FermiNews

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Feynman Center Opens New Era for Fermilab Computing

by **Kevin A. Brown**

Turn back the calendar to the 1800s and imagine the excitement westward-bound settlers felt when they saw seemingly unlimited expanses of land available to them for development and growth. Viewed from their cramped conditions of 1988, Fermilab's Computing Department relived the essence of that feeling when the 74,000 square-foot Feynman Computing Center officially opened its doors on December 2, 1988, to meet Fermilab's computing space needs. Construction of the new center was funded by a portion of the $24.6 million, 4-year Fermilab Central Computing Upgrade Project (CCUP). The Department of Energy described the project's goals as "to increase five-fold the computing capacity available for scientific applications and to provide new space for these and related activities."

The CCUP was conceived under the direction of Al Brenner, previous head of the Computing Department. The project, in its last year, is is now directed by Computing Department Head Jeff Appel. This article, which focuses on the architectural evolution of the building and general building layout, is the first in a series of articles about the new center.

* * * *

"The Feynman Computing Center is, I think, a particularly successful adaptation of Dr. Wilson's artistic ideas," said Edward Crumpley *(Const. Engin. Serv.)*. Fermilab Director Emeritus Robert R. Wilson acted as architectural consultant to the project and Wayne Nestander, Head of Construction Engineering Services (CES), oversaw the architectural work. Crumpley, as Lead Architect, made sure that he designed a building that accurately reflected Dr. Wilson's artistic vision of the new center.

The whole process, from conception to completion, took a little more than four years. "It's extremely unusual how much of the architectural work was done here; it was quite an undertaking for a group the size of ours," Crumpley said. Throughout this process, Crumpley worked closely with Dr. Wilson. "During the very early planning stages of the building, Dr. Wilson had an idea of what the building might look like. We worked with him to combine his artistic approach with our functional requirements." **Continued on page 2**

Scientific Appointments

Fermilab Director Leon M. Lederman has, on the advice of the Fermilab Committee on Scientific Appointments, announced the following promotions:

From Applied Scientist I to Applied Scientist II: Herman Haggerty *(RD/Facil. Dept.)*; Peter O. Mazur *(Tech. Suppt./MTF)*; Leo Michelottti *(Accel. Div./Theory)*

From Scientist I to Scientist II: Charles M. Ankenbrandt *(Accel. Div./Theory)*; John E. Elias *(RD/CDF)*; R. Keith Ellis *(RD/Theory)*; Stephen D. Holmes *(Accel. Div./Accel.)*; Robert D. Kephart *(RD/CDF)*; Rajendran Raja *(RD/D0)*.

Congratulations to all.

Neural Nets Under Study

Bruce Denby, a Wilson Fellow in Fermilab's Computing Department (one of 10 Wilson Fellows currently doing research at the Lab), is devoting his Fellowship to working with neural networks, interconnected electronic circuits with the ability to rapidly solve complex problems. Neural networks, or "neural nets," are based on the biological nervous system, which consists of interconnecting neurons, or nerve cells. Each neuron has a cell body, an axon, and a dendrite. The typically single, long axon ends in short branches relatively far from the cell body, and generally carries impulses away from the cell body. In contrast, the short and branched dendrite carries impulses toward the cell body. A neural network is the technological analogue to these biological components.

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Crumpley explained that "as one of Dr. Wilson's 'landmark buildings,' many design elements in the Computing Center carry over from other Fermilab buildings." For example, "the pre-cast concrete panels reflect those at the Ramsey Auditorium, except that these are larger and not set at quite the same angle," and the semi-circular shape recalls the Auditorium's curve.

The Feynman Computing Center

An early challenge was developing detailed building plans. "We had to establish, among other things, how much space a certain kind of computer would require, where we would need access floors, and where cables would run from one floor to another." Crumpley emphasized the role team effort played in developing building plans. "We worked with CES mechanical and electrical engineers to develop environmental systems, and our people have done a spectacular job." He credited Steve Krstulovich *(Const. Engin. Serv.)* and his staff with designing an energy-efficient climate control system. "It's an extremely efficient building, and the Association of Energy Engineers awarded its annual Corporate Energy Management Award in recognition of the building's efficiency."

Crumpley recalled that even some of the apparently simple design decisions were difficult. "Dr. Wilson's design called for one side of the building to be an all-glass facade, but we weren't sure what kind of glass to use. We started out with the notion that it would be blue reflective glass." To help visualize such a facade, "We took Dr. Wilson on a tour of Chicago to look at buildings with different colors of glass. We saw too many unattractive buildings with such treatment, and as a result, we backed into the choice of gray reflective glass instead." In addition to resembling the gray glass in other Lab buildings, the reflective quality "helps to reduce the solar load."

Crumpley feels that, architecturally, the building is unique in two respects: the pre-cast panels and the smooth glass facade. "The panels are some of the largest pre-cast panels anywhere. They weigh 37.5 tons each and are about 48 feet long. Because of their size, one of the major concerns was getting them down the highway. And it's also very difficult to get one of those off the truck and into a vertical position." In contrast to the pre-cast panels, on the other side of the building, is a very sleek, all-glass facade with all-glass entries. "It's as though the entries were carved out of the glass."

In comparison to the relevant sections of the Department's original home in Wilson Hall, Jeff Appel said, the new three-story building increases available space by "a factor of two for each function." The building actually becomes two or three areas, secure from each other, and that's where the different floor levels helped to develop this security ability.

Jack MacNerland, building manager for the Center, pointed out that access to many of the Center's rooms is computer controlled and monitored. "Users have 24-hour access to the Center, but inside the building, many areas are limited to personnel with special cards. The cards are more convenient and offer greater security than easily-duplicated keys."

The first and second floors contain computing space and utility-support space. A portion of the first floor will be a user area with a nearby conference room. In the users' area, people can use a terminal and obtain a printout. Currently, much of the users' area is a large classroom. A major portion of the first floor houses attended computers and operations responsible for mounting computer tapes. The Fermilab-designed Advanced Computer Program systems are also on the first floor. This section is inaccessible to users. A walk down a short ramp on the first floor leads to a tape vault where, from wall to wall and ceiling to floor, racks store computer tapes. "As tape vaults go, this is quite large," explained Gene Dentino, Manager, Computer Operations. "This tape vault can accommodate approximately 180,000 tape reels. Right now, it houses the 35,000 tapes taken during the last fixed-target run. Alternatively, with higher-

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A year ago, when Denby would mention neural networks as a new approach to data analysis and parallel processing, "people thought that I had gone off the deep end; they assumed that you want to use real neurons. But from a high-energy physics standpoint, the neural network is simply a new approach to data analysis and parallel processing. It forces you to think in a completely parallel way. To get gains in processing speed, you have to go to parallel processing, and it's hard to get people to write parallel programs.

"It's not to say that we really understand how the brain works," Denby said, "but it seems that we can take a very large number of highly interconnected, simple electronic units and make them work in ways we're just beginning to explore. It's a form of parallel processing, but it's called fine-grained parallel processing, in that each of the processors is a very simple unit. In fact, each unit isn't really a processor, but an amplifier. And when one thinks of a interconnected collection of these units, it's clear why they're called neural networks, because they resemble the brain."

The concept of neural networks is not new. "Researchers have been studying neural networks for a long time, ever since people understood what biological neurons were, with the idea that science could use electronics to imitate biology. In the 1950s, there was a lot of interest in neural nets, but as is typical for many new areas of science, interest faded when the field didn't seem to advance rapidly." Nevertheless, "There are a lot of people who have been working on this for many years, even when it was unpopular, and they deserve a lot of credit."

Interest in neural nets resurfaced in the 1980s. "I'm not sure exactly what sparked this renewed interest, [but] there were a couple of papers written by John J. Hopfield, who is with the California Institute of Technology and AT&T Bell Laboratories, that focused on a particular approach or angle of attack that seemed to be very promising - optimization in neural networks.

"Within the past six or eight years some remarkable advances have been made. For instance, there have been a number of advances in learning algorithms in the past five years, and that's one of the most exciting aspects of neural networks - the ability to train them, much like training a person how to do something."

Denby believes that the recent surge of activity in the field is essentially a U.S. phenomenon, although "there's certainly excellent research in Europe and Japan. For example, Europe has a lot of new initiatives with the Esprit Project in parallel computing and information science.

Given the prospects for even more advanced technology for high-energy physics research at the SSC, "data rates are going to be much higher than anything anyone has worked with before. You really need to try and find ways to select interesting events and pull those events out of the background very, very quickly." This is where neural networks will be useful. "To select an interesting event, you have to do some kind of pattern recognition. We hope that the neural networks will be able to do that kind of pattern recognition very fast.

"My immediate goal is to build a prototype neural net that solves a high-energy physics problem, initially on a small scale, perhaps track finders or cluster finders. Some small-scale neural circuits have been built at Bell Labs and Caltech, so I'm pretty sure that the concept works." Right now, neural net research is akin to the early days of integrated-circuits research. The primary advantage of using neural networks in high-energy physics research is that "one would have an answer very quickly, in the sense of hundreds of nanoseconds.

"My road into neural networks came through an interest in track finding in particle physics. It has always been the case that pattern recognition is something that digital computers are not very good at. I read some articles, in popular magazines, about neural networks, and it seemed to me that neural nets were actually good at doing pattern recognition very fast."

Denby explained that building a neural-net circuit is difficult because he would need thousands of individual neurons to run a track reconstruction program, which is something he confirmed while in Orsay, France, at LAL (Laboratoire de l'Accélérateur Linéaire) working on an experiment at CERN. "I wrote a simulation to do track finding with neural networks and determined that the network would require at least 2000 neurons and 200,000 interconnections. Imagine building something on a silicon chip with all of those interconnecting wires." Although microprocessors have a large number of connections as well, "the neural net is a new kind of architecture, and nobody is really sure how to build them."

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Benefits Notes

TIAA Declares New Dividends

TIAA annuity dividends are declared for a year at a time. Dividends are credited to annuity accumulations as additional compound interest, over and above the contractual rate guarantee, which is 3% for current premiums. The dividends bring the total effective interest rates to the levels described below for the period March 1, 1989, through February 28, 1990. (Included for comparison are the interest rates for the period March 1, 1988, through February 28, 1989.)

	3/1/89-2/28/90		3/1/88-2/28/89	
Fund Applied	**Reg. Annuity**	**SRA**	**Reg. Annuity**	**SRA**
On & after 1/1/89	9.25%	9.00%		
1988	9.25%	9.00%	9.00%	8.75%
1986-1987	9.00%	9.00%	9.00%	9.00%
1985	10.50%	10.50%	10.75%	10.75%
1982-1984	10.75%	10.75%	11.25%	11.25%
1979-1981	9.75%	9.75%	10.00%	10.00%
Prior to 1979	9.00%	9.00%	9.25%	9.25%

Retirement: How Much Will I Get?

During the month of March, TIAA-CREF will be mailing the annual annuity report which illustrates your projected retirement benefits based upon certain assumptions. The report will enable participants to also project their retirement income using different earnings and inflation assumptions. The report is quite comprehensive. If you have any questions about the report or do not receive one by late March, you can contact TIAA-CREF at 1-800-842-2733. (EMPLOYEES WHO JOINED THE PLAN EFFECTIVE MARCH 1 WILL NOT GET AN ANNUITY REPORT THIS YEAR.) **- Paula Cashin**

Estimated value of U.S. stock taken off the market in 1988 due to mergers and acquisitions: **$131,000,000,000**

Estimated value of all new stock issued in 1988: **$22,000,000,000**

Portion of all corporate bonds currently outstanding in the U.S. that are junk bonds: **1/4** - *Harper's*

Recent Retirements

(NOTE: As some of these retirement dates will indicate, FermiNews *has been anything but up-to-date on retirements. Our apologies to those who retired several months ago and are just now receiving their long-overdue recognition.)*

Harold Satter (ID #275) began his career at Fermilab on September 24, 1968, and retired from the Lab on August 8, 1988. Beginning in January of 1969, Harold was with the Main Ring Power Supply Group, doing electromechanical work on bending magnets, power supplies, active filters, the Capacitor Tree, and the Energy Saver/Doubler systems. Harold's retirement plans, now well under way, include working on his house, traveling, and "looking for a less crowded place that I can afford."

Howard L. Hart (ID #646) joined the Lab on September 10, 1969, and retired effective November 30, 1988. Among his accomplishments at the Lab, Howard performed liaison work in the fabrication of the "AVIS" and "HERTZ" superconducting analytical magnets and assisted in the conversion of the Chicago Cyclotron Magnet from conventional to superconducting. He also was responsible for reconnecting the liquid helium control dewar to the superconducting solenoid used at the Collider Detector. Howard is building a house in Hot Springs Village, Arkansas. He also plans to travel the U.S., and do Christian missionary work.

Leonard M. Indykiewicz (ID #698) began his Fermilab career on October 27, 1969, and retired on the 29th of January 1989. As a member of the Meson and Proton Departments, and later the Mechanical Department, in the Research Division, Leonard worked on: septum coils, Kautzky valves, magnets, collimators, Experiment 605, the Meson target box, the toroid pile in the Meson M3 line, and the Meson vacuum, water, and cryogenic systems. Leonard plans to "Take every day as it comes and enjoy life!"

Portion of all single-family homes sold in the U.S. each year that are mobile homes: **1/4**

Total length of all U.S. interstate highways, in miles: **44,328**

Total length of all roads built during the Roman Empire, in miles: **49,000** - *Harper's* Index

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density data storage media, the first floor can house as many as 500,000 cartridges."

The second floor supports functional computer groups: the IBM administrative processor, the Digital Equipment Corporation VAX clusters, and the new Amdahl large-scale scientific computer. This floor houses the central processing units and their disk storage systems, and also the communication functions that feed back to the rest of the Lab.

The third floor houses support personnel from the Computing Department, including the Data Acquisition Hardware Groups, Computing Hardware Maintenance Group, the Instrument Repair Group, and the Physics Research Equipment Pool. If needed, the third floor can economically accommodate additional computing equipment. The third floor is accessible to Fermilab personnel during working hours. In the future, a library will complete the center's accommodations for the user community.

The Center meets and exceeds the expectations of those involved with its development. Appel feels that "the building is working very well; people are very happy." Others, like Crumpley, feel similarly: "It's a nice mixture of practicality and Dr. Wilson's aesthetic. A lot of good work went into it."

Congratulations to:

The Film Society Presents:

Tonight, March 10, at 8:00 p.m., in the Ramsey Auditorium: *That Sinking Feeling*, an "offbeat comedy directed by Bill Forsyth. High-school dropouts in Glasgow, bored with unemployment and poverty, devise a plan for an outrageous heist." $2 for adults, $.50 for kids.

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Denby believes that the field "isn't going to disappear tomorrow; just about every department in every university has somebody working on neural networks." Caltech created a new department a few years ago called Computing and Neural Systems, and they have people majoring in neural networking. The field also has a professional society, The International Neural Network Society, which publishes a journal. "The journal first came out last year, and the Society's first annual meeting in September generated more than 500 abstracts from all kinds of different fields," including work in Japan that involves automatic character recognition. "They're trying to recognize Chinese characters, and this would be useful for machines that could read hand-written characters. The people who do neural nets for a living are in somewhat of a bind because of all the 'gee-whiz' science that's not real." To help solve this problem, vigorous research that demonstrates simple, yet real applications of neural networks is necessary. In response to this, "at a neural-net conference to be held in June in Washington, D.C., one of the sessions will be on 'Real World Applications,' such as in image processing, robotics, and an autonomous land vehicle with a television camera and a neural network that communicates to the vehicle the location of the road's edges and obstacles. They're really pushing applications to demonstrate that the technology works."

Perhaps even more beneficial applications will be found in medical technology. "General image processing could also ultimately lead to an artificial eye for the blind, and robotics applications could improve artificial limbs," Denby pointed out. Neurons would be associated with specific joints, and the neural network would correlate the joints so that the arm could reach out for objects.

Applications in high-energy physics research could help the efforts of neural network researchers. "Track finding in a drift chamber is so simple compared to autonomous land vehicles; all we need to do is find the tracks. This simplicity may be attractive to the people who do this work for a living."

Regardless of the simplicity or complexity of potential neural network applications, researchers are striving to capture the essence of a biological process and apply it to computer technology. Denby's work demonstrates the growing support for this research, and through it, "the potential advances in physics and other fields are enormous." **- Kevin A. Brown**

Trudy's News from NALREC

Our February **Social Hour** was a lot of fun, and congrats go out to Tom Regan & Co. for a job well done. We have quite a schedule of activities lined up, as follows:

Easter Egg Hunt - Saturday, March 18, at 1:00 p.m. for employees', visitors', and security contractors' children up to age 8. Kids are asked to bring a basket or bag for their loot. The Easter Bunny will be there, as will a clown with balloons.

Some time in March (watch for posters) we'll have another **Social Hour**, this one hosted by the "Italian Stallions," Dominick Carullo and John Satti. They promise excellent food and refreshments.

April looks like the month for the ever-popular **Monte Carlo Night**. Bob Shovan is a pro at putting this event together. Gary Smith is working on a Maywood Park **Racing Evening**. Watch for the ubiquitous posters.

Jo Baaske and Glenn Lee are planning an **Old Timers' Party** for May (the month). I'm not sure if it's a party for old people or for people who have been at the Lab a long time, but everyone will be invited. Rumor has it that the food will priced as if the last 10 or 20 years never happened.

Tom Regan (again?) is arranging a **Hard Times Party** for June, and Joe Morgan is planning a trip to Wrigley Field, hopefully when the Cubs are there playing baseball.

As you can see, NALREC has a full schedule of events through June. If you have any questions or comments, please call me at ext. 3228 or call Jesse Guerra at ext. 4305. **- Trudy Kramer**

Total distance driven each year worldwide, expressed in light-years: **.5**

Average number of hours that Americans say they feel "romantic" each day: **1**

Number of weed species that have developed a resistance to herbicides since 1968: **70** - *Harper's*

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FOR SALE

Motorized Vehicles:

1986 MUSTANG LX HATCHBACK, white, w/V6 engine, factory T-tops, auto. trans., A/C, premium factory stereo/cassette, full power incl. windows and locks, tilt, cruise, new tires and wire wheels, alarm, transferable warranty, extra clean, now $7495. Call Jon at ext. 3281 or 355-7075 evenings and weekends.

1983 MERCURY LYNX LS, only 41,000 miles, good body and engine, 4-cyl., 2-barrel carb., 2-tone blue, loaded. $2600 or best offer. Call Joe at ext. 3846 or 897-3592.

Miscellaneous:

JBL SOUND SYSTEM, professional PA system speakers and horns. Great sound, can handle at least up to 400 watts. Horns are Model 2370A, drivers are Model 2425J, cross-overs are Model 3110A. Also, 18-in. JBL front-loaded speakers. Will sell for $400, call Tony, (312) 968-4462.

FOUR P235/70 x 15 WHITE LETTERED TIRES, $40. KITCHEN TABLE, corner booth style, 36 in. x 36 in. w/1 chair and 2 benches, $50. LEVOLOR RIVIERA MINI-BLINDS, two 47 in. x 64-1/4 in., reddish brown, $25 ea., two for $40; one 43-1/4 in. x 43 in., burnt orange, $15; two 38-3/4 in. x 82 in., cream (patio door), $25 ea., two for $40. Call Ed Dijak at 690-1145 after 5:00 p.m.

SNOW THROWER, 6 h.p., self propelled, four forward speeds, one power reverse, excellent condition, $300. Call George at ext. 4129 or (312) 416-3875.

OVAL BRAIDED RUG, 8 ft x 6 ft, colors: rust, green, and brown; in good condition. Call Linda at ext. 3777 or 897-2377 after 6:00 p.m.

SEARS RADIAL-ARM SAW, 10 in., digital readout, 1 year old, $325. Call Ron at ext. 3095.

PIT GROUP (FURNITURE), beige, 10 pieces, will sell pieces separately, $20 each piece or best offer. Call Mark at ext. 4339 or 393-6427.

CANOE, 17-ft Old Town Canadienne, bought in '85, red fiberglass, black vinyl gunwales, like new, used only four times. $800/best offer. Call Bob Ducar, ext. 4040.

COMPLETE SATELLITE SYSTEM, 10-1/2-ft mesh dish, tracker 4 plus positioner, Drake receiver, remote control, cable, needs electronic work, $600 or best offer. Call Greg, ext. 3011 or 557-2523.