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INVENTIONS OF THE YEAR

WHAT'S NEW

ROBERT CLARK FOR TIME

INSIDE VIEW: A FIRST

THE PROCESS OF INVENTION IS AN ENDLESS CHURN OF ACTIVITY that has little respect for the calendar. But in an effort to celebrate what has become a binge of industrial and scientific creativity around the world, the editors of TIME have locked the creative achievements of the year 2000 into freeze-frame and selected three Inventions of the Year. They are from the areas of **CONSUMER TECHNOLOGY, MEDICAL SCIENCE** and **BASIC INDUSTRY.**

We define an invention as something new, created by human ingenuity. It is not a discovery of a natural phenomenon that already exists. It is not merely a product of convergence, technology's latest buzz word used to describe the combining of existing technologies. Yet as our first two choices illustrate, the art of making two or more technologies work together often requires a new invention—even if it is just a complex line of computer code.

The course of invention, from concept to commercial use, almost always runs over many years, so we limited our list of candidates to products that have become available to their ultimate users during the calendar year 2000. Many of these were granted patents several or more years ago. Some fascinating products that are already demonstrably successful nonetheless missed the cut because they won't reach consumers until early 2001. Because the yield from our survey was far more than these three inventions, we are including a gallery featuring dozens of other products, devices and ideas. Some are serious in their impact; some are just fun. Most are available now, but others are still just a few steps short of making their debut.

Which is all the more reason for us to do this again next year.

—By Barrett Seaman

a winning combination

Two Americans working in the Alps come up with a plan to merge two widely used scanning devices—the PET and the CT—into one

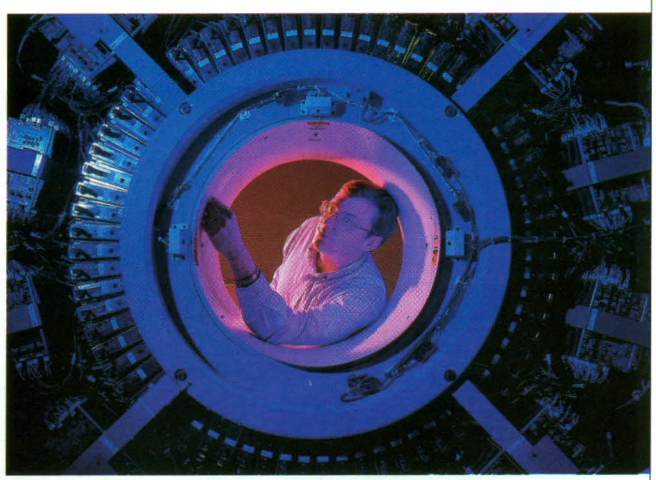
BY LEON JAROFF

THE IDEA CAME OUT OF LEFT field. Electrical engineer Ronald Nutt and physicist David Townsend, working at the University of Geneva in Switzerland, had just taken the cover off their newly developed metabolic-imaging machine and were admiring its innards when an oncology surgeon happened by. "You have a lot of space between those detectors," he offered. "You ought to try to put something in there that would be useful."

At the time, eight years ago, PET (positron emission tomography) machines, which can reveal subtle metabolic processes such as tumor growth, and CT (computerized tomography) scanners, which show precise anatomical details, were already in widespread medical use. But doctors, especially cancer surgeons, were often frustrated in their attempts to match the two different scans to determine, for example, the precise location of a tumor in relation to an organ or to the spinal column. There seemed to be no better way than simply "eyeballing" the two separate images.

That is, until Nutt and Townsend had their epiphany in the Alps. Last October the U.S. Food and Drug Administration approved the marketing of a combination PET/CT machine, the first medical-imaging device that simultaneously and clearly reveals both anatomical details and metabolic processes within the body. By early next year the new scanners will be installed at Manhattan's Memorial Sloan-Kettering Cancer Center, Indiana University, the University of Iowa and other medical facilities.

Others had attempted, with little success, to match the two different images by using computer algorithms as a way to unify data from CT and PET scans made at different times and in different settings. "The problem is that the body is kind of a flimsy structure," says Nutt, co-founder of CTI, the Knoxville, Tenn., imaging company that is gearing up to produce the new scanning combine. "If you lay it on the bed one time for a CT scan and another time for a PET scan, just a small difference in body position will result in all of the organs shifting about a bit, so it's very difficult to do that matching."



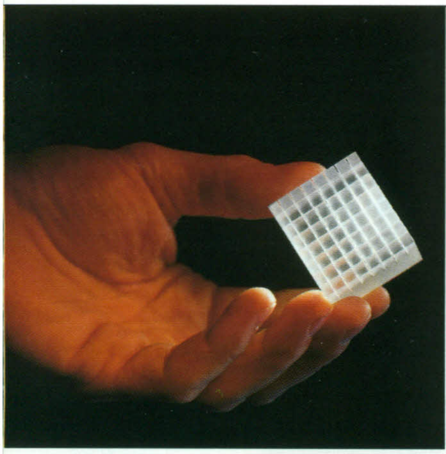
After refining their combined PET and CT concept for three years, Nutt and Townsend, who had transferred from the University of Geneva to the University of Pittsburgh, received a three-year, $1.5 million grant from the National Cancer Institute in 1995 that enabled them to complete a prototype machine. Installed at the University of Pittsburgh medical center in 1998, it has been used successfully to scan some 200 patients.

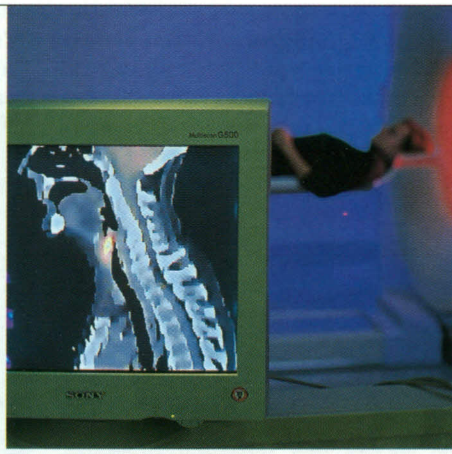
In many of these cases, says Dr. Carolyn Cidis Meltzer, who with Townsend is a co-director of the University of Pittsburgh PET facility, the use of the PET/CT machine has resulted in decisions to modify or change treatment. In one case a standard CT scan had detected a tumor on the left side of a patient's neck but none elsewhere. "When CTs are read and you look for a spread of tumor to the lymph nodes," Meltzer explains, "all you're able to look at is the size of the lymph node."

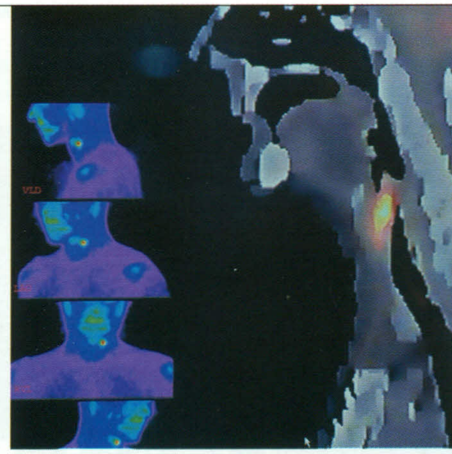
If a CT shows that a lymph node is less than one centimeter in size, it is considered to be normal. But on the PET/CT, Meltzer says, "we saw a very small lymph node in the right side of the neck that we thought was involved with the tumor." A biopsy that otherwise would not have been performed confirmed her suspicion.

The Pittsburgh machine has also made a difference in the diagnosis and treatment of cervical and ovarian cancers. Blood tests of some women who had already been successfully treated for these malignancies began to show markers suggesting that tumors were recurring. CT scans showed nothing amiss, but PET/CT surveys revealed the precise locations of small new tumors in the pelvic area that surgeons were able to remove before they metastasized.

Despite the limitations of a standard CT, it does a superb job of picturing the internal anatomy of the body. "The CT shines a fan beam of X rays though the human body," Nutt explains, "and makes a series of slices. Al-







PET/CT AT WORK

The roomier tunnel (opposite page, being inspected by CTI product manager Jonathan Frey) employs a detector consisting of 64 crystals, left. Each crystal detects any radiation from a 16-sq-mm area scanned here on a patient suspected of having a neck tumor. The PET screen shows the tumor as a blue dot, which the PET/CT screen, right, places in the exact anatomical location most what you'd see if you took a knife and cut a person in two." Literally slices of life.

These slices are made possible by the CT's detectors, which gauge the attenuation of the X-ray beam as it passes through the body. The attenuation, in turn, is a measure of the mass that the X rays encounter in their passage.

And that measurement is translated into precise images of the body's internal structure by an algorithm programmed into the CT computer. The newest machines, called spiral CTs, take many slices in rapid succession and can now image the entire torso in seconds, a procedure that once took as long as an hour.

The PET scan operates on an entirely different principle. In one application, a solution of sugar, its molecules tagged with a radioactive chemical isotope (usually fluorine 18) is injected into a patient's veins. Like any sugar, it migrates to metabolically active vital organs and tumors, if any, which use it for energy.

As the radioactive fluorine isotope, now concentrated in the organs and tumors, decays, it gives off positrons, the antimatter counterpart of electrons. And when an ejected positron collides with an electron, which occurs almost simultaneously, both particles are annihilated, their mass instantly converted into gamma rays, which the PET machine detects and turns into an image.

If there is a metabolically active tumor in the region being scanned, says Meltzer, "you can see an area where there has been sugar uptake. But it looks like a blob and it's difficult, especially in some parts of the body, to tell exactly where it is." Dr. Steven Larson, director of the PET program at Manhattan's Sloan-Kettering, has his own description of the blob: "It's a little like lighting a match in the blackness of a vast cavern. We detect the match, but the location is imprecise."

In designing the PET/CT to remedy this imprecision, says Townsend, one of the problems that he and Nutt faced was the engineering of the scanner tunnel into which the patient is rolled. "You don't want a very long tunnel that's frightening to patients," he explains. To further minimize the claustrophobic effects, they increased the diameter of the PET/CT tunnel to 28 in., making it far more spacious than the familiar typical magnetic resonance imaging (MRI) tunnels. "For the patient, it's very comfortable and convenient," says Townsend. "They arrive, they have a single scan, and then we have all the information."

A far greater problem came in writing the code to run PET/CT's computer. "We needed and finally created software to control two different imaging systems from one computer console," says Townsend, "something that hadn't ever been done before."

Now, given the go-ahead by the FDA, CTI will soon be producing an advanced version of the Pittsburgh prototype. Larson, who has ordered a machine for Sloan-Kettering's PET center, predicts that the PET/CT will "improve clinical management of patients and cut the overall time of their imaging in half, from about one hour for a whole body survey to about a half hour."

Even apart, PET and CT scanners are triumphs of technology, devices that have saved countless lives, prolonged others, and often made many exploratory operations unnecessary. Yet each has limitations that can lead to uncertainties in diagnosis. By successfully combining the two technologies, Ronald Nutt and David Townsend have eliminated those uncertainties and provided medicine with a powerful new diagnostic tool. ■

Patients arrive, they have a **single scan,** and the doctors have all the information