Mechanical Engineering Profile

This is the first in a series of articles to profile PSL departments.

The UW-Madison Physical Science Laboratory (PSL)'s mechanical engineering department consists of a team of engineers and drafters who design a variety of projects which range from very simple tools and equipment to complex multifunction instruments. Each member of the department is an expert in an area which determines the projects he or she will be assigned.

Fred Middleton, associate director, has been with PSL since 1976, and splits his time between administrative and engineering duties. The latter includes conceptual work on proposals, design for small projects and collaborative work on optical instrumentation.

Middleton and lead mechanical engineer Farshid Feyzi both work on proposals for new projects. Feyzi, who has been with PSL since 1983, spends 75% of his time on mechanical engineering and 25% on administrative duties. He keeps the engineers, drafters and mechanical shop working in unison.

When a new project comes in, Feyzi determines which engineers and drafters will work on it based on their area of expertise, past experience and previous customer relationships. The department also includes four mechanical engineers and four computer aided drafting (CAD) specialists.

Mechanical engineer Jeff Cherwinka* works primarily on high energy physics projects, but is also involved with plasma physics research (HSX) as well as coil analysis.

Lee Greenler has a PhD in mechanical engineering from UW-Madison. He recently joined PSL and is becoming involved in high energy and plasma physics work.

Mechanical engineer Ken Kriesel has expertise in the area of in-depth engineering analysis including heat transfer and stress analysis. He also has had considerable experience with optical instrumentation.

Bill Mason is a mechanical engineer with considerable optical instrumentation experience; he also has a vast background of mechanical design. According to Feyzi, Mason's expertise is the ability to immediately make a project look finished—an important quality in stereotactic radiotherapy devices and other equipment that will be used in hospitals.

The engineers collaborate on projects with the CAD specialists who also each have an area of expertise.

Glen Gregerson works on high energy physics projects, and is an expert in solid modeling, a 3D technique used for intricately detailed and complex projects.

(continued on page two)

PSL Designs Drill for Study of Neutrinos at South Pole

Researchers from UW-Madison and scientists from the Universities of California at Berkeley and Irvine are studying high energy particles known as neutrinos which have no charge, no mass and travel at the speed of light.

The study, which is located at the South Pole, is called Antarctic Muon and Neutrino Detector Array (AMANDA). AMANDA currently consists of four .5 meter diameter holes, each drilled one kilometer deep in the ice and filled with strings of detectors. (PSL mechanical engineer Bill Mason helped design the instrumentation, guidance module and hot water for the drill.) Neutrinos can be seen when the detectors monitor flashes of light given off by neutrinos as they collide with the ice.

The detectors have been placed at the South Pole so that the earth can be used as a shield to block out other radiation while scientists search for neutrinos in the northern sky that penetrate the earth.

The sources of neutrinos are believed to be pulsars, quasars and black holes. Scientists believe that by studying neutrinos, they will discover where these elusive objects originate.
PSL/SRC Business Services Implements New Accounting Software

By Mark Faber

The business services department is currently in the process of implementing a new fully integrated accounting system which will replace a manual system that has been used since the 1960's.

The software for this system, which runs on a Micro VAX 3100, was purchased from Computer Associates and includes general ledger, purchasing, fund accounting, accounts payable, job cost, labor distribution and inventory modules. These modules, when fully implemented, will provide much-needed improvements in efficiency of data handling, project and fund management and reporting capabilities.

The new system's job cost module will allow Work Breakdown Structures (WBS) to be utilized in managing complex projects undertaken by PSL or SRC. Each project can be broken down into tasks with budgets (cost and quantity) assigned to labor and no labor cost categories. Reporting will be greatly enhanced by the new system. Ad hoc reports which can take hours with the current system will take only minutes. Monthly financial statements and weekly reports will be generated automatically and will report costs and quantities by category. PSL labor, which is currently shown on the financial statements as one line item, will be listed by labor categories. Materials and services will also be reported by major category.

Testing of the new system is currently in progress with an estimated cut-over later this summer.

If you have PSL news that you would like to put in the next issue of The Observer, please submit it to Leanne Penfield via e-mail:

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Mechanical Engineering
(continued from page 1)

Amy Pagac frequently works with the Center for X-ray Lithography, and is currently collaborating with Bill Mason on the stereotactic radiotherapy project featured on page 3.

John Pippin has worked on almost all of the monochromators designed by PSL.

Al Riley is presently assigned to full-time support of the UW Synchrotron Radiation Center (SRC).

*Jeff Cherwinka recently left PSL for a position with the Laboratory of Nuclear Studies at Cornell.

Engineering Departments Receive New PCs

PSL's engineering departments recently received 12 new PCs which replaced the old VAX/VMS system.

PSL software engineer Gary De Clute said that the change was made because the departments' use of graphic oriented software determined the need for PCs.

De Clute also said that he is planning to upgrade the 12 other PCs used in various departments, enabling the system to be maintained more cost-efficiently.

He said that this will be accomplished by running Windows NT or Windows Version 4 using the Internet (TCP/IP network). He added that he is considering using NT Advanced Server as the core of the PC configuration, because it is compatible with the Internet.

De Clute said that this process, which began in September 1993, should take two to three years to complete.
PSL Designs Telescope for Study of Cherenkov Light at the South Pole

PSL mechanical engineer Ken Kriesel has been working with Robert Morse of the UW-Madison Physics Department on a project known as Gamma Ray Astronomy South Pole (GASP) for the past four years. GASP consists of a telescope at the South Pole which is used for observation of sources of Cherenkov light. Cherenkov light is radiation produced when high-energy particles enter a transparent medium in which the speed of light is slower than the particles are moving.

The South Pole location is ideal for GASP because the southern sky is particularly rich in potential gamma ray sources and the long polar night permits almost continuous observation of a source—up to 400 hours per month and up to 1700 hours per year. Long viewing time is important because very high energy (VHE) observations indicate that all known VHE sources are episodic in their emissions, producing short bursts of radiation of duration from 100 to 1000 seconds, with a duty cycle of no more than a few percent.

The almost continuous observation from the South Pole makes it easier to detect such episodes. Excellent winter viewing conditions—the average temperature is -60°C, there is no moisture in the air and very little wind, snow or cloudy weather—also make the South Pole an ideal location for observation.

How the Telescope Works

Light is collected by a multiple-mirror telescope pointed in the source direction and detected by photomultipliers (PMTs). High quality optics are not required, because the light signal is spatially diffuse—roughly 1 degree in width.

Each mirror is fitted at its focus with two PMTs, and apertures limit each PMT’s angular acceptance to about 1 degree. The PMTs are separated by 3 degrees and simultaneously monitor the source under study and the background from a nearby portion of the sky. The entire mirror and PMT system is enclosed in an insulated cylindrical barrel with a front face of plexiglass.

The bottom surfaces of the mirrors are heated and insulated to prevent frost and snow buildup. The insulated barrels serve to funnel the mirror heat and keep the enclosed region and the plexiglass entrance window above ambient air temperature and free of frost crystals.

Kriesel, who designed the telescope’s mount and drives, says that the project is interesting to work on. “There is a real emphasis on record-keeping because it’s so inconvenient to measure in parkas and mittens with flashlights,” he said.

The telescope for GASP installed at the South Pole.

PSL Designs Stereotactic Radiotherapy Hardware for Cancer Treatment

PSL mechanical engineer Bill Mason, in conjunction with the UW Human Oncology Department, recently designed hardware for a radiosurgery device at Wilkes-Barre Hospital in Scranton, PA. The device, called a Linac, is used for radio-surgery—a treatment for cancer.

The stereotactic radiotherapy hardware consists of a collimator, film holder, floor stand and phantom.

The collimator consists of mounting hardware for accurate attachment to the Linac, a set of interchangeable collimator slugs having different sized holes through radiation-blocking metal alloy for radiation beam sizing, an XY gimbaled collimator slug mounting that allows lateral and angular adjustments of the slug in order to adjust the beam precisely so that it impinges directly on the axis of Linac rotation and patient couch rotation.

The film holder attaches accurately to the collimator assembly and has an indexable sheet of film used for exposure to the beam emitting from the collimator slug. It is used before patient treatments to verify that the patient's head will be properly located for radiation treatment. It is a means of double checking the setting made on the patient's head restraint.

The floor stand mounts on either the patient's couch or a turntable to which the couch is attached. It holds an XYZ stage used for holding and positioning the patient's head frame and has accurate linear read outs of XY and Z positions. The XYZ coordinates of the head frame position the patient's head (held in the head frame) for treatment with the target area precisely located on the X axis of Linac rotation and Y axis of the patient's couch rotation, called the isocenter.

(continued on page 4)
Stereotactic Radiotherapy (continued from page 3)

The phantom is a three axis device having backward coordinates and readout from the XYZ head holder frame stage. It attaches to the patient's head frame stage before treatment. The phantom has a small metal ball accurately located at the isocenter when both sets of stages are set at zero. The patient's target coordinates are adjusted on the head frame XYZ stage which will locate the target area on the isocenter. The phantom has the same coordinates adjusted into position. Since they are backwards from the head frame stage, they cancel out if properly located. Through the use of the film holder and exposure of the film, the shadow of the small ball should be on the isocenter if the coordinates are properly adjusted.

This is a means of making a last check before treatment since an error of adjustment would be hazardous to the patient.

During radiosurgery the patient is positioned under the Linac. The Linac pivots on a horizontal axis coincident with the target area of the patient, giving a known diameter spot of radiation at the target area. In addition to gantry rotation on the horizontal axis that intersects the target area, the patient lies on a couch which pivots about a vertical axis that is also located at the target area. The intersection of the vertical axis of the patient's couch and the horizontal axis of the gantry define the isocenter which is also the location of the sized and collimated beam of radiation and the target (cancer) area.

By rotating both the gantry of the Linac and the patient couch, a series of arcs of radiation is made primarily on cancerous tissue. The use of this scanning method minimizes exposure of healthy tissue since the collimated beam of radiation always impinges on the target area and isocenter from different directions. This technique has been proven to be very effective in prolonging lives of patients with brain cancer. Radiosurgery is effective because it obliterates cancerous cells with a single, relatively high dose of radiation. The end result is clinically comparable to surgical removal of the tissue, but radiosurgery is less invasive, and recovery is quick. Patients can go home the same day that they receive treatment.