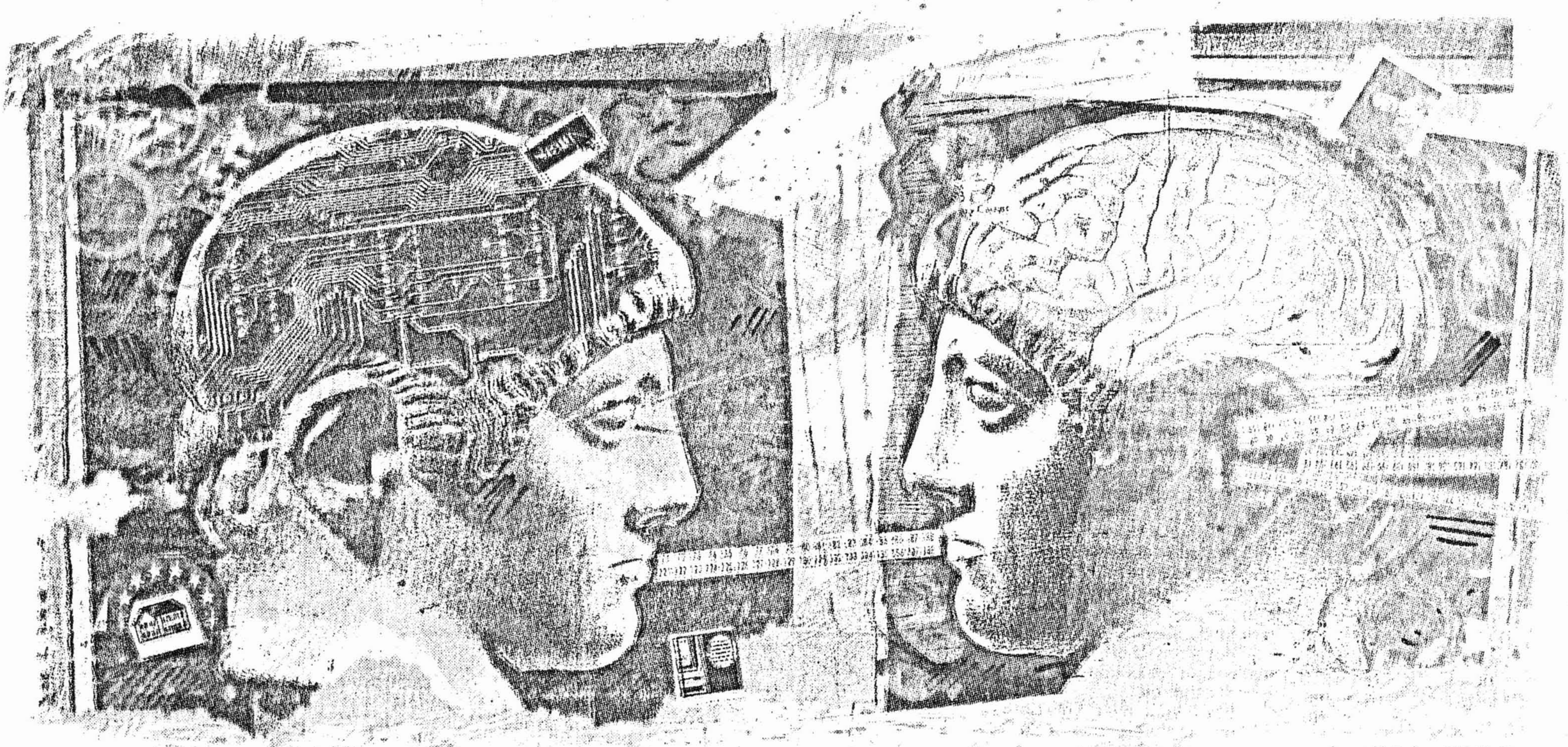
Monday, June 17, 1991 The Seattle Times

DISCOVERY

SCIENCE IN OUR TIMES



James McFarlane / Seattle Times

Power matchup

COMPUTERS

Neural networks are the product of work to imitate "the most complicated and sophisticated thing on the planet" — the brain. At this stage, they can't compete with human brain power, but research and development goes on.

by Hill Williams
Times science reporter

It was man against machine. Lloyd Reed, with seven years' experience in a complex job, competed against an upstart computer that had learned all it knew in only two days.

When it was over, Reed's job was safe. But the computer, programmed in eerie similarity to a human brain, had performed impressively.

Reed is power scheduler for Puget Power. Each day, after weighing a list of variables, he gives the company his prediction of how much power it will need to meet the next day's demand.

The computer made its own predictions during the test period, from November through March. It was one of the Pacific Northwest's first trials of what's known as a neural network in which a computer can train itself by learning from its own mistakes.

"I felt all along that no computer, no matter how sophisticated, could do what I do,' Reed said. "Computers are great at crunching numbers, but they have a hard time dealing with the odd things that affect power demand."

He was right. In the cold spell following the December snowstorm, the computer failed miserably to predict power load, which on one morning with the thermometer showing 13 degrees Fahrenheit set a company record.

But the neural network, set up by electrical-engineering professors and graduate students at the University of Washington, showed promise. For the five-month test, Reed's average error was 4.6 percent. The neural network's average error was 4 percent.

"But the network did much worse (than Reed's forecasts) during the December cold spell," said Casey Brace, a senior engineer at Puget Power. "And, of course, those are a utility's critical periods."

The computer was trained in somewhat the same way a human accumulates experience.

Brace spent several months digging up information to put together a day-by-day picture of the company's experience in meeting power demands during the past five years. It included the day of the week, the date, the weather, special circumstances such as holidays and anything else that affects demand. The information included what the power load had actually been for each day.

It took two days for UW scientists to feed Brace's information into the computer.

Then, unlike a conventional computer that works according to rules set by humans, the neural network began a process somewhat similar to the way a

Please see **NEURAL** on D 3

Neural networks get close to the real thing:

NEURAL

continued from D 1

child builds up the body of knowledge upon which adults base decisions.

In an oversimplified description, here is what happened: The neural network analyzed each daily example compiled from company records — the day of the week, the weather and any other factors affecting power use, even bans on wood burning during air-pollution episodes.

Then the network made its best guess at predicting the power demand for each day and compared its own prediction to the demand actually met by the company. The network calculated its own error, made adjustments and tried again.

It repeated the process — each taking maybe a millionth of a second — thousands of times, as often as its human instructors had told it to. Each time, the network would make adjustments to try to decrease its own error.

The network was running other days simultaneously, making predictions based on conditions specific to the day, calculating its error, adjusting and trying again, improving its accuracy.

For the competition, Reed and the computer based their predictions on the same information, daily weather forecasts and other factors.

"It's an exciting technology, the ability (of the network) to gain wisdom from experience," said Robert Marks, a professor in the UW's department of electrical engineering. The department is one of the nation's leaders in development of neural networks.

Neural networks are an attempt to imitate the human brain, described by one expert as "the most complicated and sophisticated thing on the planet."

But, at best, they are a poor imitation simply because scientists have almost no idea how the brain works.

The brain is composed of at least 10 billion nerve cells, or neurons. Each neuron has thousands of connections with other neurons. Electrochemical impulses travel between neurons as the brain receives information, sorts it out and acts on it.

An artificial neural network is composed of a collection of processing elements, the equivalent of neurons. Each processing element has a memory in which it stores

Neural networks forum

Experts in neural networking will gather in Seattle for a major conference July 8-12.

The International Joint Conference on Neural Networks will be at the Washington State Convention and Trade Center. Speakers will discuss industrial and research applications for the sophisticated computer technology.

The conference is sponsored by the International Neural Network Society and the Institute of Electrical and Electronics Engineers. Robert Marks, a University of Washington professor of electrical engineering, is president of the institute's neural-networks council.

content of Antarctica's snow and ice, critical information if the climate warms and the planet's biggest ice pack begins to melt.

Tsang is feeding the neural network data recorded by NASA satellites on flights over the frozen continent. He hopes the network will train itself to interpret the information — microwave-frequency emissions from the ground — to produce maps of Antarctica showing the extent of ice and snow, ice depth and water content.

So far, Tsang says, progress is "very encouraging in interpreting a vast amount of data very rapidly."

The Japanese, whose written language makes keyboard communication difficult, are interested in using neural networks to teach computers to understand human speech.

At Stanford University, a researcher put a neural network in the driver's seat of a tractor-trailer truck simulator and taught it to back the trailer to a loading dock, a challenge even for skilled humans.

After thousands of tries, the network learned to position the trailer perfectly, even when starting from a jack-knifed position.

Finance companies are interested in the possibility of training neural networks to evaluate loan or mortgage applications.

"The amazing thing is that it doesn't matter what information

brain power

you're giving the network – interest rates, mortgage defaults or weather and power load – you use the same technique, the same learning algorithm," said Puget Power's Brace. (An algorithm is the set of mathematical rules a computer uses to solve problems.)

Brace admits the man-computer competition reminded him of the legend of John Henry – the worker who died while pitting his information, and is connected to many other processing elements so all of them can send and receive signals.

"A problem with neural networks is that they take a long time to train," Marks said. "You have to show them what to learn thousands and thousands of times."

Today's neural networks are software programs that run on conventional computers, a time-consuming process. But the introduction of neural-network chips, which will move the processing function from software to hardware, promises much greater speed. The UW's electrical-engineering department has been selected as a test center for the new chips.

A neural network's special talent is learning to recognize patterns, as it did in finding relationships between Puget Power's electrical demand and the weather, a job beyond the capability of regular computers.

Leung Tsang, a UW electrical-engineering professor, hopes to use that talent by training a neural network to figure out the water strength with a sledgehammer against that of a steam drill. But Reed, the power scheduler, is not intimidated.

"I hope they find a system that really works well," he said. "I could use it as a tool, especially on the days that are the most difficult to predict, when the weather is changing rapidly.

"The thing to remember is that any prediction – human or computer – is only as good as the weather forecast."

And Brace keeps things in perspective with the observation that even the most promising artificial neural networks don't have the brain power of a house fly.

"House flies may not be intelligent," Brace said. "But with only about 1,000 brain cells, they can recognize food and danger, and they can fly.

"With a network of, say, 10,000 cells, we might be able to use neural networks to control robots. But that's a long way off."