Census," International Journal on Human Computer Interaction, Special Issue (January 1997).

P.J.E. Vermeulen, E. Barnard, Y. Yan, M. Fanty & R. A. Cole, "A Comparison of HMM and Neural Network Approaches to Real-World Telephone Speech Applications," IEEE International Conference on Neural Networks and Signal Processing, Nanjing, P.R. China, Dec. 10-13, 1, 796-499, (1995).

E. Barnard, R. Cole, M. Fanty, and P.J.E. Vermeulen, "Real-World Speech Recognition with Neural Networks," invited paper in Applications of Neural Networks to Telecommunications, R.J. Alspector & T.X. Brown (eds.), 2 (Hillsdale, New Jersey), 186-193, IWANNT95, Lawrence Erlbaum Assoc. (1995).

P.J.E. Vermeulen, E.C. Botha & E. Barnard, "Down-Range Radar Target Recognition with Neural Nets," Transactions SAIEEE, 84(2), 174-180 (June 1993).

P.J.E. Vermeulen & E. Barnard, "The Least-Squares Discriminant Function," Optics Comm., 89, 73-79m (April 1992).

P.J.E. Vermeulen & D. Casasent, "Karhunen-Loeve Techniques for Optimal Processing of Time-Sequential Imagery," Optical Engineering, 30(4), 415-423 (April 1991) (invited paper).

E. Barnard, P.J.E. Vermeulen & D. Casasent, "Optical Correlation CGH with Modulated Error Diffusion," Applied Optics, 28(23), 5358-5362 (December 1989).



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Ph.D., Electrical Engineering
Stanford University, 1994
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RESEARCH INTERESTS

Learning algorithms and architectures for neural networks and adaptive signal processing; applications to time-series prediction, speech enhancement, adaptive control, and telecommunications.

REPRESENTATIVE PUBLICATIONS

E. Wan & A. Nelson, "Networks for Speech Enhancement," in Handbook of Neural Networks for Speech Processing, Edited by Shigeru Katagiri, Artech House, Boston, USA, 1999.

E. Wan & F. Beaufays, "Diagrammatic Methods for Deriving and Relating Temporal Neural Networks Algorithms, In Adaptive Processing of Sequences and Data Structures," Lecture Notes in Artificial Intelligence, M. Gori & C.L. Giles (eds.), Springer Verlag, (1998).

E. Wan and A. Nelson, "Neural Dual Extended Kalman Filtering: Applications in Speech Enhancement and Monaural Blind Signal Separation," IEEE Workshop on Neural Networks and Signal Processing (1997).

E. Wan, "Adjoint LMS: An Alternative to Filtered-X LMS and Multiple Error LMS," ICASSP96, 3, 1842-1845 (1996).

F. Beaufays & E. Wan, "Relating Real-Time-Backpropagation and Backpropagation-Through-Time: An Application of Flow Graph Interreciprocity," *Neural Computation*, 6(2) (1994).

E. Wan, "Time Series Prediction Using a Neural Network with Embedded Tapped Delay-Lines," in *Predicting the Future and Understanding the Past*, A. Weigend and N. Gershenfeld (eds.), SFI Studies in the Science of Complexity, Proc., 17, Addison-Wesley (1993).

E. Wan, "Discrete Time Neural Networks," *Journal of Applied Intelligence*, 3(1), 91-105 (1993).

E. Wan, "Neural Network Classification: A Bayesian Interpretation," *IEEE Transactions on Neural Networks*, 1(4), 303-305, December 1990.



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RESEARCH INTERESTS

Signal processing, machine learning, neural networks. Applications of statistical methods in independent component analysis (ICA), blind deconvolution, nonlinear signal processing, time series analysis, and problems in speech signal processing, data mining and e-commerce.

Research over the last five years has focused on blind signal processing, including blind separation, blind identification and blind equalization. Each of these areas focuses on different aspects of the same problem: blind deconvolution. Problems of blind signal processing arise in many areas such as speech recognition, signal enhancement, digital communication, sensor signal processing, image processing, brain science and medical science. The algorithms for blind signal processing have been developed based on statistical inference and information theory. These algorithms are very useful for data visualization and data mining.

REPRESENTATIVE PUBLICATIONS

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course offerings

ECE500 Introduction to Electronics and Instrumentation

Review of fundamental electronics components and design: passive components, transistor circuits, op amps, RC circuits, frequency domain, and time domain response. Feedback theory, op amp limitations, precision op amp circuits. Noise, interference, grounding, and shielding. Phase-locked loops, lock-in amplifiers. Practical advice on component selection and circuit design. Equipment and circuit demonstrations in class. Homework includes PSpice circuit simulation problems. 4 credits

ECE507 Introduction to Electromagnetic Fields and Waves

ECE507-509 provide a practically-oriented theoretical basis for modern electromagnetic applications in electrical and computer engineering, such as semiconductor devices, signal propagation and integrity in IC design, electromagnetic properties of materials, electron and ion beam lithography and probes, shielding and packaging, communications electronics, optoelectronics, engineering optics, vacuum electronic devices, and electronic displays. Principles of basic numerical methods are discussed throughout.

ECE507 covers basic experimental laws, Laplace and Poisson equations for static electric and magnetic fields, Maxwell equations for static and time-varying fields, electromagnetic wave equations, and Poynting theorem. Waves in conductors and skin effect. Retarded potentials for time-varying fields. Finite-difference numerical solution of boundary-value problems. Prerequisite: Some undergraduate electromagnetism, calculus through ordinary and partial differential equations, some vector calculus, or consent of instructor. 4 credits

ECE508 Electromagnetic Fields and Waves II

Electromagnetics of lumped-element circuit theory. Plane wave propagation and reflection, polarization states, and Stokes parameters. Analytical methods for boundary-value problems and numerical solution by boundary-element method. Field theory of transmission lines and waveguides, and its relation to circuit model. Prerequisite: ECE507 and some linear algebra or consent of instructor. 4 credits

ECE509 Electromagnetic Fields and Waves III

Field theory of multiple-conductor transmission lines: Modes, coupling, and cross-talk. Dielectric waveguides. Resonant cavities. Radiation from antennas and apertures. Electromagnetic properties of materials. Variational formulation of field problems and finite-element numerical solution. Analytical and numerical calculation of charged-particle motion in electromagnetic fields. Prerequisite: ECE508 and some linear algebra or consent of instructor. 4 credits

ECE510 Introduction to Quantum Mechanics for Electrical and Computer Engineers

Courses ECE 510-511 present basic quantum theory for understanding solid state devices, lasers and other optoelectronic devices, properties of electronic materials, band-gap engineering, quantum effects due to shrinking IC feature sizes, quantum-dot and quantum-well devices, and

quantum computing. ECE 510 introduces the Schroedinger equation, postulates of Quantum Mechanics, and basic Hilbert-Dirac formalism. The free particle. One-dimensional quantum-well bound states and tunneling through barriers. Bloch functions in periodic potentials and the origin of solid-state band structure. Prerequisite: calculus through ordinary and partial differential equations or consent of instructor. 4 credits

ECE511 Advanced Quantum Mechanics for Electrical and Computer Engineers

Two and three-dimensional quantum wells. Angular momentum and spin. Matrix formulation of Quantum Mechanics. Atomic structure. Approximation methods, including perturbation theory. Interaction of matter and electromagnetic waves. Prerequisite: ECE 510 plus some linear algebra, or consent of instructor. 4 credits

ECE512 Operation of Semiconductor Devices I: Basics and Bipolar

Review of semiconductor basics. Ohmic contacts, Schottky diodes and pn junctions: depletion approximation, capacitance/voltage behavior and current/voltage characteristics, ideal and nonideal behavior, Shockley-Hall-Read recombination. Basic operation of MESFET and JFET. Fundamentals of bipolar transistors: ideal Shockley model, current gain, low- and high-level injection effects, transit time concepts. Ebers-Moll and Gummel-Poon models. Device parameter extraction for SPICE models. 4 credits

ECE513 Operation of Semiconductor Devices II: MOS

Fundamentals of MOS devices. Contact potentials and semiconductor surfaces, analysis of the MOS capacitor, the role of oxide charge. MOSFET modeling, one-dimensional approaches based on depletion and charge sheet approximations, threshold voltage and body effect, sub-threshold behavior based on concepts of weak, moderate, and strong inversion. Ion implanted channels. Short and narrow channel effects, such as channel length modulation, velocity saturation, effective threshold variations, breakdown and punch-through. Device parameter extraction for SPICE models, device scaling. 4 credits

ECE514 MOSFET Modeling for VLSI Circuit Design

A comprehensive study of compact models used in circuit simulators for VLSI design. Topics covered include modeling of small geometry effects, high speed and frequency (non-quasistatic) models, quantum effects, substrate and gate current models for reliability simulation and device scaling issues. In-depth study of parameter extraction, optimization and device characterization techniques required for developing compact models. Development of statistical, mismatch and noise models for analog circuit design. Review of state of the art models used in industry. Implementation algorithms for MOSFET models in circuit simulators. 4 credits

ECE515 Introduction to Device Physics

The fundamental properties and concepts needed to understand and predict semiconductor device performance are introduced in this course. Starting with electrons in the hydrogen atom, we expand this model to demonstrate electron interactions in solids, such as semiconductor crystals. The physics behind the energy bandgap in semiconductors are examined, and used to ultimately derive the energy band structure, effective mass, and equilibrium carrier statistics. Next, we use these statistics to define carrier transport in semiconducting materials. The second half of the course uses these preliminary concepts to understand the simple pn-junction diode and finishes with the metal-oxide-semiconductor structure.

This course is recommended if you have never taken a semiconductor device course (or if you need a refresher). The materials covered will provide you with background for other semiconductor device, processing, and characterization courses offered at OGI. Although not required, you will

achieve a more advanced understanding of the concepts discussed in this class if you have taken quantum mechanics. 4 credits

ECE516 Fundamentals of Semiconductor Device Design and Processing I

Semiconductor bulk, junction and surface properties. Lectures and hands-on laboratory experiments are used to teach the fundamentals of semiconductor synthesis; bulk defects; mechanisms affecting electron/hole transport at low and high electric fields; junction formation/stability (p-n, metal-semiconductor, and metal-insulator); and relationships between semiconductor properties and device performance. Lecture and lab; lab fee required. 4 credits

ECE517 Semiconductor Device Design and Processing II

Concepts of minority carrier and majority carrier devices, and electron/hole transport across metal-semiconductor junctions (ohmic and rectifying) are presented in lectures and illustrated by hands-on processing and characterization by the student. The course objective is to provide the student with the concepts required to understand the current-voltage characteristics of p-n junction devices (diodes, bipolar transistors, and thyristors), and metal-semiconductor devices (Schottky diodes and MESFETs). Lecture and lab; lab fee required. 4 credits

ECE520 Introduction to Transmission-Line Theory

The following topics will be covered in this course: Maxwell's equations; quasi-static analysis of transmission lines; telegrapher's equations; equivalent circuit models for lossy and lossless transmission lines (circuit theory); microstrip; stripline; loaded transmission-line impedance; skin effect; dispersion; transient response of transmission lines; studies of transmission-line effects on digital signal integrity; transmission-line discontinuities (vias, bends); introduction to crosstalk; and other related topics. CAD tools may be used. 4 credits

ECE521 Introduction to Microwave Engineering

The following topics will be covered in this course: traveling waves and transmission-line concepts; time harmonic transmission-line equations; construction and applications of Smith chart; impedance transformers; impedance matching networks; matrix representation of multiport networks; parameters conversions; microwave transmission lines; characteristics of microwave transistors; and other related topics. CAD tools may be used. 4 credits

ECE525 Analytical Techniques in Statistical Signal Processing and Communications

Development of the mathematical techniques needed to analyze systems involving random variables and/or stochastic processes with particular application to communications and instrumentation. Topics include Bayes Theorem (discrete and continuous forms), Tchebycheff inequality, Chernoff Bound, Central Limit Theorem, stationary processes and linear systems, mean square estimation, Poisson process, Gaussian process, Markoff process, and series representations. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE526 Analog and Binary Digital Communications Systems

Mathematical descriptions of signals and noise, bandwidth requirements, sampling theorem, intersymbol interference, digital multiplexing, line encoding, pulse code modulation, quantizing, quantization and noise error in PCM, bandpass random processes, quadrature representation, Wiener-Hopf filter, amplitude modulation systems (AM, DSB, SSB, VSB), angle modulated systems (PM, FM) pre-emphasis/de-emphasis. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE527 M-ary Digital Communication Systems, Information Theory, and Coding

Optimum threshold detection, geometrical representation of signals, optimum M-ary Communication (MASK, MPSK, MFSK) systems, Gram-Schmidt orthogonalization procedure, measure of information, source encoding, channel capacity, error-correcting codes (linear block, cyclic, burst-error detecting and correcting, interlaced, convolutional), Viterbi's Algorithm. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE529 Fiber Optics

An introductory course in fiber optics aimed at scientists and engineers from widely varying backgrounds. Topics include light propagation in dielectric media, attenuation in optical fibers, step- and index-graded fibers, photon generation and detection devices used in fiber optics, and integration of fiber optics with the photon devices. 4 credits

ECE532 Biomedical Optics I: Tissue Optics

Light propagation in tissue: This course treats light transport in scattering and absorbing media such as biological tissue. Light transport is modeled using a variety of theories and computational techniques, including Monte Carlo simulations and approximate solutions of the radiative transport equation. Steady-state and time-dependent problems are treated. Spectroscopy and fluorescence measurements are introduced. Optical imaging techniques are presented. Students learn the basics required for design of optical devices for therapy and diagnostics. 4 credits

ECE533 Biomedical Optics II: Laser-Tissue Interactions

Physics of laser-tissue interactions: The course treats the immediate physical processes that accompany the absorption of light by biological tissues, including photochemical reactions, heating and tissue coagulation, vaporization, creation of plasmas, and production of stress waves in tissue. Such processes are modeled using finite-difference techniques. Applications in medicine and biology are discussed. Prerequisites: ECE 532 or permission of instructor. 4 credits

ECE534 Biomedical Optics III: Engineering Design

The students work as a team in preparing five business plans throughout the quarter. Each business plan is devoted to a potential medical device or protocol using optical technologies. The team is divided into a CEO, scientific officer, marketing manager, regulatory affairs manager, and manufacturing manager. The roles are rotated amongst the students for each business plan. Feasibility studies are conducted in a laboratory exercise designed by the students. The team formally presents a business plan every two weeks. Prerequisites: ECE 532 and ECE 533, or permission of instructor. 4 credits

ECE535 Thin Film Deposition and Applications in Semiconductor Fabrication

Covers thin film deposition topics, such as thermal evaporation, plasma deposition, chemical vapor deposition (CVD and MOCVD), molecular beam epitaxy (MBE), atomic layer epitaxy (ALE), electrochemical deposition, and electroless deposition. Thin film deposition forms the basis for manufacture of modern integrated circuits; a knowledge of methods available for thin film deposition is essential for IC process engineers. Course is designed to cover the theory and applications of main deposition techniques in use or being considered for future IC fabrication processes. 4 credits

ECE536 Surface Science for Semiconductor Technology

The study of gas-solid surface science with emphasis on understanding semiconductor systems

and the mechanisms of epitaxial growth of semiconductor films by molecular beam epitaxy (MBE), metal-organic molecular beam epitaxy (MOMBE), atomic layer epitaxy (ALE), etc. The study of thermal desorption, surface diffusion. Surface electronic properties such as work function. Physical absorption, the growth of multilayer films and the application of this phenomena to the study of the BET equation as a tool for the determination of surface area. 4 credits

ECE537 Characterization of Thin Films for Semiconductor Technology

An introduction to the techniques of surface analysis, such as Auger analysis, X-ray photoelectron spectroscopy, energy dispersive X-ray analysis, X-ray wavelength dispersive spectroscopy, secondary ion mass spectroscopy, Rutherford Back scattering Spectroscopy, together with their interpretations. Particular emphasis on semiconductor technology applications. 4 credits

ECE540 Auditory and Visual Processing by Human and Machine

Interaction between humans and machines could be greatly enhanced by machines that could communicate using human sensory signals such as speech and gestures. Knowledge of human information processing including audition, vision, and their combination is, therefore, critical in the design of effective human-machine interfaces. The course introduces selected phenomena in auditory and visual perception, and motor control. Students learn how to interpret empirical data, how to incorporate these data in models, and how to apply these models to engineering problems. The anthropomorphic (human-like) signal processing approach is illustrated on engineering models of perceptual phenomena. 4 credits

ECE541 Speech Processing

Speech is one of the most important means of communication. This course teaches theory of human speech production, properties of speech signal and techniques for its processing in speech coding, and automatic speech and speaker recognition. Emphasis is on active research in auditory modeling that exploits special properties of speech to improve performance of speech technology in practical applications. Prerequisites: ECE 540, ECE 551, or consent of instructor. 4 credits

ECE542 Introduction to Image Processing

Course covers basic image processing principles and techniques with a brief introduction to machine vision. Students acquire theoretical and working knowledge of image processing approaches including image representation, transform methods, image filtering, multi-resolution representation, edge detection, texture characterization, and motion analysis. Course demonstrates application of these methods to image enhancement, image restoration, and image compression, with emphasis on image quality metrics based on human visual perception. Selected areas in machine vision include image segmentation, elementary techniques in pattern recognition, and object representation. Application of these techniques is illustrated in numerous examples. Prerequisite: ECE 551. 4 credits

ECE543 Introduction to Digital Video Processing

Course provides introduction to digital video processing for multimedia systems. The course first introduces video capture, image formation, analog and digital video signal and standards, and spatio-temporal sampling. Subsequent topics include motion estimation, segmentation and tracking, video filtering, and video standards conversion. Students are familiarized with video compression techniques and standards (JPEG, MPEG2, H.261, H.263), and model-based video quality estimation. Students gain working knowledge of these video techniques through class projects. Familiarity with digital signal processing and transform methods is desirable. 4 credits

ECE544 Introduction to Signals, Systems and Information Processing

This course provides the essential mathematical tools and analytical techniques needed for the analysis of continuous-time and discrete-time systems. Basic signal and system characteristics -- linearity, time-invariance, convolution and correlation -- are first examined from the time domain perspective. We then proceed to study a family of Transforms - Fourier Series, Fourier Integral Transform, Laplace Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) and z-Transform -- which take the study of these systems to a deeper level and introduce a host of useful properties which the time perspective alone does not reveal. Basic applications taken from the areas of information processing, communication and control will serve to fill out the mathematically derived results.

A greater portion of the syllabus in ECE 544 is allotted to continuous time signals/systems than to discrete time signals/systems, for reason that the latter are taken up in detail in other information processing courses, particularly ECE 551. A goal of the presentation in ECE 544 is to impart the essential unity of all the Transforms and the almost perfect correspondence of approach in continuous-time and discrete-time contexts. You then become a well equipped practitioner who knows the way around the entire territory.

This course is a useful prerequisite or corequisite to ECE 551 and all other courses in the information processing area. 4 credits

ECE545 Speech Systems

Speech is one of the most natural means for communication and carries information from many sources. The explosive growth of communications and computer technologies puts new demands on techniques for machine extraction of information content of speech signals, for its storage or transmission, and for reconstruction of the speech signal from its parametric representation. Course covers techniques for processing of speech signal used for speech coding and synthesis, enhancement of degraded speech, speech recognition, speaker recognition, and language identification. 4 credits

ECE547 Signals for Multimedia Engineering

The course discusses concept of signal as a carrier of information, basic principles of signal analysis in engineering, and fundamentals of human auditory and visual perception. It is intended for those who have a good undergraduate-level of basic knowledge in mathematics and physics but who need an introduction to or refreshing of fundamental concepts of signals, systems, and human information processing, necessary for further mastering specialized multi-media topics in speech and image processing, classification, and transmission. 4 credits

ECE548 Modern Applied Statistics

This course provides an introduction to modern applied statistics. The topics include distributions and data summaries, density estimation, generalized linear models, nonlinear regression (projection-pursuit and neural networks), robust statistics, factor analysis, linear and nonlinear classifiers, Bayesian classifiers, cluster analysis, decision trees, ensemble learning methods such as boosting, bagging and arching, validation techniques, Bootstrap and Monte Carlo methods and point process analysis. The goal of the course is to provide a solid understanding of practical statistical inference methods and proficiency in using modern statistical tools. The primary analysis tool for this course is S-PLUS. 3 credits. Recommended prerequisite is CSE 544 or equivalent

ECE550 Linear Systems

This course introduces the State Variable representation of linear dynamical systems and studies a large body of State Space techniques to reveal both inner structure and external behavior of the systems modeled in this way. A general framework for treating time-varying linear systems is developed and utilized. Major emphasis is placed, however, on the time-invariant systems, whose

structure and dynamics are investigable and knowable to the very utmost detail. Both continuous-time and discrete-time linear systems are explicitly studied. The course provides a strong body of foundational material, which is utilized either explicitly or implicitly in virtually all applications-specific areas pertaining to system analysis/design and signal/information processing.

The major topics covered are : canonical realizations, equivalent systems, canonical transformations, canonical decompositions, solution of state equations, stability, controllability and observability , design of asymptotic observers, state-feedback compensation schemes. Linear Quadratic Regulator and Kalman Filter are also introduced. The Linear Algebra material required for this study -- matrices as linear operators , solutions of sets of linear equations, eigenvalues and eigenvectors, eigenstructure factorizations and spectral decompositions -- will be presented and developed concurrently, as needed. The relevant Differential Equations material will also be concurrently reviewed. 4 credits

ECE551 Introduction to Digital Signal Processing

Representation and analysis of discrete time signals and systems. Z-Transform, Discrete-Time Fourier Transform, and Discrete Fourier Transforms. Applications of the Fast Fourier Transform to high-speed computation of convolution and correlation products. Signal flow graph realizations of finite word-length implemented discrete time linear systems. Sampling and windowing techniques pertaining to the discrete time processing of continuous time signals. Analysis and design of recursive and nonrecursive digital filters. 4 credits

ECE552 Digital Signal Processing II

This follow-up course to ECE 551 examines several widely used advanced signal processing. Topics include computational complexity considerations in DSP algorithm development; multirate signal processing; filterbanks and wavelets, and their application in audio and image processing (e.g. MPEG standards). Topic coverage is weighted toward the interests of the students enrolled. 4 credits

ECE553 Control Systems: Classical, Neural, and Fuzzy

Applications of modern control systems range from advanced fighter aircraft to processes control in integrated circuit manufacturing, to fuzzy washing machines. The aim of this class is to integrate different trends in control theory. Background and perspective are provided through the study of basic classical techniques in feedback control (root locus, bode, etc.), as well as state-space approaches (linear quadratic regulators, Kalman estimators, and introduction to optimal control). The course covers recent movements at the forefront of control technology. Neural network control is presented with emphasis on nonlinear dynamics, back-propagation-through-time, model reference control, and reinforcement learning. The course also covers fuzzy logic and fuzzy systems as a simple heuristic-based, yet often effective, alter-native for many control problems. Prerequisite: ECE 551, ECE 554, or equivalent. 4 credits

ECE554 Adaptive Signal Processing

Theory and application of adaptive linear systems. Topics include Wiener filters, least squares, steepest descent, LMS, RLS, Newton's method, FIR and IIR adaptive structures, adaptive lattice filters, and systolic arrays. Applications in noise canceling, signal enhancement, adaptive control, system identification, and adaptive equalization. Prerequisites: ECE 551, statistics, and programming experience. 4 credits

ECE555 Engineering Optimization

Issues of Optimization appear in virtually every area of Engineering and Applied Research. Most practitioners tend merely to rely on "canned" routines when optimization needs to be performed.

But successful Optimization entails both a lot of science and a lot of art -- deep mathematical derivations and formal convergence proofs on the one hand, conventional engineering "folklore and experiential "rules of thumb on the other. Through this course you will be able to choose intelligently among the very wide range of available optimization strategies, customize given algorithms; to your own specific applications, and even write your own routines entirely from scratch when this approach is needed or preferred.

After reviewing some necessary mathematical fundamentals from Linear Algebra and Multivariable Calculus, including Lagrange Multipliers and Kuhn-Tucker conditions, the following topics will be covered. Unconstrained and Constrained nonlinear Multivariable Optimization, via direct-search and gradient-based; methods, including: Pattern Search, Simplex Search, Conjugate Gradient, Variable Metric, Feasible Directions, Cutting Plane, Gradient Projection and Penalty Function methods. Algorithms for specially structured problems, such as: Linear Programming, Quadratic Programming, Integer Programming, Geometric Programming. Methods which utilize random heuristics, including: Genetic Algorithm, Dynamic Evolution and Simulated Annealing. Time permitting, an introduction to Dynamic Programming and the Optimal Control problem will also be included. 4 credits

ECE556 Principles of Electronic Packaging

This course introduces the principles and tradeoffs involved in the design of electronic packaging for integrated circuits. Topics include packaging architecture, electrical design concepts in electronic packaging design, thermal management, mechanic design, electrical contacts, reliability and testing, material selection and fabrication, plated through-hole technology, etching by wet processes, joining materials, stress issues, diffusion problems, chemical and physical methods of analysis, and trends in electronic packaging. 4 credits

ECE557 Computer-Aided Analysis of Circuits

Course covers the algorithms and techniques for formulation and solution of circuit equations for large-scale VLSI circuits. Topics include Equation formulation, linear AC and DC networks, linear transient networks, and stability analysis. Solution of nonlinear DC and transient problems. Frequency domain (AWE) techniques for VLSI interconnections, Sensitivity analysis, harmonic balance, circuit optimization, and statistical design. The implementation of device models in circuit simulators and convergence issues is covered. Assignments stress computer-aided implementation techniques and use of simulators such as PSPICE. 4 credits

ECE558 High Speed Interconnect Design

Electrical analysis, design, and validation of interconnect for digital buses operating at speeds of up to >1 GHz. Key topics include: transmission line analysis and tools, digital signals and timing analysis, measurement equipment and techniques, lossy and coupled transmission lines, advanced signaling techniques, design tools and methodology. A design project is used to give students practical insight into high speed bus design problems. 4 credits

ECE559 Introduction to Application Specific IC (ASIC) Design

ASIC design tools and techniques are presented with an emphasis on achieving correct functionality. A design is created in a high-level Register Transfer Level (RTL) language and simulated. Synthesis then is performed to create a real ASIC design. In addition, common ASIC problems of unacceptable path delays and poor routing and placement are discussed while presenting the student with a comprehensive understanding of the operation of synthesis tools. Students take a design from concept to RTL verification and synthesis. A commercial set of software tools is used, and the student should learn real-world ASIC design in this class. This course complements the CMOS Digital VLSI Design sequence (ECE 574, ECE 575), though neither is prerequisite to the other, since the fundamental design environment is quite different. Prerequisite: ECE 573. 4 credits

ECE560 Microelectronic Device Fabrication I

This course is the first in a full year, three term sequence that treats both the science and practice of modern microelectronic fabrication. The principles of crystal growth and wafer preparation, ion implantation, doping and diffusion, and oxidation are all covered. Emphasis is placed on understanding the basic chemistry, physics, and material science of wafer processing. This includes crystal structure and defects, heterogeneous chemical reactions, the thermodynamics and kinetics of diffusion, etc. In addition, the practical implementation of these processes is also discussed. This includes realistic process flows, physical metrology, device structure and electrical behavior, trade-offs, etc. The course is intended to serve a wide community including both working process engineers and matriculating graduate students. 4 credits

ECE561 Microelectronic Device Fabrication II

In the second class of this series emphasis is on metallization and dielectrics. Metallization issues examined include silicides, barrier layers, interconnects (e.g., Cu), multilevel metallization, and low k dielectrics. This followed by discussion of deposition and properties of different dielectric films. Finally, processing issues of epitaxial growth and properties of SOI devices are covered.

Class assignments include computer simulation of device fabrication. 4 credits

ECE562 Microelectronic Device Fabrication III

This class starts with electron beam, x-ray, and photolithography, including discussion of resist technology (e.g., chemically amplified resists). This followed by fundamentals and applications of plasmas for etching and deposition (e.g., high density plasmas), including plasma damage. Other topics considered are process integration that includes several devices such as BiCMOS and memories. Finally yield and reliability statistics as related to microelectronic device fabrication is discussed.

Class assignments include computer simulation of device fabrication and testing. 4 credits

ECE563 Plasma Processing of Semiconductors I

Fundamental plasma properties. Plasma production, properties, and characterization. DC and RF plasmas. Sputtering. Sputtering as a deposition process for the growth of thin films. Multicomponent films. Plasma etching. 4 credits

ECE564 Plasma Processing of Semiconductors II

This course, a continuation of ECE 563, covers specific applications of plasmas for processing semiconductor materials. Topics include etching and deposition and the dependence of these processes on plasma parameters. Materials based on both silicon and III-V technology are examined. 4 credits

ECE565 Analytical Scanning Electron Microscopy

This course introduces the operation and theory of SEM and covers sources, lenses, accelerating voltage, detectors, image formation, beam-specimen interactions, beam-produced signals, the combined effects of signal-to-noise ratio and spot size in determining resolution, and stereo imaging SEM. The process of specimen preparation, metallo-graphic grinding and focused ion beam-produced transverse cross sections, planar sections, coating techniques for nonconductors, sampling of powders, and isolation of contaminants are some of the topics covered. Students are encouraged to work on materials they provide. The course covers the operation of energy dispersive X-ray detectors, qualitative analysis, quantitative analysis, elemental mapping, spectrum

artifacts, and contaminant and compound identification.

The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade. 3 credits

ECE566 Focused Ion Beam Technology

This course covers operation and theory of a FIB workstation, including ion sources, accelerating voltage, electrostatic lenses, beam material interactions, resolution, beam intensity distribution, beam produced signals, detectors, metal and oxide deposition, and enhanced etch. FIB-produced, site- specific SEM transverse cross sections, the location and sectioning of micron and sub-micron scale structures on the surface and buried in multilayered stacks or bulk materials, cross sections in metals, semiconductors, ceramics, and composites are covered. The location and sectioning of micron and submicron surface and buried structures to create electron transparent foils with little or no damage in metals, semiconductors, ceramics, and composites, and artifacts of specimen preparation are presented. This course uses a combination of lectures and hands-on practice to cover these topics.

The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade. 4 credits

ECE567 Transmission Electron Microscopy

Electron microscopy is a continually evolving discipline which has developed a wide range of techniques to solve specific problems. This course is designed to help the student develop a broad appreciation and knowledge of the important techniques for analysis of crystalline materials. Modern transmission electron microscopes can give the investigator detailed information of crystal structure, crystal defects and quantitative local chemistries on a nanometer scale. This information is often critical to the understanding of material properties. Principles, methods and application of transmission electron microscopy to crystalline materials. The construction and design of electron microscopes, electron diffraction, reciprocal lattice and Ewald Sphere construction will be covered. Kinematic and dynamic theories of image formation will be introduced. Combining lectures with hands-on laboratory practice, students will be instructed in the use of sample preparation equipment and an analytical transmission electron microscope. Students will be expected to carry out basic experiments on selected materials which illustrate fundamental concepts covered in the lecture.

The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade. 3 credits

ECE568 Failure and Reliability in Microelectronics

The failure and reliability of microelectronics depends on the stability of thin films and the purity of the bulk semiconductors. Contamination, film thickness, diffusion and phase changes all drive mechanisms of failure. Characterization of a failed device depends on analysis of thin film structure, crystalline structures, contaminant identification and microchemistry. This requires a variety of microanalytical techniques involving the SEM, TEM, and FIB. This course covers the potential defects, failure mechanisms and the methodology used to analyze them. Case studies also are discussed.

The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade. 3 credits

ECE569 Electronic Materials and Device Characterization

The objective of this class is to examine contemporary electrical and optical techniques used for characterizing semiconductor materials and simple electronic devices such as MOSFETs. Semiconductor parameters examined include carrier and doping concentration, as well as carrier mobility and lifetime. Measurement and analysis of device parameters such as channel length and threshold voltage are covered. 4 credits

ECE570 Gallium Arsenide MESFET Integrated Circuit Design

Technology overview, device structures, SPICE models, limitations, regions of MESFET operation. Transconductance, output resistance, biasing. Single-stage, high-gain, and feedback amplifiers, current sources, compensation. Buffered FET logic, enhancement/depletion technology, zero-diode data conversion, comparators, digital-to-analog converters. 4 credits

ECE571 Analog Integrated Circuit Design

Design techniques for analog integrated circuits. Silicon bipolar and JFET analog integrated circuit design. Technology overview, device structures, Ebers-Moll equations, hybrid-pi model. Single-stage amplifiers, current sources, active loads, output stages. Operational amplifiers, frequency response, feedback, stability. Design project. 4 credits

ECE572 Digital Integrated Circuit Design

Design techniques for digital integrated circuits. Silicon bipolar and MOS digital integrated circuit design. Technology overview, device structures, modeling. Standard logic families. NMOS and CMOS logic design. Regenerative circuits and memory. Design project. 4 credits

ECE573 Introduction to Computer Logic Design

This course constitutes a basic introduction to the design and implementation of computer logic. Basic principles of discrete logic will be presented, including boolean algebra, finite-state machine theory, minimization, and optimization. Students will apply logic design theory to actual PLD (Programmable Logic Devices) and FPGA (Field Programmable Gate Array) devices. In addition, students will learn the basics of the hardware design languages, Verilog and VHDL. This course or its equivalent is a prerequisite to all other ECE Electronics Design Automation courses. 4 credits

ECE574 CMOS Digital VLSI Design I

An introduction to CMOS digital IC design. Course covers basic MOS transistor theory; operation of basic CMOS inverter; noise margins; switch level modeling of MOS devices; capacitive characteristics of MOS devices; introduction to device fabrication, design rules and layout issues; power consumption; gate design/transistor sizing; pass transistors and complimentary pass transistor logic; dynamic domino and precharge/discharge circuits; memory element design (RAM/ROM/flip-flops) and subsystem design (adders, multipliers, etc.). An understanding of basic digital design concepts is assumed. Lab exercises use industry standard design tools. Laboratories include circuit validation and characterization. Prerequisite: ECE 573. 4 credits

ECE575 CMOS Digital VLSI Design II

Concentration on advanced VLSI design techniques. Architecture and micro-architecture of VLSI components, clocking schemes, input/output circuits, and special functional blocks such as random access memories, read only memories and programmable logic arrays. The course covers design tradeoffs, especially considering cost, power and performance. The course devotes a considerable amount of time to layout, parasitics and performance verification. Introduction to design and verification tools with hands-on experience. Prerequisites: ECE 574, familiarity with MOS transistor operation; programming skill in a high-level language such as C is a plus. 4 credits

ECE577 Principles for Technology Development and Introduction to Manufacturing

A project-oriented course on management procedures and key underlying concepts for effective manufacturing technology planning and development; an introduction to commercial production in a competitive environment. While emphasis is on semiconductor technology, most principles and methodology are generally applicable to both hardware and software technology management. Issues of technology strategic planning, process definition and characterization, decision making, technology transfer, product definition, yield and reliability improvement, and concurrent engineering are explored to identify effective management approaches to shorten time-to-volume production, reduce risk, and minimize engineering effort. 4 credits

ECE578 Embedded and Real Time Operating Systems

A study of concepts, techniques, and standards in embedded operating systems including real time embedded operating systems. Topics include kernel design, device driver and interface techniques, scheduling, robustness and industry standards such as Windows-CE and Tornado (VxWorks). This is a hands-on lab course where students will experience real-world real time embedded systems using commercial software tools. Prerequisites: CSE 521 Introduction to Computer Architecture or a demonstrable understanding of computer architecture. 4 credits

ECE579 Embedded Computer Systems

A study of concepts, techniques, and standards in embedded systems from design through deployment to retirement. Topics include programmable logic, interfacing, power supply, packaging, robustness, certification, and maintenance. This is a hands-on lab course based on a student project, where students will experience real-world embedded systems using commercial software and hardware tools. Prerequisites: CSE581 Introduction to Computer Architecture, ECE 578 Embedded and Real Time Operating Systems, or permission from instructor. 4 credits

ECE580 Special Topics

Under this number, we offer courses of particular relevance to the research interests of faculty or in state-of-the-art subjects of interest to the community.

ECE591 Independent Study

Student works with professor on selected topic(s). Requires pre-approval of professor, ECE Department, as well as formal agreement between student and professor outlining objectives and expectations of independent study topic. May only be taken once during a student's graduate program at OGI for a maximum of 3 credits.

ECE600 Research Participation

Supervised research participation. Pre-qualifying Ph.D. research prior to passing ECE department qualifying examination. Variable and repetitive credit.

ECE610 Nonthesis Research

Supervised research for up to eight credits as a component of the nonthesis M.S. degree. Students are required to produce cogent research deliverable(s) including, but not limited to, a final report equivalent to an EE project paper. This research classification requires the approval of the department head and the student's SPC. Variable and repetitive credit

ECE620 Professional Internship

These courses provide the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers.

Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. Variable and repetitive credit

ECE640 Industrial Fellowship

For students selected to participate in the Industrial Fellowship program. Students register for one credit of internship per quarter for 3 quarters and nine credits of internship during summer quarter while interning full-time with the sponsor. Students submit a project paper focused on the internship, as directed and approved by the department head and the students' SPC. Grade credit required.

ECE700 M.S. Thesis

Research toward the thesis for the M.S. degree. Variable and repetitive credit.

ECE800 Ph.D. Dissertation

Research toward the dissertation for the Ph.D. degree. Variable and repetitive credit.

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admissions and degree requirements

Admission Requirements

Applications for admission to full-time and part-time degree programs are invited from persons with bachelor's degrees in the physical or biological sciences, mathematics, or engineering. Previous course work in chemistry, biology, and mathematics (through one year of calculus) is expected.

Requirements for admission to the department of Environmental Science and Engineering are the same as the institutional admission requirements, except for the minimum TOEFL score. The department requires TOEFL scores of all applicants whose native language is not English. The minimum acceptable TOEFL score is 600 for the written test or 250 for the computer-based test. Students who earned undergraduate degrees in the United States are exempt from this requirement.



GRE general aptitude scores are required for all M.S. and Ph.D. programs. A GRE subject examination score may also be submitted, but is not required.

Completed Ph.D. applications should be received by February 15. M.S. applications are considered year-round, although most new M.S. students apply by June for matriculation in the fall.

Prospective applicants for the Ph.D. program should examine the faculty research programs to determine whether their professional goals can be fulfilled at OGI. Communication with individual faculty members prior to applying is encouraged.

► [Click here to apply on-line for admission to OGI.](#)

A Note About Tuition

Tuition for the full-time nonthesis M.S. program is \$18,720 for the 2000-2001 academic year, which can be paid in full at the beginning of Fall quarter or spread equally over the first four quarters. A part-time nonthesis M.S. program is available to meet the needs of working students, and interested students are encouraged to contact the Office of Academic and Student Services for additional information. A \$100 deposit is required with the return of your acceptance to reserve your place in our department. This deposit is non-refundable and will be applied toward your tuition for Fall quarter.

Degree Requirements

DISTRIBUTION REQUIREMENTS

To achieve the necessary breadth in training, students in all programs take courses that cover a range of scientific disciplines and environmental media. Five courses must be taken that satisfy the following distribution requirements. No course can satisfy more than one requirement.

One course must be taken from three of the following four discipline groups.

- | | |
|------------------------|---|
| 1. Applied Mathematics | ESE500 ; ESE504 ; ESE506 ; ESE508 |
| 2. Chemistry | ESE510 ; ESE511 ; ESE514 ; ESE516 |
| 3. Fluid Dynamics | ESE530 ; ESE537 ; ESE539 ; ESE538 |
| 4. Biology | ESE550 ; ESE554 |

One course must be taken from each of the following environmental media groups:

- | | |
|-------------------|---|
| 1. Surface Waters | ESE530 ; ESE537 ; ESE538 ; ESE539 |
| 2. Ground Water | ESE540 ; ESE541 ; ESE542 ; ESE543 |

All full-time students are required to take ESE 599 each quarter (except Summer). This course does not count toward degree credit requirements.

Up to eight credits may be granted for courses taken in other OGI departments. Up to 12 quarter credits may be transferable from other accredited institutions for graduate courses comparable in content and level to courses offered in the department. The Student Program Committee (SPC) decides on the appropriateness of internship and transfer credits.

Transfer credits may not be used to reduce the annual tuition, but may allow for greater flexibility in scheduling.

PH.D. IN ENVIRONMENTAL SCIENCE AND ENGINEERING

Students pursuing the Ph.D. in Environmental Science and Engineering or [Environmental Information Technology](#) must complete five distribution courses as [outlined above](#). Students must also complete additional courses for a total of at least 52 credit hours of course work, selected with the approval of their SPC.

Ph.D. candidates must pass a two-part comprehensive exam. The first part is a written examination covering four subject areas selected by the department. The second part is the preparation and oral defense of a proposal that defines the student's Ph.D. dissertation research. A defense of the Ph.D. dissertation also is required.

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE AND ENGINEERING

The M.S. in Environmental Science and Engineering is offered with a thesis option, nonthesis option, a nonthesis option in the [Ecosystem Management and Restoration \(EMR\)](#) track, and beginning Fall 2002, in the [Environmental Information Technology \(EIT\)](#) track.

THESIS OPTION

Students pursuing the thesis option of the M.S. degree in ESE must complete at least 45 credits.

This includes research, [distribution requirements](#) and additional courses, selected with the approval of the SPC. Master's thesis research is usually no more than nine credits.

NONTHESIS OPTIONS

For the nonthesis M.S. in ESE, five distribution courses must be taken as [outlined above](#). Students must complete additional courses for a total of at least 45 credit hours. No general examinations are required for the nonthesis option. ESE599 does not count toward degree credit requirements.

Up to eight credits may be granted for approved participation in nothesis research or approved work as an intern with a local company or government agency.

Ecosystem Management and Restoration Program

[Ecosystem Management and Restoration Program](#) is a 12-month, nonthesis M.S. track offered within the [Department of Environmental Science and Engineering](#). The objective of the EMR program is to integrate rigorous environmental principles, field and laboratory applications, modeling, project management, and policy/regulation into a cohesive curriculum. The program emphasis is on timely issues, including nonpoint source pollution, water quality, and ecological and human risk assessments. For more information, please see www.ese.ogi.edu/EMR/.

Requirements are the same as for the above nonthesis option described above, except that students must include ESE570 and ESE589 in their elective course work. ESE599 does not count toward degree credit requirements.

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research programs

Contaminant Diffusion in Clay

Clay liners are often used in waste disposal facilities to prevent the advective transport of contaminants into the surrounding groundwater. Even when advective transport is small, however, contaminant transport through liners may be significant as the result of molecular diffusion. This phenomenon is being studied in the laboratory and at actual waste disposal facilities to evaluate its roles in mass transport and groundwater contamination. *Johnson, Toccalino*

Processes Controlling the Subsurface Transport of Dense Chlorinated Solvents

The uncontrolled release of chlorinated solvents is a common cause of serious groundwater contamination in many parts of the world. It is in this context that it is important to understand the physical and chemical principles that govern the movement of these dense nonaqueous phase liquids (DNAPLs). Experiments under way at OGI and in conjunction with the University of Waterloo are examining the behavior and remediation of chlorinated solvents in the saturated and unsaturated zones. *Johnson, Pankow, Tratnyek*

Simulation of Subsurface Processes Using Very Large Scale Experimental Aquifers

Many important chemical, physical, and biological processes are difficult to study in the laboratory because of problems of scaling. Many of these processes are also difficult to characterize in the field, because of the complex and uncontrolled nature of environmental systems. For these reasons, OGI has established the Large Experimental Aquifer Program (OGI/LEAP). At present, the facility consists of five large aquifers used to examine the movements of organic solvents and petroleum compounds in the unsaturated and saturated porous media. Future LEAP aquifers will examine inorganic geochemistry and the interactions between chemical, biological, and physical processes in contaminated aquifers. *Johnson and other faculty*

Gas-Phase Transport in Unsaturated Porous Media

Gas-phase transport is important in controlling many subsurface processes including respiration, pesticide behavior, and contaminant volatilization and movement. Laboratory experiments are under way to determine diffusion rates of a variety of organic compounds in porous media and the kinetics of adsorption and desorption for a variety of soil types and a range of water contents. *Johnson, Toccalino*

Multi-Phase Monitoring of Gasoline Movement Using a Very Large Physical Model

(OGI/LEAP) Leaks from underground storage tanks (UST) represent a major ongoing source of groundwater contamination. The rapid detection of leaks is, therefore, a major goal of UST legislation. The OGI/LEAP facility is used to study the movement of gasoline components in the vapor, aqueous, and pure-product phases. This work will help establish which of a variety of leak-detection technologies is best suited to detect leaks under a range of environmental conditions. *Johnson*

Remediation of Halocarbon-Contaminated Groundwater

There is enormous demand for improved ways to clean up aquifers that have been contaminated with halogenated hydrocarbon solvents like carbon tetrachloride and TCE. Recent field-scale tests have shown that technologies based on dechlorination with granular iron may have substantial value. The goal of our research in this area is to provide a sound scientific basis for designing and operating such technologies by determining the mechanisms of dechlorination by iron and the geochemical and microbiological processes that affect the performance of this technique in the field. *Tratnyek*

Reduction Reactions of Organic Pollutants in Anaerobic Environments

Some organic pollutants undergo rapid reduction in anaerobic sediments, soils, and groundwaters. Despite the potential importance of this process, little is known about the natural reducing agents that are responsible for these reactions. In this project, assays are being developed that will identify and quantify environmental reducing agents in situ. These assays will be used in kinetic studies of important pollutant reduction reactions. *Tratnyek*

Photoreactions of Organic Substances in Surface Waters

In sunlit surface waters, a variety of highly reactive photo-oxidants are formed. These oxidants include singlet oxygen, hydroxyl radical, and hydrogen peroxide. Research in this area focuses on singlet oxygen, the kinetics of its reaction with organic pollutants, and the effects of organic pollutants on its formation and toxicity in the environment. *Tratnyek*

Correlation Analysis of Contaminant Reactivity

Quantitative Structure-Activity Relationships (QSARs) are of enormous importance in environmental chemistry and toxicology because of their predictive power, but they also reveal a great deal about reaction mechanisms and the nature of substituent effects. We are involved in the development of QSARs for a wide range of redox reactions involving organic contaminants. This work involves the use of computational chemistry methods as well as advanced statistical techniques in exploratory data analysis. *Tratnyek*

Fate and Effects of Fuel Oxygenates

The recent realization that oxygenated fuel additives such as MTBE are becoming widely

distributed groundwater contaminants has created a sudden and pressing demand for data on the processes that control their environmental fate. On-going work in this area includes modeling of MTBE infiltration to the groundwater, laboratory studies of MTBE biodegradation, and field studies of several contaminated sites for MTBE and its possible breakdown products. *Pankow, Tratnyek, Johnson*

Hydrocarbon Biodegradation in Soil

Petroleum hydrocarbon contamination is prevalent in soils and groundwater. Efforts to clean up this extensive petroleum contamination have prompted research into in situ bioremediation. Depending on site characteristics, in situ hydrocarbon biodegradation is a cost effective and environmentally sound remediation alternative or partner to pump-and-treat and vacuum extraction technologies. One objective of a bioremediation study conducted using soil from the LEAP facility is to understand the processes by which the biodegradation rates of organic compounds can be increased in soil systems, and to use this knowledge to enhance remediation and restoration activities at contaminated sites. *Toccalino*

Human Health Assessment of Water Quality

A national effort is underway with the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) program, in collaboration with the U.S. Environmental Protection Agency (USEPA), to conduct a pilot effort to develop, test, and refine concepts to more effectively communicate water-quality information in a human health context. Part of the scope of the study is to determine how to effectively communicate the data from this study in a human health context to Congress, the media, the public, etc. *Toccalino*

Oceanographic and Environmental Characterization of Coastal Regions

The long-term goal is to enhance understanding of oceanographic and environmental processes in estuaries and coastal regions, and to incorporate this understanding into diagnostic and predictive models toward operational nowcast-forecast systems.

Short-term goals are to enhance the observation and representation of selected hydrodynamic processes, with emphasis on density-driven turbulent flow and transport in tidal inlets, tidal propagation at coupled spatial scales, and longwave inundation; to enhance the representation of geochemical and biogeochemical processes at sediment-water interfaces under shear or disruption; and to investigate software integration of field observations, laboratory experiments, and computer models.

This is a strongly interdisciplinary effort, involving components of numerical modeling, field observations, laboratory experiments, and software integration. *Baptista, Tratnyek, Jay, Pu, external collaborators*

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Distribution of Organic Compounds Between the Gas and Urban Aerosol Particulate Phases

The behavior of organic compounds in the atmosphere depends in large part on the extent to which they partition from the gas phase to aerosol particulate matter. Processes that are affected by this partitioning process include precipitation scavenging of gases and particles as well as dry deposition of gases and particles. Fundamental gas/solid sorption theory is being used to investigate important aspects of atmospheric gas/particle partitioning. The study involves the investigation of basic partitioning behavior of a wide range of representative atmospheric compounds (including alkanes and polycyclic aromatic hydrocarbons) on a variety of representative model particulate substrates, including elemental carbon, organic carbon, silica, and clay. *Pankow*

Thermodynamics of Inorganic Solid Solutions

The manner in which inorganic solid solutions behave is one of the last major research frontiers in ambient temperature aqueous geochemistry. Coprecipitation of metal ions is well known in nature, e.g., Sr^{2+} can form a solid solution in calcium carbonate ($\text{CaCO}_3(\text{s})$). Unfortunately, little is known about the thermodynamics of such solid solutions. That is, little is known about how the activity coefficients of metal ions vary as a function of composition in solid solutions of various types. The values of the activity coefficients are of interest because they control the extent to which the constituents in the solid solutions will be soluble in water, e.g., the extent to which a toxic metal ion like Cd^{2+} that is present in calcium carbonate will be soluble in water. In this work, activity coefficient values for a variety of environmentally important divalent metal ions are being sought as a function of composition in calcium carbonate. *Pankow*

Distribution of Organic Compounds Between the Gas and Particulate Phases in Air Contaminated with Environmental Tobacco Smoke (ETS)

Toxic compounds present in ETS (e.g., the polycyclic aromatic hydrocarbons [PAHs]) are distributed between the gas and aerosol particulate phases. Understanding the factors controlling this distribution is important because the health effects of toxic compounds in the air are strongly dependent on the chemical form of those compounds. We are measuring the gas/particle distribution of compounds like the PAHs in air contaminated with ETS and also are studying the thermodynamics of the partitioning process in the laboratory. *Pankow*

Earth/Atmosphere Partitioning of Anthropogenic Organochlorine Compounds

Field data collected over the last decade by various researchers indicate there is a temperature-driven partitioning of organochlorine compounds between the surface of the earth and the atmosphere. Atmospheric concentrations of compounds like DDT and lindane increase in the Northern Hemisphere in the summer and decrease again in the winter. Modeling results suggest the nature of these temperature-driven changes can be used to estimate the fraction of the mass amounts of these compounds in the global environment that are in mobile and biologically available forms. *Pankow*

Global Distributions and Mass Balances of Halocarbons, Nitrous Oxide, and Other Trace Gases

Gases such as CCl₃F (F-11), CCl₂F₂ (F-12) CHClF₂ (F-22), CF₄ (F-14), C₂Cl₃F₃ (F-113), CH₃CCl₃, CH₃Cl and N₂O are being added to the atmosphere by various industrial processes and the use of high-technology products by the public. Such chlorine-containing compounds are believed to threaten the earth's natural ozone layer high in the atmosphere (stratosphere). This research will systematically obtain a long-time series of concentration measurements by a flask sampling system. The results are then interpreted with global mass balance models and sophisticated statistical techniques to quantify the sources and lifetimes of these gases in the environment. Such data are now obtained from sites all over the world extending from the Arctic Circle to the South Pole. *Rasmussen*

Studies of Past Atmospheres

Atmospheric gases such as N₂O, CO₂, CO, CH₃Cl, carbonyl sulfide (OCS), and CH₄ are primarily produced by natural processes, but over the past century human activities have been adding growing amounts to their natural abundance. This process can upset the cycles of these gases and lead to possibly adverse environmental effects such as the warming of the earth's surface (N₂O, CO₂, CH₄). When both natural and anthropogenic processes contribute to the current atmospheric abundance of a trace gas, it is of interest to determine the amount which existed before human activities had any effect. Perhaps the only realistic method to determine the composition of the ancient atmosphere is to analyze the air in bubbles buried deep in polar ice. The depth of the ice indicates the age of the air in the bubbles. By going far enough back in time, the relationship between past atmospheric composition and climate might be found. The novel and simple method of studying the old atmosphere of the earth is beset by many problems that complicate the relationship between the gases in the bubbles and the composition of the old atmosphere. Theoretical and experimental research for resolving these problems as well as the measurement of trace gases are the major goals of this project. *Rasmussen*

Ocean-Air Exchange of Gases

Some atmospheric gases are greatly influenced by the earth's oceans. For instance, a large amount of the atmospheric methyl chloride (CH₃Cl) and methyl iodide (CH₃I) are produced in the oceans, possibly by biogenic processes. It has also been shown recently that carbonyl sulfide (OCS) is produced in the oceans and subsequently emitted to the atmosphere. On the other hand, man-made gases such as CCl₃F (F-11) can dissolve in the oceans and thus be removed from the atmosphere. This research project is devoted to determining the solubility of such gases in water and to modeling the flux of gases into or out of the oceans. The results obtained are essential ingredients in determining the sources and fates of atmospheric trace gases and in estimating the

effects of human activities on the future warming of the earth or depletion of the ozone layer.

Rasmussen

Studies of Atmospheric Methane

Considerable evidence has been accumulated showing that methane (CH₄) is increasing in the atmosphere, most likely as an indirect result of growing human population. In the future, such an increase of CH₄ can lead to a global warming by enhancing the earth's natural greenhouse effect and create more ozone and carbon monoxide in the atmosphere. However, it might also prevent some of the destruction of the stratospheric ozone layer by the man-made fluorocarbons 11 and 12. In this project, experimental and theoretical research is focused on statistical trend analyses for the global increase of CH₄, its seasonal variation, sources and sinks, models of its effect on the CO, O₃, and OH cycles and its role in the future of the environment. *Rasmussen*

Development of Experimental Methods for Trace Gas Measurements

At present, some 50 atmospheric gases can be measured at the Trace Gas Laboratory. Still, new methods are needed to improve the accuracy and precision of measurements and to satisfy the stringent demands of ultra-clean background air sampling. New methods are also being developed for automated real-time analysis of many trace gases. Research programs include development of gas chromatographic and mass spectrometric methods for the analysis of trace gases. At present, GC/MS systems in the laboratory are being used to routinely measure C₂-C₁₂ nonmethane hydrocarbons at tens of parts per trillion levels. Techniques for collecting and storing air and water samples also are being developed. *Rasmussen*

Biogenic Sources of Atmospheric Gases

Living organisms produce and consume a variety of gases and may therefore form an integral part of the global cycle of a trace gas. Selected plants and animals, living in the sea or on land, are being studied to determine their role in the cycles of CH₄, N₂O, CH₃Cl, CH₃I, isoprene and other hydrocarbons. *Rasmussen*

The Global Cycle of Carbon Monoxide (CO)

Based on 15 years of global sampling and the application of modern trend analysis techniques, our data have shown that CO increased in the atmosphere until around 1987 and has since declined. These changes in CO have major implications for atmospheric chemistry and the role of biomass burning in causing global increases of trace gases. Present research includes modeling of the global budgets, seasonal cycles, and potential environmental effects. *Rasmussen*

Methane Emissions from Rice Fields

Methane concentrations have nearly tripled compared to the natural atmosphere of 300 years ago (based on ice core analyses). The increase of rice agriculture to sustain an increasing population may be a major contributor to the increase of methane during the last century. This research

program is designed to determine the role of rice agriculture in the global methane cycle. Field experiments are being conducted in China, Indonesia and the U.S. Laboratory experiments and theoretical research are being done at the Global Change Research Center (Portland State University) in a comprehensive research program. This work includes modeling the production, oxidation and transport of methane in the rice paddy ecosystem and measuring the controlling parameters. *Rasmussen*

Land-Margin Ecosystem Research in the Columbia River Estuary

The Columbia River Estuary Land-Margin Ecosystem Research (LMER) Program funded by the National Science Foundation focuses on the estuarine turbidity maximum, which is the heart of the estuarine ecosystem. Long-term funding allows analysis of seasonal and interannual variability in estuarine processes and evaluation of the impacts of flow regulation on the system. The extensive data sets collected by this program provide a basis for studies of estuarine circulation, hydraulic control processes at the estuary mouth, nonstationary tidal processes, suspended sediment transport, turbulence and mixing, and biological processes. Jay, Baptista, and external collaborators

Internal Circulation in Tidal Channels and Straits

This project, funded by the Office of Naval Research, seeks to use wavelet data analysis techniques and novel modeling strategies to improve our conceptual understanding of estuarine circulation and scalar transport. Continuous wavelet transforms allow resolution of time variation in tidal processes in each frequency band. Dr. Jay's group is using this technique to understand estuarine internal circulation and shelf internal tides in buoyant plumes. Modeling efforts use symbolic mathematics software to provide a balance between the intuitive understanding and compact nature of analytical solutions and the superior flexibility and accuracy of full-numerical solutions. *Jay*

CORMIX Graphic User Interface and GIS Database Integration

This project develops computer information systems for the CORMIX mixing zone water quality model. A fully interactive Windows-based application is proposed, designed to give CORMIX additional functionality, flexibility, and power using object-oriented rule-based technology for forms-based interactive data entry, flow classification, simulation logic description, and GIS database integration. *Doneker*

D-CORMIX Decision Support System

This project involves development, validation, and scientific review of the D-CORMIX decision support system. D-CORMIX is a physically-based simulation model linked to a knowledge-based classification system for predicting of water quality and sediment deposition impacts resulting from dredging operations. The purpose of the project is to assist water quality managers in performing waste load allocations for continuous dredge discharges. The methodologies developed in this project are also necessary for long term pollutant fate and transport studies by providing information on initial boundary conditions. This project also develops validation studies and documentation for USEPA Science Advisory Board (SAB) review of D-CORMIX. *Doneker*

CORMIX Documentation Development, Workshop Instruction, and Technical Support

OGI has a 3-year cooperative agreement to maintain, update and distribute the CORMIX user manual, conduct technical training workshops on mixing zone models, and to provide technical assistance to CORMIX model users. The CORMIX water quality model has approximately 1000 users worldwide, feedback from them through technical support and training workshops directly supports current model development activities. *Doneker*

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CENTER FOR GROUNDWATER RESEARCH

The principal mission of the [Center for Groundwater Research \(CGR\)](#) is to conduct state-of-the-art research in areas relating to the transport and fate of contaminants in the subsurface. This is accomplished through a combination of research grants and contracts, support from Center corporate sponsors, and through collaboration with other universities, industries, and government agencies.

The Center coordinates a range of projects relating to the transport and fate of contaminants in soils and groundwater. The scope of the Center includes, among other things, the development of: 1) new sampling and site characterization techniques; 2) new analytical techniques; and 3) improved groundwater remediation methods.



The Center operates the Large Experimental Aquifer Program (LEAP) which contains the experimental cells outlined below. The LEAP facility provides staff with the capability to conduct both bench-scale experiments and pilot-scale demonstrations. Current projects include transport through fractured clay, air sparging of source petroleum zones containing MTBE, and a pilot scale demonstration of zeolite as an in-situ permeable barrier material.

Students involved in LEAP research graduate with a rare combination of experience in full-scale remediation engineering and a process-level understanding of contaminant hydrology and chemistry.

Additional information about CGR may be obtained from:

Dr. Richard Johnson
Phone: (503) 748-1193
Email: rjohnson@ese.ogi.edu
CGR web site: cgr.ese.ogi.edu.

Faculty

[Richard Johnson](#), Associate Professor
[James F. Pankow](#), Professor
[Patricia L. Toccalino](#), Assistant Professor
[Paul Tratnyek](#), Associate Professor

LEAP Equipment

- Five tanks: one 10 m x 10 m x 3 m, two 10 m x 10 m x 5 m, one 10 m x 2.5 m x 0.5 m, and one 8 m x 2.5 m x 0.5 m
- In situ instrumentation, including: automated temperature, pressure, and water level monitoring; multilevel samplers; down hole video camera; and automated vapor and product sensing equipment
- Remediation equipment, including soil vapor extraction and air sparging capabilities
- Automated on-site analytical equipment, including capillary GC-MS instrumentation

CENTER FOR COASTAL AND LAND-MARGIN RESEARCH (CCALMR)

The Center for Coastal and Land-Margin Research (CCALMR) is an interdisciplinary research center affiliated with the Department of Environmental Science and Engineering. CCALMR conducts research, graduate education and advanced technology development that directly address the need for better scientific understanding of coasts, land margins and estuaries. Improved knowledge of these complex systems is necessary to preserve and enhance their environmental integrity, maintain the economic viability of communities dependent on them and protect human populations from natural and man-made hazards.



Real-world natural resource management issues motivate CCALMR research and education activities. Insights drawn from the experience of science and engineering professionals in the public and private sectors influence the identification of emerging research challenges, the design of research projects, the development of supporting tools and applications and the transfer of knowledge and technology.

Additional information about CCALMR may be obtained from:

Antonio Baptista
 Phone: (503) 748-1147
 Email: baptista@ccalmr.ogi.edu
 CCALMR web site: www.ccalmr.ogi.edu/

Faculty

Antonio Baptista, Professor and Director
 David Boone (Portland State University)
 Robert Doneker, Assistant Professor
 William Fish (Portland State University)
 Wesley Jarrell, Professor
 David Jay, Associate Professor
 Calton Pu, Professor of Computer Science and Engineering
 Paul Tratnyek, Associate Professor

CCALMR FEATURED PROJECTS

- Cascadia Subduction Zone tsunamis
- CORIE: a pilot estuarine nowcast-forecast system
- CORMIX: mixing zone decision support system
- Coupled physical and biogeochemical processes at sediment-water interfaces

- Internal circulation in tidal channels and straits
- Land-margin ecosystem research in the Columbia River estuary
- Ocean survival of salmonids
- Reduction reactions of organic pollutants in anaerobic environments
- Trace element distributions
- Watershed analysis

RESEARCH FACILITY

The Center is well equipped to conduct state-of-the-art scientific research. The following is a list of facilities and instruments available in addition to those available through the Department of Environmental Science and Engineering.

REAL-TIME DATA ACQUISITION NETWORK

The pilot nowcast-forecast system CORIE includes a real-time data acquisition network with twelve multi-sensor oceanographic stations in the Columbia River estuary. Field operations are conducted from the Marine Environmental Research and Training Station (MERTS). MERTS is a facility developed in partnership with and operated by the Clatsop Community College (CCC). CCC operates two training and research vessels: the 50-foot M/V Forerunner and the 21-foot R/V Tansy Point.

OCEANOGRAPHIC EQUIPMENT

300, 600 and 1200 kHz Acoustic doppler current profilers (RD)
 500 and 1500 kHz Acoustic doppler profilers (Sontek)
 Conductivity and temperature pairs (Seabird)
 Conductivity, temperature and pressure sensors (Coastal Leasing and Ocean Sensors)
 Echosounder and digitizer (Ross)
 Optical backscatter sensors (Downing Associates)
 Wind gauges (Coastal Leasing)
 High-density thermistor chains (CCALMR)
 Differential GPS (Trimble)
 Spread spectrum radio data modems (FreeWave)

BIOGEOCHEMICAL ROTATING ANNULAR FLUME (RALF)

RALF, a 2-meter biogeochemical rotating annular flume, supports research on coupled physical and biogeochemical processes at sediment-water interfaces. Instrumentation providing real-time or pseudo real-time data include:

3-dimensional Acoustic Doppler Velocimeter (Sontek)
 DO (Orion) and pH/ISE (Orion)
 DLK-100 Potentiostat (AIS)
 Solid State Au/Hg amalgam microelectrodes
 Bipotentiostat equipped with rotating disk electrode (Pine)

CCALMR RESEARCH PROJECTS

[CORIE: A PILOT ESTUARINE NOWCAST-FORECAST SYSTEM](#)

Since 1996, we have been developing CORIE, a nowcast-forecast system for the Columbia River estuary. The motivation is two fold. First, the Columbia River and its near-shore plume are a dominant oceanographic feature of the northeastern Pacific Ocean and the focus of

controversial ecosystem management issues. CORIE represents a novel, promising, and much needed infrastructure for physical and ecological research in this system. Second, we envision that multi-purpose nowcast-forecast systems will become central to the management of coasts and estuaries worldwide. The Columbia River estuary is a challenging natural laboratory to test concepts and tools, and CORIE is a pilot system developed to anchor our nowcast-forecast research.

CORIE has three main components. The first component is a real-time data acquisition system, including an array of 12 permanent stations, a variable number of temporary stations, and one mobile station. We currently monitor, in various combinations at each station: temperature, conductivity, water pressure, water velocities, acoustic backscatter, wind speed and direction, air temperature, and atmospheric pressure. "Real-time" is defined by latencies of typically a few seconds, and is achieved through a telemetry network based on spread-spectrum radio technology. The second component of CORIE is a suite of circulation and transport models currently extending from the Bonneville dam to the coastal vicinity of the CR estuary, and including parts of the Willamette and Cowlitz rivers. Hindcast model runs are being used to benchmark systematically all models, individually and in their contrasting features. Exploratory nowcast-forecast runs are being performed daily with a 2D model, and will eventually be extended to a 3D baroclinic model. The third component of CORIE is a data management and distribution system, with real-time and archival access through the web to script-generated graphical displays and actual data. Baptista

COUPLED PHYSICAL AND BIOGEOCHEMICAL PROCESSES AT SEDIMENT-WATER INTERFACES

The overall goal of this project is to advance our quantitative understanding of the fate and bioavailability of chemical elements in estuaries by coupling meso-scale experimentation with diagnostic numerical modeling and field observations. In a preparatory phase, we designed, constructed and instrumented a meso-scale biogeochemical rotating annular flume (<http://www.ccalmr.ogi.edu/RALF>). We are beginning the process-based research phase on the project, in which we will focus on elements important for both water quality and ecosystem dynamics, namely the cycling of Fe, Mn, and other divalent metals at sediment-water interfaces (SWI). We are especially interested in quantifying the effect of episodic sediment disruptions on the speciation and phase (dissolved, particulate, and colloidal) of these metals. We are also interested in the effect of shear upon particle desegregation, differential settling, sorption, precipitation, and dissolution. We will place the chemical reactions in a controlled, yet realistic, shear-driven physical environment by conducting primary experiments in the controlled environment of RALF. Baptista, Tratnyek, external collaborators

OCEAN SURVIVAL OF SALMONIDS

We are initiating an integrated observational/ modeling study of the physical variability of the Columbia River plume and estuary, to provide oceanographic context for research on the role of the coastal ocean on the life cycle of salmon. Baptista, Jay, external collaborators

CASCADIA SUBDUCTION ZONE TSUNAMIS

Large tsunamis are believed to be locally generated in the Cascadia Subduction Zone (CSZ) every 200 to 600 years, based on geological records. The last large tsunami dates back about 300 years, raising concerns about the protection of coastal communities in Oregon, Washington,

California, and British Columbia. The coastal impact of potential CSZ tsunamis is being investigated through numerical modeling. The need to use geological evidence on paleotsunamis as the sole, loose reference for model validation makes this an unusually interesting and challenging problem. The Oregon Department of Geology and Mineral Industry (DOGAMI) has incorporated our joint research results into the development of tsunami inundation maps for the Oregon and Washington coasts. Baptista, external collaborators

Department Research Facilities

The department is well-equipped to carry on a vigorous research program. Instruments and equipment available, in addition to those listed for the centers, include:

General and Analytical Equipment

Carbon/nitrogen/sulfur analyzer

Several high-performance liquid chromatographs with UV-absorbance, fluorescence, refraction index, and conductivity detectors.

Ion chromatograph

Graphite furnace atomic absorption spectrophotometer

Access to FT-IR, fluorescence, diode array UV/VIS, scanning UV/VI Snear IR spectrophotometers

Access to scanning electron microscopes

Access to a complete Raman spectroscopy facility

Purge and trap concentrator and thermal desorption apparatus

Rain and air sampling equipment

Groundwater and soil sampling equipment

Groundwater monitoring equipment, including water table, ambient, and ground temperature measurement, and pressure transducers all integrated into a data logging system

Equipment for supercritical fluid extraction and supercritical fluid chromatography

Several rapid flow injection analysis systems

Sediment samplers

Two-dimensional polyacrylamide gel densitometer

Aerosol samplers

Trace reduction-gas analyzer

Liquid nitrogen freezer

Computer Equipment

Computer lab with numerous Pentium and Pentium Pro PCs running Windows NT

SPARC workstations

Network access via X-terminals and personal computers

Numerous IBM compatible and Apple Macintosh computers with HP LaserJet printers, digitizing tablets, plotters and a film image recorder

Support Facilities

Fully equipped machine shop

Toxic chemicals handling laboratory

Electronics support personnel

Greenhouse facility and growth chambers

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ANTONIO M. BAPTISTA

Professor and Department Head
Director, Center for Coastal and Land-Margin Research
Ph.D., Civil Engineering
Massachusetts Institute of Technology, 1987
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RESEARCH INTERESTS

Integrated understanding and prediction of hydrodynamic and environmental processes in estuaries and coasts. Development of associated technologies: nowcast-forecast systems, numerical methods and models, real-time data acquisition systems, laboratory mesocosms.

REPRESENTATIVE PUBLICATIONS

Myers, E.P., A.M. Baptista and G.R. Priest, "Finite Element Modeling of Potential Cascadia Subduction Zone Tsunamis," *Science of Tsunami Hazards*, 17(1): 3-18, 1999.

Yang, Z., A.M. Baptista and J. Bailey-Darland, "Numerical Modeling of Flow Characteristics in a Rotating Annular Flume," *Dynamics of Atmospheres and Oceans*, in press, 1999.

Oliveira A. and A.M. Baptista, "On the Role of Tracking on Eulerian-Lagrangian Solutions of the Transport Equation," *Advances in Water Resources*, 21(7), 539-554 (1998).

Oliveira A. and A.M. Baptista, "Diagnostic Modeling of Residence Times in Estuaries," *Water Resources Research*, 33(8), 1935-1946 (1997)

Fortunato A.B., A.M. Baptista and R.A. Luetlich, Jr., "A Three-Dimensional Model of Tidal Currents in the Mouth of the Tagus Estuary," *Continental Shelf Research*, 17(14), 1689-1714 (1997).

Wood T.M., A.M. Baptista, J. Kuwabara, and R. Flegal, "Diagnostic Modeling of Trace Metal Partitioning in South San Francisco Bay," *Limnology and Oceanography*, 40 (2), 345-358 (1995).

Baptista A.M., E.E. Adams, and P. Gresho, "Benchmarks for the Transport Equation: The Convection-Diffusion Forum and Beyond," in *Quantitative Skill Assessment for Coastal Ocean Models* (Lynch and Davies, Eds.), AGU Coastal and Estuarine Studies, 47, 241-268 (1995).



ROBERT L. DONEKER, P.E.

Assistant Professor
Ph.D., Environmental Engineering
Cornell University, 1989
doneker@ese.ogi.edu

RESEARCH INTERESTS

Development of decision support systems for environmental simulation modeling, engineering design optimization, and natural resource management. Current research areas focus on development of technology transfer systems with emphasis on water quality modeling and control of point and nonpoint source pollutant transport.

REPRESENTATIVE PUBLICATIONS

Doneker, R. L. And G. H. Jirka, 1999, "CORMIX Applications: Schematization and Boundary Interaction" Journal of Hydraulic Engineering, ASCE, in print.

Doneker, R. L. And G. H. Jirka, 1999. Discussion of "Mixing In Inclined Dense Jets" by P.W. Roberts, A. Ferrier, and G. Daviero, Journal of Hydraulic Engineering, ASCE, vol. 125 No.3 pp.317-318.

Doneker, R. L. and G. H. Jirka, "D-CORMIX: A Decision Support System for Hydrodynamic Mixing Zone Analysis of Continuous Dredge Disposal Sediment Plumes", ASCE National Conference of Environmental Engineering, Chicago, June 1998.

Ford D.A., A.P. Kruzic, and R.L. Doneker, "Using GLEAMS to Evaluate the Agricultural Waste Application Rule-Based Decision Support System (AWARDS) Computer Program", Water Science and Technology, Vol. 28, No-35, pp.625-634, 1993.

Doneker, R.L., and G.H. Jirka "Expert Systems for Mixing Zone Analysis and Design Aqueous Pollutant Discharges," Journal of Water Resources Planning and Management, ASCE, Vol. 117, No. 6, November/December 1991.

Jirka, G.H. and R.L. Doneker "Hydrodynamic Classification of Submerged Single Port Discharges", Journal of Hydraulics Division, ASCE, Vol. 117, No. 9, September 1991.

Jirka G.H., R.L. Doneker, and T.O. Barnwell, "CORMIX: A Comprehensive Expert System for Mixing Zone Analysis of Aqueous Pollutant Discharges," Water Science and Technology, 24, No. 6, 267-274, 1991.



DAVID A. JAY

Associate Professor
Ph.D., Physical Oceanography
University of Washington, 1987
djay@ese.ogi.edu

RESEARCH INTERESTS

River basin, estuarine, and continental shelf processes, turbulent mixing, tides and tidal analysis. A unifying theme is the influence of hydrodynamic processes on ecosystems.

REPRESENTATIVE PUBLICATIONS

D.A. Jay & E.P. Flinchem, "Interaction of a fluctuating river flow with a barotropic tide: A test of wavelet tidal analysis methods," J. of Geophysical Research, 102, 5705-5720 (1997).

C.N. Cudaback & D.A. Jay, "Buoyant plume formation at the mouth of the Columbia River-an example of internal hydraulic control?," Buoyancy Effects on Coastal and Estuarine Dynamics, AGU Coastal and Estuarine Studies, 53, 139-154 (1996).

B.M. Hickey, L.J. Pietrafesa, D.A. Jay & W.C. Boicourt, "The Columbia River Plume Study: subtidal variability in the velocity and salinity field," J. Geophysical Research, 103(10), 229-368 (1996).

D.A. Jay & J.D. Musiak, Internal Tidal Asymmetry in Channel Flows: Origins and Consequences, C. Pattiaratchi (Ed.), "Mixing Processes in Estuaries and Coastal Seas, an American Geophysical Union," Coastal and Estuarine Sciences, 53, 219-258 (1996).

D.A. Jay & C.A. Simenstad, "Downstream effects of water withdrawal in a small, high-gradient basin: erosion and deposition on the Skokomish River Delta," Estuaries, 19, 501-517 (1996).

D.A. Jay & J.D. Musiak, "Particle trapping in estuarine turbidity maxima," J. of Geophysical Research, 99(20), 446-461 (1994).

LMER Coordinating Committee, "Understanding changes in coastal environments: the Land Margin Ecosystems Research Program," EOS, 73, 481-185 (1992).



RICHARD L. JOHNSON

Associate Professor, Director; Center for Groundwater Research
Ph.D., Environmental Science
Oregon Graduate Center, 1985
rjohnson@ese.ogi.edu

RESEARCH INTERESTS

Physical and chemical behavior of organic contaminants in the air, soil, and water; analytical organic chemistry; groundwater transport, fate, and modeling of contaminants in porous and fractured porous media.

REPRESENTATIVE PUBLICATIONS

W. Daily, A. Ramirez & R.L. Johnson, "Electrical Impedance Tomography of a Perchloroethylene Release," Environmental and Engineering Geophysics, 2(3), 189-201 (1998).

P.C. Johnson, R.L. Johnson, C. Neaville, E.E. Hansen, S.M. Stearns & I.J. Dortch, "An Assessment of Conventional In Situ Air Sparging Tests," Ground Water, 35(5), 765-774 (1997).

J.F. Pankow, N.R. Thomson, R.L. Johnson, A.L. Baehr & J.S. Zogorski, "The Urban Atmosphere as a Non-point Source for the Transport of MTBE and other Volatile Organic Compounds (VOCs) to Shallow Groundwater," *Environmental Science and Technology*, 31(10), 10, 2821-2828 (1997).

K.A. McCarthy & R.L. Johnson, "Measurement of Trichloroethylene Diffusion in Soil with a Vertically-Varying Moisture Content," *J. Environ. Quality*, 24(1), 49-55 (1995).

K.A. McCarthy & R.L. Johnson, "Measurement of trichloroethylene diffusion as a function of moisture content in sections of gravity-drained soil columns," *J. Environ. Qual.*, 24, 49 (1995).

R.L. Johnson & J.F. Pankow, "Dissolution of Dense Chlorinated Solvents into Groundwater. 2. Source Functions for Pools of Solvent," *Environ. Sci. Technol.*, 26, 901 (1992).

R.L. Johnson & M. Perrott, "Gasoline Vapor Transport Through a High Water Content Soil," *J. Contamin. Hydrol.*, 8, 317 (1991).



JAMES F. PANKOW

Professor

Ph.D., Environmental Engineering Science

California Institute of Technology, 1978

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RESEARCH INTERESTS

Physical and analytical chemistry of trace organics and metals in natural waters and in the atmosphere; fates of organic and inorganic chemicals in the environment.

REPRESENTATIVE PUBLICATIONS

J.F. Pankow, B.T. Mader, L.M. Isabelle, W. Luo, A. Pavlick, C. Liang, "Conversion of Nicotine in Tobacco Smoke to its Volatile and Available Free-Base Form through the Action of Gaseous Ammonia," *Environmental Science and Technology*, 31, 2428-2433 (1997).

P.J. Squillance, J.F. Pankow, N.E. Korte, J.S. Zogorski, "Environmental Behavior and Fate of Methyl tert-Butyl Ether (MTBE)," Fact Sheet, U.S. Department of the Interior - U.S. Geological Survey - National Water Quality Assessment Program (NAWQA) (1996).

C. Liang & J.F. Pankow, "Gas/Particle Partitioning of Organic Compounds to Environmental Tobacco Smoke: Partition Coefficient Measurements by Desorption," *Environ. Sci. Technol.* 30(9), 2800-2805 (1996).

J.F. Pankow, "An Absorption Model of Gas/Particle Partitioning in the Atmosphere," *Atmos. Environ.*, 28, 189 (1994).

R.L. Johnson & J.F. Pankow, "Dissolution of Dense Chlorinated Solvents into Groundwater. 2. Source Functions for Pools of Solvent," *Environ. Sci. Technol.*, 26, 896 (1992).

J.F. Pankow & S.W. McKenzie, "Parameterizing the Equilibrium Distribution of Chemicals between the Dissolved Solid Particulate Matter and Colloidal Matter Compartments in Aqueous Systems," *Environ. Sci. Technol.*, 25, 2046 (1991).



REINHOLD A. RASMUSSEN

Professor

Ph.D., Botany Plant Physiology

Washington University, St. Louis, 1964

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RESEARCH INTERESTS

Atmospheric chemistry of trace gases; biogenic and anthropogenic emissions of trace gases and their roles in stratospheric ozone destruction and tropospheric ozone formation; measurements of trace gases at parts per trillion to parts per quadrillion levels; sources and sinks of isoprene and other hydrocarbons.

REPRESENTATIVE PUBLICATIONS

R.A. Rasmussen, M.A.K. Khalil & F. Moraes, "Permafrost Methane Content: 1. Experimental Data from Sites in Northern Alaska," *Chemosphere*, 26:591 (1993).

M.A.K. Khalil, R.A. Rasmussen, J.R. French & J. Holt, "The Influence of Termites on Atmospheric Trace Gases: CH₄, CO₂, CHCl₃, N₂O, CO, H₂ and Light Hydrocarbons," *J. Geophys. Res.*, 95:3619 (1990).

D.A. Hegg, L.F. Radke, P.V. Hobbs, R.A. Rasmussen & P.J. Riggan, "Emissions of some trace gases from biomass fires," *J. Geophys. Res.*, 95:5669 (1990).

D. Pierotti, S.C. Wofsy, K. Jacob & R.A. Rasmussen, "Isoprene and its oxidation products: Methacrolein and methyl vinyl ketone," *J. Geophys. Res.*, 95:1871 (1990).

M.A.K. Khalil & R.A. Rasmussen, "Atmospheric methane, Ice Ages, and population: A graphical review of methane concentrations over the last 1,600,000 years," *Ant. J. of the U.S.*, 23(5):177 (1989).

R.A. Rasmussen & M.A.K. Khalil, "Isoprene over the Amazon basin," *J. Geophys. Res.*, 93:1417 (1988).

L.A. Barrie, J.W. Bottenheim, R.C. Schnell, P.J. Crutzen & R.A. Rasmussen, "Ozone Destruction and Photochemical Reactions at Polar Sunrise in the Lower Arctic Atmosphere," *Nature*, 334:138 (1988).

M.A.K. Khalil & R.A. Rasmussen, "Carbon Monoxide in the Earth's Atmosphere: Indications on a Global Increase," *Nature*, 332:242 (1988).



PATRICIA L. TOCCALINO

Assistant Professor

Ph.D. Environmental Science and Engineering

Oregon Graduate Institute, 1992

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RESEARCH INTERESTS

Human and ecological risk assessments, optimization of hydrocarbon biodegradation in soil and subsurface systems, contaminant fate and transport, mass transport between the unsaturated and saturated zones and in fractured porous media.

REPRESENTATIVE PUBLICATIONS AND TECHNICAL REPORTS

P.L. Toccalino, & R. L. Johnson, "Transport of gases to groundwater under constant and fluctuating water table conditions," in preparation for J. of Environmental Quality (2000).

Toccalino, P. L., K. M. Auer, D. A. Mervyn, and B. Stirling. 1997. Phase II Remedial Investigation/Risk Assessment Report for Westside Light Rail Transit (LRT) COstruction Spoils at the Port of Portland's Portland International Center, Portland, OR.

Toccalino, P. L., and D. A. Mervyn. 1997. Phase II Remedial Investigation/Risk Assessment Report for Westside LRT Tunnel Construction Project at Pointer's Pond, Portland, OR.

Wayman, D. R., and P. L. Toccalino. 1997. Environment, Safety and Health Issues and Mitigative Options Associated with Contained Burn of Rocket Motors in the U25X Test Chamber, Joint Demilitarization Technology (JDT) Program Activities at the Nevada Test Site, Las Vegas, NV.

Toccalino, P. L. 1997. Evaluation of the Contained Burn of Two M88 NIKE Rocket Motors for Environmental Safety & Health Implications, Nevada Test Site X-Tunnel Facility (U25X), Las Vegas, NV.

P.L. Toccalino, R.L. Johnson & D.R. Boone, "Nitrogen limitation and nitrogen fixation during alkane biodegradation in a sandy soil," Applied and Environmental Microbiology, 59, 2977 (1993).

K.M. Harmon, , P. L. Toccalino & M. S. Janos, "Hydrogen bonding, Part 29: Thermodynamics of dissociation and stoichiometric study of the lower hydrates of tetraethylammonium and tetrapropylammonium chlorides," J. of Molecular Structure, 213,193-200 (1989).

P.L. Toccalino, K. M. Harmon & J. Harmon, "Hydrogen bonding, Part 26: Thermodynamics of dissociation and infrared spectra-crystal structure correlations for betaine monohydrate and trimethylamine oxide dihydrate," J. of Molecular Structure, 189, 373-382 (1988).

K.M. Harmon, J. E. Cross & P. L. Toccalino, "Hydrogen bonding, Part 25: The nature of the hydrogen bond in hydroxytropenylium chloride (tropone hydrochloride)," J. of Molecular Structure, 178:141-145 (1988).



PAUL G. TRATNYEK

Associate Professor
Ph.D. Chemistry
Colorado School of Mines, 1987
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RESEARCH INTERESTS

Mechanistic and kinetic aspects of the fate of organic pollutants in the environment; degradation reactions involving pesticides, phenols, munitions, dyestuffs and chlorinated hydrocarbon solvents; chemical and microbiological processes in sediments, soils and groundwaters as well as photochemical processes in surface waters.

REPRESENTATIVE PUBLICATIONS

Smolen, J. M., E. J. Weber, and P. G. Tratnyek. 1999. Molecular probe techniques for reductant identification in reducing sediments. *Environmental Science and Technology* 33(3): 440-445.

Balko, B. A., and P. G. Tratnyek. 1998. Photoeffects on the reduction of carbon tetrachloride by zero-valent iron. *Journal of Physical Chemistry B*, 102(8): 1459-1465.

Scherer, M. M., B. A. Balko, D. A. Gallagher, and P. G. Tratnyek. 1998. Correlation analysis of rate constants for dechlorination by zero-valent iron. *Environmental Science and Technology* 32(19): 3026-3033.

Johnson, T. L., W. Fish, Y. A. Gorby, and P. G. Tratnyek. 1998. Degradation of carbon tetrachloride by iron metal: Complexation effects on the oxide surface. *Journal of Contaminant Hydrology* 29(4): 377-396.

Scherer, M. M., B. A. Balko, and P. G. Tratnyek. 1998. The role of oxides in reduction reactions at the metal-water interface. In : D. L. Sparks and T. J. Grundl (ed.), *Mineral-Water Interfacial Reactions: Kinetics and Mechanisms*. ACS Symposium Series No. 715, American Chemical Society, Washington, DC, Vol. ACS Symp. Ser. 715, pp 301-322.

Scherer, M. M., J. C. Westall, M. Ziomek-Moroz, and P. G. Tratnyek. 1997. Kinetics of carbon tetrachloride reduction at an oxide-free iron electrode. *Environmental Science & Technology* 31(8): 2385-2391.

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Department of Environmental Science and Engineering

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course offerings

ESE500 Numerical Methods

Introduction to numerical methods for environmental fluid dynamics. Theory and application of the solution of initial-value, boundary-value, and mixed initial-boundary value problems by finite differences, weighted residuals, numerical integration, and finite elements. Prerequisites: Calculus. 4 credits (*not offered 2000/2001*)

ESE504 Uncertainty Analysis

A survey of basic probability concepts followed by introductions to several statistical advanced techniques that play an important role in environmental data analysis. Topics may include distribution functions, propagation of error, hypothesis testing, analysis of variance, experimental design, sampling theory, regression analysis, time-series analysis, and spatial statistics techniques. The course provides a balance of theory and application using environmental data sets. 4 credits

ESE505 Introduction to Spatial Sciences

Students will learn theoretical and practical applications of geo-spatial sciences within the context of Environmental Sciences and Engineering. Theory of satellite-based Geographic Positioning Systems (GPS) will be studied while performing practical, hands-on laboratory experiments using the latest in GPS equipment. Classroom discussions will then focus on relating location on the Earth's surface to a common mapping grid. Non-projected and projected maps, ellipsoids and spheroids, and geoids will be discussed. Spatial relationships, or analysis, of continuous and categorical data will be addressed through the application of standard statistics and probability. ARCVIEW, a popular Geographic Information System (GIS) software tool will be stressed. 4 credits

ESE506 Environmental Systems Analysis

Introduction to techniques of systems analysis applied to environmental quality management. Emphasis is placed on development and application of mathematical models with computer simulation and optimization. Analysis is efficient computational algorithms and search techniques. Linear and separable programming applied to evaluate management alternatives. Applications to air, water, solid, and hazardous waste management. Prerequisites: Computer programming and calculus. 4 credits (*not offered 2000/2001*)

ESE508 Advanced Topics in Numerical Methods

Each offering is independent in content and structure. Typically, an advanced topic related to numerical modeling of flow or transport equations is formally presented and analyzed in great depth. Course offered only on demand. Prerequisites: Advanced calculus and ESE 500. 4 credits (*not offered 2000/2001*)

ESE510 Aquatic Chemistry

General acid/base concepts (mono- and polyprotic systems); activity corrections; numerical

calculations; titration concepts as applied to natural systems; buffer intensity; dissolved CO₂ chemistry; pH, acidity, and alkalinity in open CO₂ systems; minerals and their role in controlling natural water chemistry; solubility characteristics of oxide and hydroxides; and the effect of metal complexation on natural water chemistry. 4 credits

ESE511 Advanced Aquatic Chemistry

Role of complexing ligands in solution chemistry; redox chemistry in natural systems; pe-pH diagram construction and use; solid/solution interfacial considerations; the electrical double layer; and selected advanced topics. Prerequisite: ESE 510. 4 credits (*not offered 2000/2001*)

ESE514 Distribution and Fate of Organic Pollutants

Discussion of the physico-chemical processes that control the behavior and fate of organic chemicals in the environment. Introduction considers all environmental compartments, water, soil, and air, and partitioning between those phases. Recommended prerequisite: ESE 510. 4 credits

ESE516 Chemical Degradation and Remediation

A thorough introduction to the transformation reactions that contribute to the fate of organic substances in the environment. The course covers pathways, mechanisms and kinetics of hydrolysis, oxidation, reduction, elimination, conjugation, etc. Treatment is balanced to reflect the importance of these processes in all types of environmental waters ranging from engineered systems to groundwater, surface water, rain, and fog. Recommended preparation: ESE 511 and ESE 514. 4 credits (*not offered 2000/2001*)

ESE530 Transport Processes

An introductory course in the physics of transport processes in the natural environment. The course examines heat, mass, and momentum transport via conservation principles and the Reynolds Transport Theorem, but strongly emphasizes the environmental applications of these processes. Example studies include atmospheric and oceanic circulation, flow and dispersion in rivers, and heat budgets for lakes and reservoirs. 4 credits

ESE532 Coastal Flow and Transport

Introduction to long wave flow and transport in estuaries and coasts. Selected case studies are used to define a range of coastal and land-margin issues. Relevant physical, chemical, or biological processes then are discussed systematically. For some of the processes, numerical modeling and field data analysis also are discussed. Prerequisites: Advanced calculus and ESE 530. 4 credits (*not offered 2000/2001*)

ESE534 Modeling Coastal Flow and Transport

Description of state-of-the-art modeling principles and techniques for simulation of flow and of conservative and nonconservative transport in coasts and estuaries. Students have the opportunity to model an actual coastal system through a hands-on term project that includes a realistic sequence of modeling steps: data analysis, grid generation, flow modeling, modeling of conservative transport, and modeling of nonconservative transport. Prerequisites: ESE 500, ESE 532. 4 credits (*not offered 2000/2001*)

ESE537 Methods in Oceanography

This course covers the fundamentals of processing estuarine and coastal oceanographic data, including time series (e.g., surface elevation, currents, and winds) and data obtained from vessels

(e.g., profile and bathymetric data). 2 credits (*not offered 2000/2001*)

ESE538 Introduction to Environmental Forecasting Systems

This course addresses the composition and novel uses of observation and forecasting systems towards the enhanced understanding and management of natural resources. Students are exposed to a novel, cross-disciplinary culture for understanding and interacting with environmental systems. This culture relies heavily on "real-time" generation of modeling and observational data, which are integrated and distributed through information networks designed to bring the right environmental information at the right time to the right user. Prerequisite: Instructor permission. 2 credits

ESE539 Methods in Estuarine Oceanography: Field Observation

This course covers the fundamentals of estuarine and coastal oceanographic data collection using ves-sels and remotely moored equipment. Topics include vessel logistics and sampling, navigation systems, interfacing of instruments with personal computers, types of moorings and their deployment and recovery, and telemetry. 2 credits (*not offered 2000/2001*)

ESE540 Subsurface Hydrology

Hydrologic cycle infiltration theory; principles of unsaturated and saturated flow in the subsurface; well hydraulics; analytical models of drawdown, capture zones and velocity plots; porous media characterization methods and tools. 4 credits

ESE541 Groundwater Modeling

Applied groundwater modeling using finite difference and finite element methods. Introduction to numerical methods for solving the partial differential equations for saturated and unsaturated subsurface flow. Model execution and calibration. Prerequisite: ESE 540. 4 credits

ESE542 Contaminant Hydrology

Processes controlling subsurface contaminant movement in porous and fractured media, including groundwater flow, dispersion, diffusion, sorption, and degradation. Parameter estimation, mathematical and laboratory modeling of aquifers is also covered. 4 credits

ESE543 Modeling in Contaminant Hydrogeology

This course is designed to be taken concurrently with ESE 542. It emphasizes the hands-on use of common mathematical models for groundwater flow and transport (e.g., MODFLOW, RANDOMWALK, SUMATRA) to examine real groundwater contamination problems. Prerequisite: ESE 542. 4 credits

ESE550 Environmental Microbiology

Introduction to microbiology, with emphasis on the role of microbes in the environment. Natural cycles of matter as influenced by plants and microbes, and man's effect on these cycles. Fates of man-made compounds; water quality issues. 4 credits

ESE554 Biodegradation and Bioremediation

A process-oriented survey of microbially mediated transformations of organic pollutants. Transformations occurring in the natural environment as well as in remediation technologies are considered. Emphasis is on the pollutant properties, micro-biological factors, and medium properties that determine the pathways and kinetics of bio-degradation. Recommended preparation:

ESE 550. 4 credits (*not offered 2000/2001 as a separate class, but combined with ESE 550*)

ESE560 Environmental Soil Science

Soil physics, chemistry, and microbiology; soil development, soil description and mapping, soils and land use, agricultural and urban forestry; soil-plant relationships for environmental restoration; soil process modeling. Prerequisites: ESE 510 and ESE 550. 4 credits

ESE562 Ecosystem Ecology

Principles of ecology and of ecosystem process, description, and measurement, with emphasis on ecosystem health assessment. Simulation modeling of ecosystem processes; transport and transformation. 4 credits

ESE570 Principles of Toxicology and Risk Assessment

This course applies toxicological principles to both human and ecological risk assessments. The principles and methodologies for risk assessments are presented within a regulatory context. Topics include hazard identification, exposure assessment, LD50, dose-response relationships, deterministic and probabilistic risk assessments, responses of various receptors to different contaminants, and environmental management decisions. Suggested preparation: ESE 504. 3 credits

ESE58X Special Topics

Typically involves a scholarly and critical review of an advanced scientific topic by one or more students together with one or more faculty members. Requirements of the student typically include a written review paper and/or a seminar to be given as part of ESE 599. Selection of this course for credit and the topic to be investigated must be approved by the Student's Program Committee. Variable and repetitive credit.

ESE580 Ecosystem Management and Restoration

This course will provide an overview of ecosystem management and restoration at the regional scale. It will follow the hydrologic cycle from upland watersheds through streams, rivers and estuaries to the ocean and will track important system parameters such as water flow and temperature. The course is designed as the first of a two-quarter sequence with the second quarter focused on more detailed aspects of management and restoration within specific ecosystems. 2 credits

ESE 581-A Partitioning of Organic Chemicals: Basic Principles

Discussion of basic organic chemistry. Presentation of the theory underlying vapor pressure, solubility, and Henry's Gas Law Constant. Calculation of activity coefficients by UNIFAC. 2 credits

ESE 581-B Partitioning of Organic Chemicals: In the Environment

Presentation of the theory governing a) $\log K_{oc}$ vs. \log solubility relationships; and b) $\log K_{oc}$ vs. $\log K_{ow}$ relationships. Retardation in porous media systems. Effects of suspended colloids on retardation in porous systems. 2 credits

ESE586 Environmental Law and Regulation

A survey of environmental law and regulation concepts essential to practicing scientists and

engineers. Topics covered include the theory and practice of environmental regulation, environmental litigation, and legislation including Superfund (CERCLA), the Clean Water Act, the Resource Conservation and Recovery Act (RCRA), the Clean Air Act, and the Toxic Substances Control Act (TSCA). 3 credits

ESE587 Clean Air Act Laws and Regulations

A thorough introduction to the Clean Air Act in its federal and state permutations, as well as the detailed regulations guiding the Act's implementation. The course focuses on the practical aspects of statutory and regulatory interpretation, application to specific facilities, and negotiation of Clean Air Act issues with EPA and the states. 2 credits (*not offered 2000/2001*)

ESE589 Special Topics: Advanced Topics in Field Sampling and Analysis

An intensive 6-week course that links field processes with theory from previous lecture material. Approximately 2 weeks are spent at site locations where students critically examine current techniques for collecting surface water, groundwater, and soil samples to characterize chemical, biological, and physical properties. Laboratory methods for analyzing organic and inorganic chemicals are included. Students work in teams on projects to collect and evaluate data, write reports, and make recommendations for future management of the sites. Anticipate overnight travel. variable credits

ESE599 Environmental Science Seminar

Weekly seminars by invited guests on all aspects of environmental science, and by ESE faculty and students on their research. Visitors are welcome. Schedules are available on the World Wide Web at <http://www.ese.ogi.edu/seminars/>, or by request at info@ese.ogi.edu. 1 credit

ESE600 Research

Variable and repetitive credit.

ESE610 Nonthesis Research

Supervised research as a component of the nonthesis M.S. degree. The plan of research and final deliverables must be approved by the research advisor and the Student Program Committee. Deliverables include a written report and/or seminar given as part of ESE 599. A maximum of 8 credits from ESE 610 and ESE 620 can be applied to a degree. Variable and repetitive credit.

ESE620 Professional Internship

This course provides the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers.

Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. International students need to submit appropriate paperwork for the Immigration and Naturalization Service. Variable and repetitive credit

ESE700 M.S. Thesis Research

Research toward the master's thesis. Variable and repetitive credit.

ESE800 Ph.D. Dissertation Research

Research toward the dissertation for the Ph.D. degree after completing the comprehensive examinations.. Variable and repetitive credit.

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Department of Management in Science and Technology

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admissions and degree requirements

Admission Requirements

Admission requirements are the same as the general requirements for the institution. In addition, the MST department requires:

- A bachelor's, master's, or doctoral degree from an accredited institution
- A recommended cumulative undergraduate grade point average of 3.0
- A minimum of two years of full-time work experience—preferably at the professional, supervisory or managerial level—in a technical, scientific, business, or related area
- Three letters of recommendation, one of which must come from an employer or supervisor
- Recommended TOEFL score of 625 if English is not the applicant's first language. Scores are not required for students who earned an undergraduate degree in the United States.
- GMAT or GRE scores are not required, except under certain circumstances.



Part-time students may apply for admission to the M.S. program during any quarter.

► [Click here to apply on-line for admission to OGI.](#)

Degree Requirements

MST offers a nonthesis Masters of Science in Management in Science and Technology. Students elect one of three areas of concentration within the degree program:

- [Managing the Technology Company](#)
- [Computational Finance](#)
- [Managing in the Software Industries.](#)

Students must complete 52 credits with an average of 'B' or better; up to four courses taken in the department prior to matriculation may be used toward the degree requirements.

MST Core Sequence

All M.S. students must take the master's degree core sequence, consisting of the following courses or their equivalent (34 credits). The courses listed below are offered both on-campus and on-line. Either is acceptable for the M.S. in Management in Science and Technology degree.

MST Core Course Sequence

(34 credits)

MST501/501D' Managerial and Financial Accounting for Science & Technology	4 credits
MST502/502D' Financial Management	4 credits
MST503/503D' Marketing in Science and Technology	4 credits
MST510/510D' Principles and Trends in Technology Management	3 credits
MST512/512D' Project Management	3 credits
MST513/513D' Manufacturing Practices and Management	3 credits
MST520/520D' Managing in Science and Technology	4 credits
MST530/530D' Strategic Management and Planning	4 credits
MST 550D* Project in Management in Science and Technology	4 credits
MST590/590D' Effective Business Writing for Management (OR)	1 credit
MST591/590D' Professional Writing for Non-native Speakers with dept. approval (4 workshops at .25 credits each)	1 credit

* Indicates an online course that has not yet been developed, but is scheduled to be offered within the next few terms.

' Indicates a course that is also offered online in one-credit modules. A maximum of 12 modules is permitted for M.S. degree credits. [Click here to see the section on modules.](#)

MANAGING THE TECHNOLOGY COMPANY AREA OF EMPHASIS

1. MST CORE (listed above)
2. MANAGING THE TECHNOLOGY COMPANY CORE (9 credits)

Choose three of:

MST511/511D' Quality Management	3 credits
MST514/514D' Issues in R&D Management	3 credits
MST522/522D' Building Effective Organizations in Science and Technology	3 credits
MST540/540D' International Management in Science and Technology	3 credits
MST541/541D* Seminar in Leadership Development	3 credits

3. SUGGESTED ELECTIVES (9 credits)

Any course in the above list not already taken and/or any of the following:

MST521/521D' Human Resource Management in Science and Technology	3 credits
MST531/531D* Software Commercialization	3 credits
MST542/542D* Seminar in Social Issues in Management	3 credits
MST58X/58XD' Special Topics	variable

ECE555	Engineering Optimization	4 credits
ECE577	Principles for Technology Development and Introduction to Manufacturing	3 credits
ESE504	Uncertainty Analysis	4 credits
ESE586	Environmental Law and Regulation	3 credits
CSE503	Software Process Practicum	4 credits
CSE549	Applied Business Forecasting	3 credits
CSE568	Empirical Research Methods	3 credits
CSE570	Principles of Modern Finance	3 credits
CSE571	Investment and Portfolio Management	3 credits
CSE572	Global Markets & Foreign Exchange	3 credits
CSE573	Options and Futures	3 credits
CSE574	Advanced Derivatives Modeling	3 credits
CSE575	Risk Management	3 credits
CSE577	Financial Time-Series Analysis	3 credits
CSE578	Financial Markets, Price Behavior and Technical Trading	3 credits
CSE579	Advanced Numerical Computing in Finance	3 credits

Students may petition the MST department for elective credit for other OGI academic courses relevant to the theory or practice of management.

* Indicates an online course that has not yet been developed, but is scheduled to be offered within the next few terms.

' Indicates a course that is also offered online in one-credit modules. A maximum of 12 modules is permitted for M.S. degree credits. [Click here to see the section on modules.](#)

COMPUTATIONAL FINANCE AREA OF EMPHASIS

1. MST CORE (listed above)
2. COMPUTATIONAL FINANCE CORE (18 credits)

Required: (Choose 6 of the following:)

CSE570	Principles of Modern Finance	3 credits
CSE571	Investment and Portfolio Management	3 credits
CSE572	Global Markets and Foreign Exchange	3 credits
CSE573	Options and Futures	3 credits
CSE574	Options and Futures II	3 credits
CSE575	Risk Management	3 credits
CSE577	Financial Time-Series Analysis	3 credits
CSE578	Financial Markets, Price Behavior and Technical Trading	3 credits
CSE579	Advanced Numerical Computing in Finance	3 credits

Students should note that tuition for the [CSE Computational Finance](#) courses listed above is higher than for other OGI courses.

MANAGING IN THE SOFTWARE INDUSTRIES AREA OF EMPHASIS

1. MST CORE (listed above)
2. MANAGING IN THE SOFTWARE INDUSTRIES CORE (6 credits)

Required:

MST531/531D*	Software Commercialization	3 credits
CSE500	Introduction to Software Engineering	3 credits

3. SUGGESTED ELECTIVES (12 credits)

Choose four of the following:

CSE503	Software Process Practicum	4 credits
CSE504	Object-Oriented Analysis and Design	3 credits
CSE514	Introduction to Database Systems	3 credits
CSE518	Software Design and Development	3 credits
CSE560	Symbolic Approaches to Artificial Intelligence	3 credits
CSE564^	Models of Human-Computer Interaction	3 credits
CSE567^	Developing User-Oriented Systems	3 credits
MST511/511D'	Quality Management	3 credits
MST522/522D'	Building Effective Organizations in Science and Technology	3 credits
MST540/540D'	International Management in Science and Technology	3 credits
MST541/541D	Seminar in Leadership Development	3 credits

Students may petition the MST department head for elective credits for other OGI academic courses relevant to the theory or practice of management.

* Indicates an online course that has not yet been developed.

^ Credit will be given for no more than one of the ^ courses in part 3.

' Indicates a course that is also offered online in one-credit modules. A maximum of 12 modules is permitted for M.S. degree credits. [Click here to see the section on modules.](#)

Modules

MST offers courses in 1-credit online module "courselets." A maximum of 12 modules is permitted for M.S. degree credits. Students should take due care to ensure they can complete courses (three modules equal one 3-credit course, four modules equal one 4-credit course) without going over the 12-module limit. A course is considered complete when all modules with the same first three numbers have been completed; for example, completing MST 501.1 D, MST 501.2 D, MST 501.3 D

and MST 501.4 D is equivalent to taking MST 501D.

The following are offered as 1-credit online modules:

Course No. Title

MST 501.1 D	Making Sense of Financials
MST 501.2 D	Cost Accounting
MST 501.3 D	Capital Budgeting
MST 501.4 D	Costing Techniques for Product Development
MST 502.1 D	Corporate Finance: Assessing and Predicting
MST 502.2 D*	Financing the Enterprise
MST 502.3 D*	Strengthening Shareholder Wealth
MST 502.4 D*	Valuation & Financial Performance
MST 503.1 D	High Tech Marketing Basics
MST 503.2 D*	Pricing and the Product Life Cycle
MST 503.3 D	Promotion and Place in the Marketing Mix
MST 503.4 D*	Promotion and Place in the Marketing Mix: Implementing the Plan
MST 510.1 D	Managing Technological Risk
MST 510.2 D	Optimizing Technology Transfer
MST 510.3 D*	Technology Fusion & its Consequences
MST 511.1 D*	Quality Management & Continuous Improvement
MST 511.2 D*	Quality Management & Corporate Culture
MST 511.3 D*	Implementing Quality Management
MST 512.1 D*	Initiating Winning Projects
MST 512.2 D	Implementing Winning Projects
MST 512.3 D*	Evaluating Winning Projects
MST 514.1 D	R&D: Reducing Time to Market
MST 514.2 D	Cross-Functional R&D Management
MST 514.3 D*	R&D Strategy and Resource Management
MST 521.1 D*	Managing High Performance Teams
MST 521.2 D*	Recruiting and Motivating High Performance Teams
MST 521.3 D*	Measuring Employee Performance
MST 522.1 D*	Organizational Design in the New Economy
MST 522.2 D*	Communication & Change Management
MST 522.3 D*	Reengineering the Organization
MST 530.1 D*	Strategy Management
MST 530.2 D*	Positioning and Strategic Planning
MST 530.3 D	Playing the Strategy Game
MST 530.4 D*	Implementing the Strategic Plan
MST 540.1 D*	Free Trade in Global Markets
MST 540.2 D	Global Business: Negotiation, Culture, and Management
MST 540.3 D*	Global Business: Financial and Resource Management
MST 581.1 D*	The Power of Strategic Alliances
MST 581.2 D*	Structuring the Strategic Alliance
MST 581.3 D*	Strategic Alliances: A Case Study
MST 590.1 D	Business Writing
MST 591.1 D	Business Writing for Non-Native English Speakers

* Indicates an online course that has not yet been developed.

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FRED YOUNG PHILLIPS

Professor and Department Head

Ph.D., Management Science/Business Administration

The University of Texas at Austin, 1978

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RESEARCH INTERESTS

Market research, marketing innovative and high-technology products, managing the new product development process, incubation and commercialization of new technologies, strategic and innovative business use of computers.

REPRESENTATIVE PUBLICATIONS

P. Brockett, A. Charnes, W.W. Cooper, D.B. Learner & F. Phillips, "Marketing Research Unification by Information Theoretic Methods," *European Journal of Operations Research*, 84, pp. 310-329 (1995).

S. Thore, G. Kozmetsky & F. Phillips, "DEA of Financial Statements Data: The U.S. Computer Industry," *Journal of Productivity Analysis*, 5(3), 229 (1994).

F. Phillips, "Conditional Information Characterization of Brand Shifting in a Hierarchical Market Structure," *Journal of the Operational Research Society*, 45(8), 901 (1994).

F. Phillips, R.K. Srivastava & R.S. Springer, "Project Valuation and Scheduling with Recourse," *Proceedings of PICMET 91, the Portland International Conference on Management of Engineering and Technology* (IEEE Engineering Management Society) (October 1991).

F. Phillips & B. Golany, "A Heuristic for Estimating Densities from Data in Histogram Form," *Decision Sciences*, 24(4), 862-881 (1990).

F. Phillips, A. Donoho, W. Keep, W. Mayberry, J.M. McCann, K. Shapiro & D. Smith, "Electronically Connecting Retailers and Customers: Summary of an Expert Roundtable," *Journal of Shopping Center Research*, 4(2), 63-94 (1997).



NICOLE STECKLER

Associate Professor
Ph.D., Organizational Behavior
Harvard University, 1990
steckler@admin.ogi.edu

RESEARCH INTERESTS

Tools for diagnosing and improving leadership effectiveness, roles in implementing (and resisting) organizational change, interpersonal communication and influence in organizations, and lateral coordination in organizations.

REPRESENTATIVE PUBLICATIONS

N.A. Steckler & N. Fondas, "Building Team Leader Effectiveness: A Diagnostic Tool," Organizational Dynamics, Vol. 23, 20-35 (Winter/Spring 1995).

J. White, S. Jacobson, R. Jacques, N. Fondas & N.A. Steckler, "You Just Don't Understand: Gendered Interaction and the Process of 'Doing' Organizational Scholarship," Journal of Management Inquiry, 4(4), p. 370-379 (December 1995).

N.A. Steckler & A. Donnellon, "Review of Peter K. Manning's 'Organizational Communication'," Academy of Management Review, Vol. 18, 374-377 (1993).

N.A. Steckler & R. Rosenthal, "Sex Differences in Nonverbal and Verbal Communication with Bosses, Peers, and Subordinates," Journal of Applied Psychology, Vol. 70, 157-163 (1985).

N.C. Ware, N.A. Steckler & J. Leserman, "Undergraduate women: Who chooses a science major?" Journal of Higher Education, Vol. 56, 73-84 (1985).



ALVIN H. TONG

Professor of Management
Ph.D., Electrical Engineering
University of Minnesota, 1967
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Alvin Tong, Ph.D., Professor of Management, teaches Project Management and the Capstone Project (Business Plan) course, and has been with MST since 1996. Alvin served as a mentor for the 1999 student team, ArtCentral that won first place in the New Venture Championship 2000, a national/international business plan competition held in Beaverton, Oregon.

Alvin has thirty years of working experience in the computer and related industry, which includes serving as chief operating officer of Acer, Inc., a Taiwan-based manufacturer of personal computers. While with Acer, he also served as President of their venture capital arm. Prior to Acer, he worked for fourteen years at IBM. In addition, he also had a significant role as the first deputy director-general of the Hsin-chu Science-Based Industrial Park (SBIP) in Taiwan. Alvin has conducted numerous management-training seminars and is frequently invited to speak and lecture on the subject of Globalization and Hi-Tech Science-Based Industrial Parks.



DR. C. NEIL BERGLUND

Professor/Joint Appointment with Electrical and Computer Engineering, Oregon
Graduate Institute of Science and Technology
Ph.D., Electrical Engineering
Stanford University, 1964
berglund@ece.ogi.edu

RESEARCH INTERESTS

Management of technology, and advanced lithography for semiconductor fabrication.

REPRESENTATIVE PUBLICATIONS

J. Ye, M. Takac, C.N. Berglund, G. Owen & R.F.W. Pease, "An Exact Algorithm for the Self-Calibration of Precision X-Y Stages," Conference on Electron, Ion & Photon Beam Technology & Nanofabrication (May 1996).

M.T. Takac, J. Ye, M.R. Raugh, R.F.W. Pease, C.N. Berglund & G. Owen, "Self-Calibration in Two Dimensions: The Experiment," 1996 SPIE International Symposium on Microlithography (March 1996).

W. Wang, J. Ye, A.B. Owen, C.N. Berglund & R.F.W. Pease, "Adaptive Metrology: An Economical Strategy for Judging the Acceptability of a Mask Pattern," J. Vac. Sci. Technol., B13(6) (November/December 1995).

J. Ye, C.N. Berglund & R.F.W. Pease, "Field Distortion Characterization Using Linewidth or Pitch Measurement," J. Vac. Sci. Technol. B13(6) (November/December 1995).

J. Ye, C.N. Berglund, J. Robinson & R.F.W. Pease, "A Review of Mask Errors on a Variety of Pattern Generators," IEEE Transactions on Semiconductor Manufacturing, 8(3), pp. 319-325 (August 1995).

J. Ingino, G. Owen, C.N. Berglund, R. Browning & R.F.W. Pease, "Workpiece Charging in Electron Beam Lithography," J. Vac. Sci. Technol., B12(3), pp. 1367-1371 (May/June 1994).

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course offerings

MST501/501D Managerial and Financial Accounting for Science and Technology

The course focuses on understanding and evaluating financial reports and information for use in making decisions, particularly as they pertain to managing in science, technology, engineering, and manufacturing. 4 credits

MST502/502D Financial Management for Science and Technology

The course combines a survey of the relevant aspects of micro- and macro-economics with in-depth study of key concepts in financial management of a firm, financial structure and financial analysis of the firm, working-capital management and short- and long-term financing. Particular attention is paid to valuation of investment alternatives through study of risk and rates of return, bond and stock valuation, and capital budgeting. The course is designed to achieve balance between understanding theoretical foundations and techniques of practical application.

Prerequisite: MST 501. 4 credits

MST503/503D Marketing in Science and Technology

The course introduces the graduate student to the full range of issues and activities involved in the marketing of technology-based products. The role of marketing within the organization is addressed, as are the key elements of an effective marketing program. The course is organized to cover the full product introduction process, from market identification to product conception and definition, to market research, to competitive analysis, and ultimately, to product launch. Topics include pricing, sales and distribution alternatives, and marketing communications. To the extent possible, assignments utilize or draw from students' work experiences in technology, engineering, manufacturing, and science. 4 credits

MST510/510D Principles and Trends in Technology Management

This course is about how companies choose, acquire, and develop the technologies that they use to develop, manufacture, deliver and support their products. We look at these practices both from the vendor and buyer points of view, and also consider internal technology development for internal use. Other topics addressed include profitably managing technology cycles; standards; technology forecasting; and the technology startup company. Related topics such as competitive analysis, managing researchers, and maintaining an innovative organizational atmosphere are dealt with in MST 503 and MST 514. The format includes lectures, discussions, guest speakers, and team and homework projects. 3 credits

MST511/511D Quality Management

The course covers total quality management (TQM) from the managerial vantage point-that is, both the behavioral and operations management aspects, excluding sophisticated statistical analysis, of TQM are addressed. Classroom discussion, based on the participants' experiences and the assigned readings from the text and cases, is the primary source of learning for many students. Lectures are used but generally as a basis for a facilitated discussion led by the instructor. The limitations of TQM also are discussed, given the inherent risks of excessive optimism associated with any social trend or perceived panacea. 3 credits

MST512/512D Project Management

The course focuses on the managerial aspects of project selection and management. Topics addressed include planning, design, scheduling, implementation, control, evaluation, and termination. 3 credits

MST513/513D Manufacturing Practices and Management

Topics covered include practices and trends in the overall design, analysis, organization, and control of manufacturing operations, as well as relationships with vendors, suppliers, and customers. 3 credits

MST514/514D Issues in R & D Management

Participants examine issues in managing R&D and technological innovation in an environment of increasing time- and competence-based competition, a competition that is simultaneously global and local in both markets and technology, where competitors draw on an existing technology base that supports incremental innovation through radical innovation, and where quality is a given. Particular attention is given to R&D management issues in integrating technology into business strategy and operations, managing internal development and external sourcing of technology, seeking competitive advantage through collaborative advantage, and building new technical competence as a part of every project.

Key trends, new conceptual frameworks, management tools and techniques, and best practices in R&D management are examined through presentation, interactive class discussions, selected readings, case studies, and a number of invited speakers from both small and large companies. 3 credits

MST520/520D Managing in Science and Technology

This course focuses on developing participants' ability to understand and influence human behavior. Four theory-based frames are elaborated and used for understanding human behavior.

Using the structural frame, we examine work design and redesign for individuals and groups, and consider the impact of restructuring. Using the human resource frame, we examine interpersonal and group dynamics, communication and creativity. Using the political frame, we consider power, conflict, and differences in the workplace. Using the symbolic frame, we examine the impact of individual leadership and corporate culture on organizational outcomes.

The course also examines the influence processes and network of relationships required for managing research scientists, engineers, and other professionals, as individuals and in teams, in a fast- changing environment. Self-assessment, networking, and developmental relationships are explored as means of developing influence and having impact within a technologically-driven organization. 4 credits

MST521/521D Human Resource Management in Science and Technology

This course focuses on the development, implementation, and evaluation of human resource management (HRM) systems, and the relationship between an organization's HRM practices and the organization's effectiveness and competitive success. Specifically, the course addresses the choices an organization must make in three HRM policy areas: organization of work and employee influence; personnel flows and development; and measurement and rewards. We consider the perspectives of both the line manager and the HRM specialist in examining these three policy areas. The course also includes a limited overview of employment law, with a particular focus on recent cases and changes in employment legislation. 3 credits

Topics covered include practices and trends in the overall design, analysis, organization, and control of manufacturing operations, as well as relationships with vendors, suppliers, and customers.

MST522/522D Building Effective Organizations in Science and Technology

This course focuses on designing effective organizations and managing change in organizations in which engineering, manufacturing, and/or scientific technologies are critical. Tools for assessing the need for reorganization and implementing structural changes are emphasized. The course pays special attention to organizing for lateral coordination and integration, as this is a required capability in technology-intensive organizations. Students are invited to consider the relationship between organizational theory and practice. A range of theoretical perspectives is reviewed, and students are encouraged to compile their own approach by combining those presented. Extensive use is made of cases and actual examples drawn from the readings and from course participants' experiences. Taking MST 520 first is recommended. 3 credits

MST530/530D Strategic Management and Planning

This course focuses on the analysis of the competitive environment and on the decision-making process leading to the formulation and implementation of strategy. Other topics include using time, knowledge, and technologies as competitive advantages, managing strategic change, and developing strategic plans. Prerequisites: MST 502, MST 503, MST 520. 4 credits

MST531/531D Software Commercialization

This course examines the structure of the software industry, and problems of marketing privately developed software and commercializing software from the government and nonprofit sector. Because the business models for hardware and software companies are quite different, the course focuses on the special problems of marketing, entrepreneurship, globalization, and alliances experienced by software firms. Relationships between marketing strategy and development strategy also are examined. 3 credits

MST540/540D International Management in Science and Technology

Topics in this course include trends in the conduct of international business, the international business environment, the operation of multinational enterprises, international technology transfer, and the special considerations associated with managing on the international level. 3 credits

MST541/540D Leadership and Negotiation

This course focuses on the negotiation and interpersonal communication skills required to exercise effective leadership. Topics include creating clarity about one's own values and mission, exercising influence through both formal and informal authority channels, and being a catalyst for change. 3 credits

MST542/542D Seminar in Social Issues in Management

This course focuses on ethical dilemmas, social issues and responsibilities, and government regulations and influences. First, the course examines different frameworks for individual decision making in an organizational setting. Next, the impact of organizational policies and practices, and the words and actions of managers, on the behavior of individuals within those organizations is examined. Finally, the course focuses on the relationship between organizations and the societies in which they operate. We consider the perspectives of key stakeholders, including government regulators, community representatives, customers, employees, managers, and stockholders, and examine different views on corporate social responsibility. 3 credits

MST550 Capstone Project: Business Plan

In the program's capstone course, students complete major integrative projects as members of teams. Prerequisites: MST512/MST512D, MST530/MST530D, and approval of instructor. 4 credits

MST58X/58XD Special Topics

Under this number, courses of particular relevance and interest to students and faculty are offered. Variable credits.

MST 580 Global Logistics and Financial Management

The global environment that characterizes the business world of today has pointed out the importance of developing strategies that go beyond the geographical boundaries of one country. Nowadays, it is not uncommon to see a company that develops a new product in the US manufactures it in Asia and sells it in Europe. Wage-rate differentials, expanding foreign markets, and improved transportation are breaking down barriers of time and space between countries forcing the logistics function to take a global dimension. Global logistics is the response to the increasing integration of international markets as firms try to remain competitive.

The emphasis of the course is the operations and logistics function in firms that source, produce, distribute and market in multiple nations. The management of logistics in such firms differs from its domestic counterpart along several key dimensions. First, there is the need to be able to identify and analyze factors that differ across nations, which influence the effectiveness of this function. These include worker productivity, process adaptability, governmental concerns, transportation availability, culture and soon. In addition, because of the distances involved, transportation and distribution are of greater significance. Finally, these geographically dispersed set of facilities and markets must be integrated and manage to enhance the strategy of the business unit. Therefore, some of the sessions of the course will focus on cross-national decisions and others will focus on managing across nations.

Although all functional areas will benefit from a global perspective, this course will also be built on a robust financial foundation to help students to develop analytical skills required from managers in companies committed to global markets doing business across borders. We will discuss one of the most current topics in global operations and logistics: risk management in global logistics. The concept of operating exposure as it is affected by the exchange rate risk, is one of the most underestimated factors in analyzing global markets. The mix of financial and operational hedging will be presented as an innovative strategy for benefiting the corporation over the long run in relation to sourcing strategies. However, the major theme throughout the course is that sourcing, manufacturing and distribution are of primary importance in the formulation of business and corporate strategy. We want to look at the strategic decisions within logistics as they impact the ability of the firm to achieve its selected overall strategies.

Topics to be covered are:

1. Global manufacturing strategies including development and implementation.
2. Global logistics planning including global sourcing and logistics.
3. Major financial risks a company faces when developing global strategies. 3 credits

MST 581 Commercialization Practicum

Students will have the opportunity to work in teams with real technologies. Student teams will produce assessments and plans for bringing new technologies to market using Vijay Jolly's Mind to Market Technology Commercialization and other frameworks such as a Total Life Cycle Planning approach. Wherever possible, industry advisors will mentor students in their area of expertise within the design, management and product manufacturing process. Each team adopts a real technology held by Batelle-Pacific Northwest Laboratories, OHSU, OGI,

Oregon Medical Laser Center, or others. Students will make one or more field trips to these institutions. The technologies may be in the areas of environmental, health, genetics, multimedia, computers or other fields.

Each team's final paper - which may include market research, a design for a manufacturable product, profiles of desired management teams, licensing plans, techno-marketing feasibility, and/or preliminary startup business plan, will be submitted to the institution that originated the technology. MST students may choose to use their 581 project as a preliminary exercise for the MST 550 Capstone Project.

Students will take a multi-disciplinary approach to the process of moving laboratory technologies to marketplace success. The course gives students insights and practical experience in the early stages of entrepreneurial technology commercialization, various aspects of company formation and finance, and technology licensing and intellectual property issues, by focusing on concept development, motivation of interest and resources, and early market assessment. 3 credits

MST 582 Opportunity and Environment: Market Research for Technology

The pace at which technology and the Internet have changed businesses and the overall economy has created a surge in the market research industry due to the growing need to understand and predict future changes. This course is designed to provide marketers, engineers and other business decision-makers with the fundamentals needed to gather and interpret market research data. Topics covered include survey design, sampling design, survey methodologies, data analysis techniques and data interpretation. Special focus will be applied to the technology industry and to the Internet as they relate to business-to-business and business-to-consumer research. 3 credits

MST 583 Strategies for Success in the Digital Economy

The purpose of this course is to equip the student with a practical and conceptual understanding of what it takes to develop and maintain a competitive advantage in the new economy. We will look at it from several perspectives. We will start by investigating the fundamental changes that the Internet and other technologies introduce in the economy and how this completely changes the rules of the competitive game. We will then look at how entire industries and activities are being transformed and why.

In the second part of the course we will look at strategy from several angles. The first one will address the question of what a company should consider to develop its competitive advantage and its competitive strategy. The second angle will address the Internet marketing side or how to go to market and rise to the top. The third angle is addressing the question of how successful companies organize and what they do to operate at the "speed of change." Students will use the learning they acquire to iteratively develop a business concept to be presented at the last session. The course will be supported by a Web site (where course materials and resources will be made available). We will also carry discussions off-line. Several executives from local companies have been invited to share their experience in the dot-com world. 4 credits

MST590/590D Effective Business Writing for Management

This course will review several aspects of conventional punctuation and grammar that address the needs of the participants. In addition, attention is given to stylistics for clear, concise communication necessary in business writing. Class size is limited to ten students. 1 credit

MST591/591D Professional Writing for Non-native Speakers

An intensive review of English grammar and sentence structure with a focus on formal English for professional purposes. Some attention to the academic essay as well as business writing. Class size is limited to ten students. No prerequisite. 1 credit

MST592A Oral Presentations Workshop- Beginning

The oral presentation workshops facilitate personal speaking style by addressing individual abilities and effective techniques. The workshops are limited to six students per session to ensure individual interaction for each student with the instructor. (.25 credit per workshop.)

MST592B Oral Presentations Workshop- Advanced

The oral presentation workshops facilitate personal speaking style by addressing individual abilities and effective techniques. The workshops are limited to six students per session to ensure individual interaction for each student with the instructor. (.25 credit per workshop.)

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