SEATTLE UNIVERSITY

School of Science and Engineering

Science and Engineering Project Center

PROJECTS DAY

MAY 31, 1996

Senior Design Projects 1995-96

WELCOME

On this, Projects Day 1996, we present the results of student work sponsored by industry and government, and developed by senior students in the science and engineering design program at Seattle University. This is a wonderful opportunity for our students to share with you the results of their hard work.

We are most grateful to our industrial and government sponsors — those who are old hands at sponsoring our projects, and also those who are new sponsors. It is a tribute to your faith in our students, and in the quality of their work, that you choose to invest your time people and resources in these projects.

The senior design experience is perhaps the most important learning experience of our students' career at Seattle University. Working in small groups, solving problems that don't have a unique solution, and being responsible to strict timelines, budgets, and outside agencies, are surely good preparations for the professional positions our seniors will soon fill.

This is the ninth year of the Science and Engineering Project Center. I congratulate all those within the school and outside, for making this Project Center the success it is today. Welcome all of you — and thank you for joining us today.

Kathleen Mailer, Dean
School of Science and Engineering

On behalf of our faculty and students, I also welcome you to Projects Day 1996, our annual presentation of design team results to sponsoring organizations, visitors, and friends. I am grateful for the encouragement and assistance provided by our Science and Engineering Advisory Board, and especially its Project Center Advisory Committee, in promoting the external sponsorship of our projects. I would also like to acknowledge the coordination efforts of professors Art Benedict in Civil and Environmental Engineering; Al Moser in Electrical Engineering; and Ray Murphy and Dennis Wiedemeier in Mechanical and Manufacturing Engineering and Sheridan Botts, contracts officer for the Project Center.

Special thanks go to the students in our engineering organizations who are your hosts today and who volunteer to carry out many of the tasks associated with our Projects Day celebration. These student societies are the American Society of Civil Engineers (ASCE), the American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers (IEEE), the National Society of Black Engineers (NSBE), the Society of Environmental Engineers and Scientists (SEES), the Society of Women Engineers (SWE), and Tau Beta Pi.

Patricia D. Daniels, Director
Science and Engineering Project Center

PROJECTS DAY

SCHAFER AUDITORIUM–MORNING

- United States Public Health Service ..... Rapid Environmental Assessment Project
- United States Public Health Service ..... Remote Data Retrieval and Storage System
- K2 ..... Ski and Snowboard Core Cutting Machine
- King County Parks, Planning and Resources ..... Tolt Pipeline Trail Bridge Design
- AT&T Wireless Services, Inc. ..... Portable Radio Frequency (RF) Signal Test Set
- Boeing Defense and Space Group ..... Thermal Analysis and Test Program of Multi-Chip Modules
- Cascade Design Automation ..... Standard Cell Variable Width Arithmetic Logic Unit
- Atlas Copco Robbins Company ..... Analysis of Gearbox Deflection
- Weyerhaeuser ..... Construction Materials from Pulp-Mill Inorganic Solid Residuals

SCHAFER AUDITORIUM–AFTERNOON

- US West New Vector Group ..... Cell Site Power Reduction
- US West New Vector Group ..... Cooling and Ventilation of Cell Sites
- Center for Design of Analog-Digital Integrated Circuits ..... Evaluation of Magnetic Core Models
- University of Washington, Harborview Medical Center ..... Power-Assisted Wheelchair
- GTE Telephone Operations ..... Joint Pole Billing Program

STIMSON ROOM–AFTERNOON

- Weyerhaeuser ..... Biological Stimulation for Solids Reduction
- Seattle City Light ..... Cedar Falls Penstock No. 6 Upper Bridge Abutment Protection
- Seattle City Light ..... Newhalem Creek Hydroelectric Project Trailrace Fish Barrier and Trail of the Cedars
- Rabanco ..... Rabanco Regional Landfill Extensions Area 5
- Parsons Brinckerhoff Quade & Douglas, Inc. ..... Sammamish Plateau Access Road

PROJECT NUMBER: CEE 96.3
PROJECT TITLE: Rapid Environmental Assessment Project
SPONSOR: United States Public Health Service
LIAISON ENGINEER Dr. Thomas Bonifield
FACULTY ADVISOR: Prof. Jean Jacoby
STUDENTS: Sandra Albertsen, Kristine Baldwin, Brent Brewer, Dan Enrico

DESCRIPTION:
The United States Public Health Service recognizes that the environmental conditions in air, water, and soil can have a direct effect on the health of humans. Seattle University students are conducting a multi-year project to develop a methodology for rapid assessment of physical, chemical, and biological factors in the environment. The design team has completed the first phase of this project by developing a protocol for monitoring fecal contamination in an aquatic medium. Indicators of fecal contamination, such as total coliform bacteria and *Escherichia coli*, are widely used to assess the suitability of water for domestic and commercial uses. The team provided data and parameters to an electrical engineering team to design a database that will utilize on-line remote sensing to enable rapid environmental assessment.

PROJECT NUMBER: EE 96.5
PROJECT TITLE: Remote Data Retrieval and Storage System
SPONSOR: United States Public Health Service
LIAISON ENGINEER: Dr. Thomas Bonifield
FACULTY ADVISOR: Prof. Al Moser
STUDENTS: Elias Nemr, Tuan Ngo, Alysa Rust, Yee Xiong

DESCRIPTION:
The United States Public Health Service asked Seattle University students to develop a methodology for physical, chemical, and biological monitoring of the environment on a real-time basis. The team obtained data and parameters from a civil and environmental engineering team, also working with the United States Public Health Service. This data was used to design the hardware and software to produce a laptop computer-based system for acquiring data from environmental sensors for storage, analysis and re-transmission. The software runs under Windows 3.1 and was designed with Visual C++. It allows manual entry of data as well as automated entry via the serial port. Data can also be displayed and/or transmitted to a host computer. The hardware provides an interface between the single serial port of the laptop computer and an array of environmental sensors: a Global Positioning Sensor (GPS) with serial interface, a temperature monitoring device with serial interface, and a hydrophone with analog interface. The hardware formats the data from all three sources and presents the data in a serial stream to the laptop.

PROJECT NUMBER: MME 96.2
PROJECT TITLE: Ski and Snowboard Core Cutting Machine
SPONSOR: K2 Corporation
LIAISON ENGINEER: Cameron Andrus, Anthony DeRocco
FACULTY ADVISOR: Prof. Greg Mason
STUDENTS: Charlie Lyford, Sereivuth Riem, Shane Sterling, Mark Stevens, Romy Widjaja

DESCRIPTION:
K2 currently has all their wood cores used inside skis and snowboards cut by an outside company using manually operated machines, since there are no automated machines on the market that will do the required task. This makes ski and snowboard design slow and difficult. K2 would like to be able to make prototype wood cores within the company, so the team designed and built an automated machine to cut wood cores. The machine is automated and computer controlled, allowing it to be programmable. Producing prototype wood cores is easier and faster as a result of the implementation of the core cutting machine.

PROJECT NUMBER: CEE 96.1
PROJECT TITLE: Tolt Pipeline Trail Bridge Design
SPONSOR: King County Parks, Planning, and Resources
LIAISON ENGINEER: Steve Massey
FACULTY ADVISOR: Prof. Richard Schwaegler
STUDENTS: Mike Armstrong, Michael Chamberlain, Nugraha Darma, Joseph Valdez

DESCRIPTION:
The King County Parks Department requested that the team develop designs for a bridge crossing over 155th Ave. NE near the Tolt Pipeline in Woodinville, Washington. The bridge will accommodate different types of trail users, such as horseback riders, bicyclists, and pedestrians as well as a 3/4 ton maintenance pick-up truck. In addition, the Seattle Water Department required a minimum of 12 feet between the bridge and the Tolt Pipeline. The design process included developing alternatives that deal with these constraints and criteria, determining site constraints, and meeting the standards set by agencies of jurisdiction.

PROJECT NUMBER: EE 96.1
PROJECT TITLE: Portable Radio Frequency (RF) Signal Test Set
SPONSOR: AT&T Wireless Services, Inc.
LIAISON ENGINEER: Thomas S. Gorton
FACULTY ADVISOR: Prof. Gary Erickson
STUDENTS: Barbara Billones, Steve Bueno, Jonathan Madamba, Scott Ziebarth

DESCRIPTION:
The team designed a low-cost test equipment set for use by AT&T Wireless' field engineers. The test set will be used to monitor field strength and communications channel availability at locations of interest. The test set consists of a standard Ericsson cellular telephone, already issued to field engineers, and a laptop computer running a Windows program designed by the team in Visual Basic. The program reads serial data from the cellular phone and displays it for the engineer's analysis. The test set will replace a bulky and expensive test set currently in use.

PROJECT NUMBER: MME 96.1
PROJECT TITLE: Thermal Analysis and Test Program of Multi-Chip Modules
SPONSOR: Boeing Defense and Space Group
LIAISON ENGINEER: Devin W. Hersey
FACULTY ADVISOR: Prof. Amanie Abdelmessih
STUDENTS: George Demopoulus, Susan LaPoint, Brian Loeffler, Benny Tjutarwy

DESCRIPTION:
A multi-chip module (MCM) consists of numerous electrical components mounted on a single package (the package can be as small as approximately 1 x 1 cm). More than half of MCM failures are caused by thermal stresses, so design engineers attempt to design MCM's to remove heat from the package rapidly. Thermal modeling identifies which designs are successful in that respect. According to Boeing, the models they are presently using are based on simplified, unvalidated assumptions. The team has obtained experimental data by instrumenting the MCM's with thermocouples and thermally scanning the components during operation. The experimental test results were compared with finite element and spread sheet models to determine the validity of the models. The team then varied testing and model assumptions to get the best possible models.

PROJECT NUMBER: EE 96.2
PROJECT TITLE: Standard Cell Variable Width Arithmetic Logic Unit
SPONSOR: Cascade Design Automation
LIAISON ENGINEER: Hossein Ahmadnia, Martin Scoones
FACULTY ADVISOR: Prof. Paul Neudorfer
STUDENTS: Freddie Davacol, Grant Erickson, Brian Wallace, Amy Westberg

DESCRIPTION:
The team designed a compiler to build a standard cell arithmetic logic unit (ALU). The module will be used with Epoch, Cascade Design's silicon compiler, which designs integrated circuits. The team programmed a variable width ALU compiler with bitwidths ranging from 4 to 128 bits, using the Compiler Development System (CDS). The team's compiler functionality includes addition, subtraction, shift, and all logical functions. The design also gives the user the option of adding a second level of carry-lookahead logic to increase speed performance. This standard cell implementation of an ALU will complement Cascade's existing datapath ALU. Standard cells result in more efficient layouts since they can be packed closer together than datapath cells and can be easily combined with other standard cell groups.

PROJECT NUMBER: MME 96.3
PROJECT TITLE: Analysis of Gearbox Deflection
SPONSOR: Atlas Copco Robbins Company
LIAISON ENGINEER: John Gibson, Jay McNeely, Keith Wohlwend
FACULTY ADVISOR: Prof. Dennis Wiedemeier
STUDENTS: Ray Henderson, Eric Joslyn, Darrin Noe, Lisa Wickwire

DESCRIPTION:
The Atlas-Copco Robbins Company makes large tunnel boring machines. Multiple 400-horsepower motors turn spur gears which drive a large ring gear mounted directly to the cutter head. The cutter head can be up to 45 feet in diameter and have a maximum of 10,000,000 foot pounds of torque. Ring gear tooth failure during operation results in expensive down time required to replace the ring gear. Preliminary tests indicate that failures occur due to single overload situations and not as a result of fatigue. The project was to analyze the maximum loading, and the gear assembly itself, to determine the maximum deflections of the drive gearbox at the spur gear and the resulting non-uniform tooth loading between the spur and ring gears. If this non-uniform loading could produce stresses large enough to cause the observed failure, the team determined whether a more rigid gearbox assembly mount would correct the problem.

PROJECT NUMBER: CEE 96.7
PROJECT TITLE: Construction Materials from Pulp-Mill Inorganic Solid Residuals
SPONSOR: Weyerhaeuser
LIAISON ENGINEER: Manfred K. Buder
FACULTY ADVISOR: Prof. Nirmala Gnanapragasam
STUDENTS: Ellen Barayuga, Rebecca Cushman, Vangie Paraico, Lisa Richards

DESCRIPTION:
Pulp and paper mills generate large quantities of inorganic solid residual streams, including hog fuel boiler bottom ash, green liquor dregs, and lime slaker grits. These highly alkaline waste products are currently disposed of in landfills. The purpose of this project was to identify and demonstrate feasible construction uses for these residual streams. Construction applications were considered from a technical, economic, and environmental standpoint. The team performed an in-depth literature review, concept screening, and selection. Laboratory analysis included compression, strength, and leaching tests.

PROJECT NUMBER: EE 96.6
PROJECT TITLE: Cell Site Power Reduction
SPONSOR: US WEST NewVector Group
LIAISON ENGINEER: Jeremy Donimirski
FACULTY ADVISOR: Prof. Xusheng Chen
STUDENTS: Manuel Harrison Ang, Parminder Dhaliwal, Steve Gittings, Jason Tanko

DESCRIPTION:
Current levels of power draw at US WEST NewVector's cellular radio repeater stations, more commonly called cell sites, are nearing the capacity of the on-site residential level power services. Rather than upgrade to commercial power services, power distribution within the cell site was evaluated. The result found reasonably efficient usage of the main power rectifiers, such that installing costly equipment to turn off one rectifier during light demand would not achieve payback in several years. Any further efficiencies would be found in more intrusive measures relating to individual components of the site.

PROJECT NUMBER: MME 96.4
PROJECT TITLE: Cooling and Ventilation of Cell Sites
SPONSOR: US WEST NewVector Group
LIAISON ENGINEER: Jeremy Donimirski
FACULTY ADVISOR: Prof. Jack Mattingly
STUDENTS: Glenn Hitosis, Shinichiro Imamura, Andy Moore, John O'Brien

DESCRIPTION:
The US WEST NewVector Group asked Seattle University to find more efficient methods for cooling their cellular phone sites. The majority of the electrical energy used by the telecommunications equipment in the cell sites is converted into heat and dissipated into the rooms. This heat must be removed since the phone equipment has temperature and humidity ranges that cannot be exceeded. Four issues were presented to the design team. First, to determine the total amount of heat being generated in the cell sites, and therefore the amount of heat that needs to be removed from the rooms. Second, to verify the effectiveness of the economizer operation of the air conditioners. Third, to investigate devices available to improve the cooling efficiency of the existing air conditioner units. Fourth, to look at alternative methods of cooling the cell sites. After evaluation, the team recommended the best methods.

PROJECT NUMBER: EE 96.3
PROJECT TITLE: Evaluation of Magnetic Core Models
SPONSOR: Center For Design of Analog-Digital Integrated Circuits
LIAISON ENGINEER: Dr. Peter Lauritzen, Howard Smith
FACULTY ADVISOR: Prof. Margarita Takach
STUDENTS: Nicholas Harris, Michael John Napalan, Abiye Nurelegne

DESCRIPTION:
In support of the need for accurate simulation of circuits used in power electronics design, the team evaluated models for magnetic cores, a common component in power electronics, and compared those models with data obtained on real magnetic cores in lab tests. The models tested were the Hodgdon model, the Jiles-Atherton model, and two curve fitting models. The coding of the models was done in the MAST modeling language for implementation in SABER. The data from lab tests was captured with programs written in the LabWindows development system.

PROJECT NUMBER: MME 96.5
PROJECT TITLE: Power-Assisted Wheelchair
SPONSOR: University of Washington, Harborview Medical Center
LIAISON ENGINEER: Anthony J. Margherita, M.D.
FACULTY ADVISOR: Prof. Ananda Cousins
STUDENTS: Greg Benson, Tony Eyre, Bill Potts, Greg Verge

DESCRIPTION:
Electric wheelchairs are expensive, don't provide exercise for users, and require users to purchase costly special vans to transport them. With these concerns, Harborview Medical Center asked Seattle University students to enhance a manually powered wheelchair to provide an alternative to electric wheelchairs for people with some mobility in their torso and arms. Students developed a design to measure the amount of effort the user makes to propel the chair, and provide power assistance proportional to that effort. After evaluating several alternatives, the team decided that a motor connected to a "fifth wheel" below the seat would be the easiest and most cost effective solution to this challenge. They designed a kit to integrate a special motor and wheel to a manually powered wheelchair, and built a prototype power assist wheelchair.

PROJECT NUMBER: EE 96.4
PROJECT TITLE: Joint Pole Billing Program
SPONSOR: GTE Telephone Operations
LIAISON ENGINEER: Dennis Keller, Mark Simonson, Ralph Yunker,
FACULTY ADVISOR: Prof. Al Moser,
STUDENTS: Mylene Almuete, Conrad Kawabata, Serge Takoulo-Tedjong, Simon Yandila

DESCRIPTION:
GTE Northwest has a variety of systems for tracking the use of "telephone" poles, whether they are owned by GTE and space rented to the power company and/or cable company, or whether they are owned by a power company and GTE rents space for telephone lines. The team designed a database system, with operator interface, that will serve as a unified recording/reporting system for all of GTE Northwest's regional operations. This system runs under Windows 3.1 and was developed with the aid of Visual Dbase 5.5. Data from the system can also be used with GTE's geographic information system, IGS.

STIMSON ROOM AFTERNOON

PROJECT NUMBER: CEE 96.8
PROJECT TITLE: Biological Stimulation For Solids Reduction
SPONSOR: Weyerhaeuser
LIAISON ENGINEER: Harold Rupert
FACULTY ADVISOR: Prof. Art Benedict
STUDENTS: Mark Batho, Douglas Carter, Karen Comings, Laurie Line, Paul Van Slyke

DESCRIPTION:
This project involved the evaluation of commercially available biological stimulation products used on existing landfilled primary solids–byproducts of the Kraft Pulp and Paper process used at the Weyerhaeuser site on Smith Island in Everett, Washington. Through biological stimulation, natural bacterial degradation rates increase and corresponding volume reductions occur within the primary solids. Two products were evaluated through a pilot study focusing on volume reductions that occured within the treated primary solids. A comprehensive analysis of the pilot study was included in the final report to Weyerhaeuser. This report included analytical results of the effectiveness and feasability of each product, and recommendations with full-scale application specifications.

PROJECT NUMBER: CEE 96.5
PROJECT TITLE: Cedar Falls Penstock No. 6 Upper Bridge Abutment Protection
SPONSOR: Seattle City Light
LIAISON ENGINEER: Walter Davis
FACULTY ADVISOR: Prof. Robert Cornwell
STUDENTS: Pam Branch, Kyle Crate, Gina Hidalgo, Brian Rahal

DESCRIPTION:
During high flows in the Cedar River, the soil near the upper bridge abutment of Penstock (water pipeline) No. 6 can become saturated. Uneven settlement of the soil beneath the foundation supports for the penstock has eliminated the bearing between the penstock and its supports, resulting in a large section of the penstock being inadequately supported. The team was asked to develop a design to prevent loss of penstock support in the event of future high flow events. During the course of the project, hydraulic models, structural designs, construction schedules, and cost estimates were developed. Deliverables to Seattle City Light included documentation of hydraulic models, construction drawings and technical specifications, quantity take-offs, and cost estimates.

PROJECT NUMBER: CEE 96.6
PROJECT TITLE: Newhalem Creek Hydroelectric Project Tailrace Fish Barrier and Trail of the Cedars
SPONSOR: Seattle City Light
LIAISON ENGINEER: Daniel O'Sullivan
FACULTY ADVISOR: Prof. Robert Cornwell
STUDENTS: Norman Cabiao, Robert Cruz, Lance Lum

DESCRIPTION:
The Newhalem Hydroelectric Powerhouse Project and the Trail of the Cedars are located in the North Cascades National Forest in Newhalem, Washington. Seattle City Light has requested designs to upgrade the trail and powerhouse to be more easily accessible by persons utilizing wheelchairs, and be in compliance with the Americans With Disabilities Act. The team designed a plan to reduce grades on the trail, build ramps to the powerhouse viewing platform, and enlarged viewing windows on the powerhouse to provide easy access by those using wheelchairs. The design team was also asked to expand on a structural design of a tailrace fish barrier. A preliminary geometric design of the barrier was provided by Seattle City Light. The team efforts were directed toward developing the final structural design drawings. Deliverables to Seattle City Light included construction drawings and technical specifications, quantity take-offs, and cost estimates.

PROJECT NUMBER: CEE 96.4
PROJECT TITLE: Rabanco Regional Landfill Extension Area 5
SPONSOR: Rabanco
LIAISON ENGINEER: Steven Harrison, Rick Morck
FACULTY ADVISOR: Prof. Nirmala Gnanapragasam
STUDENTS: Jeanette Brena, Andrew Hwangbo, Joseph Maramis-Tulong, Marcus Rivera

DESCRIPTION:
The team was asked to design an extension to the Roosevelt Regional Landfill. The extension, Area 5, must meet volume and capacity needs for the landfill for two years, 1998 and 1999. In addition, the extension must meet environmental requirements set by Washington Administrative Code WAC 173-351-300. To accomplish this, the team did a literature review, site selection and sizing, design investigation of the lining and leachate collection system, technical drawings and specifications, construction quality control plan, engineer's estimate, and budget.

PROJECT NUMBER: CEE 96.2
PROJECT TITLE: Sammamish Plateau Access Road Retaining Wall: Conceptual Design
SPONSOR: Parsons Brinckerhoff Quade and Douglas, Inc.
LIAISON ENGINEER: Kareem Greiss, Michael Horn, Susan K. Serres
FACULTY ADVISOR: Prof. Rolf Skrinde
STUDENTS: Cynthia Blazina, Marc Kirkpatrick, Danh Nguyen, Phi Nguyen

DESCRIPTION:
Parsons Brinckerhoff is involved in the design of a major thoroughfare, the Sammamish Plateau Access Road, that will run North to South through Issaquah. A large hillside covered with dense greenery will be cut by this proposed roadway. The resulting cut and fill will need to be supported by retaining structures. Throughout the project, the team evaluated various wall designs and roadway alignment alternatives. The team developed the conceptual design of an aesthetically pleasing, structurally sound, reasonably priced retaining wall system for this roadway.

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SPONSORING ORGANIZATIONS AND LIAISONS

We want to acknowledge with special thanks the organizations who sponsored engineering design projects in 1995-96, and especially the liaisons representing the sponsors, who worked with the students throughout the year. The time these liaison representatives spent in consultation with our design teams is much appreciated by the students and their faculty advisers. It is the liaisons who provide the history and background of each project, its relationship to other work in the sponsoring organization, and much of the technical direction that makes a project successful.

AT&T Wireless ..... Thomas S. Gorton

Atlas Copco Robbins Company ..... John Gibson, Jay McNeely, Keith Wohlwend

Boeing Defense and Space Group ..... Devin W. Hersey

Cascade Design Automation ..... Hossein Ahmadnia, Martin Scoones

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K2 ..... Cameron Andrus, Anthony DeRocco

King County ..... Steve Massey

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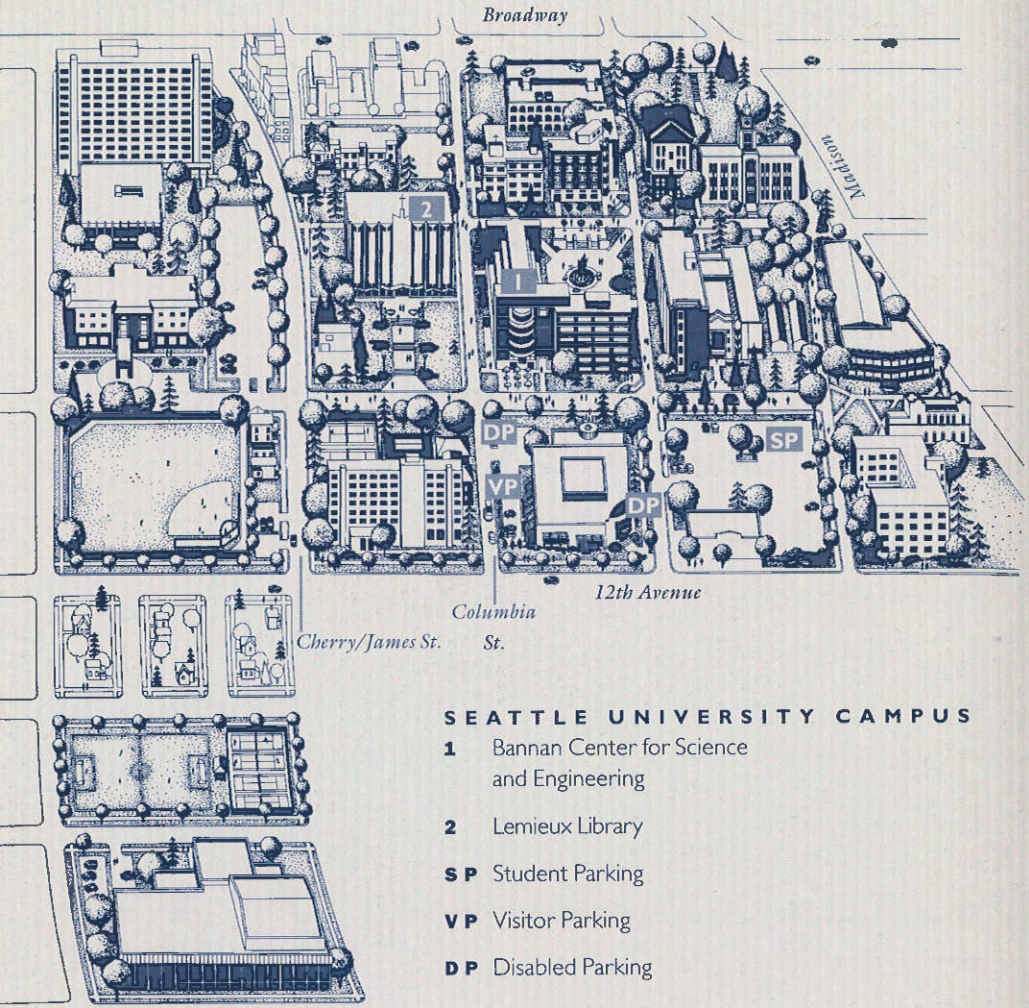

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