Electronics Industry Takes to "Potting" Its Products for Market

A recurring complaint about U.S. technology these days is the chant that the country is in an "innovation recession" that makes Americans vulnerable to threats from supposedly more creative foreigners, such as the West Germans and the Japanese.

One of the pieces of evidence generally used to support this view is the across-the-board decline in the number of patents the government has granted to U.S. inventors since the early 1970's. Patents are often taken as an index of a country's technological creativity. *Time* magazine, for instance, in a gloom-and-doom piece on the subject in its 2 October issue, called patents "a key measure of R. & D. vitality." And *Science Indicators—1976*, a well-known report of the National Science Board, used charts showing patent declines in field after field as partial support for its generally pessimistic conclusion about the health of American science. Finally, a blue-ribbon study of U.S. innovation made by the Commerce Department is expected to cite the patent data in the policy recommendations it will send to the President next April.

In some key areas of electronics, however, the real situation may be quite different from what policy-makers imagine: Americans have remained inventive, but they have been using the patent system less and less as a method of protecting their work. Thus, the so-called patent decline may be merely a patent bypass and not such an ill omen after all.

Bench engineers and inventors in the electronics field have told *Science* that parts of their field are moving so fast, and are so competitive, that an invention can be obsolete in the 2 or so years it takes to be patented. By that time, the company filing the patent can have lost whatever edge it had by having developed the thing in the first place. Moreover, they complain, in integrated circuit devices especially, a patent helps the competition almost more than it protects the inventor, because when a competitor reads the public patented design of a circuit, he can modify it only slightly and quickly have a new device he can market without fear of an infringement suit. "I don't think we're in an innovation decline," says a top engineer at one small electronics firm. "It's just that the patent process doesn't serve our needs."

Figures developed by the Office of Technology Assessment and Forecast (OTAF) of the Commerce Department's Patent Office could bear this out. Says William S. Lawson, director of the OTAF, "We have found in nearly every field that the R & D manpower per patent filed is going up, while the number of patents filed per R & D dollar spent is going down. One interpretation of this is that people aren't patenting as much as they used to." But they might, he admitted, be continuing to invent things as much as ever before.

Patent Office data for the industrial classification category of electronics that includes semiconductors and circuit components show that since 1971 the number of patents granted to U.S. applicants declined from 7800 to approximately 5000. In the same 7 years, the number of patents granted to foreign applicants has risen from 2700 to 2800. While the increase in foreign patents (which is relatively low in this category compared with some others) has been taken as a sign of the U.S. decline, Lawson notes that it could be just a sign of greater foreign trade activity in the United States and a resulting desire by foreign companies to cover the things they sell here with patent protection.

Black Boxing and "Potting"

Inventors in the electronics field resort to techniques more exotic than the humble patent to protect their creations from plagiarists. One widely used technique is black boxing, or "potting" of electrical circuits and combinations of components. At Powercube Corp. in Billerica, Massachusetts, for example, engineering manager Ted Harpley explains how it is done. "Our products are encapsulated in epoxy resin, for the most part," Harpley says, leaving only the terminals protruding. The products are stamped with the company's unique identification numbers so Powercube can replace or service them. A would-be imitator would have to dissolve the entire unit in a solvent to find the circuitry inside, but the solvent, according to some experts, would dissolve key components too, so the imitator would not learn the device's configuration.

Harpley also explains that potting has other goals besides hiding what is inside. Powercube sells devices that control and condition electric power sources, mainly to the defense and aerospace industry. Fixed in epoxy resin, they become resistant to temperature changes, vibration, shock, and other forces which could disable the electronics, he explains. But Powercube makes selective use of the patent system. "There are a large number of things we might judge to be patentable but that we elect not to patent. One reason is that by the time a new patent would issue, we would have innovated beyond the product," he says.

The black boxing technique is widespread in the electronics industry, according to Clessom Duke, marketing manager of Integrated Circuits, Inc., a Bellevue, Washington, firm that had $1.5 million in sales this year and expects to double that figure in 1979. Integrated Circuits sells some custom-made components and some of its own inventions to big firms such as Bell & Howell, Bell Laboratories, and Texas Instruments.

Duke says "Eight or nine years ago, in the beginning, we went for patents a lot. . . . But now the only time [the firm files with the Patent Office] is when we want a trademark that we can use for a long time, for several different products." Duke firmly believes that the trend away from patents is widespread because of the expense, time, and potential danger of exposing electronics designs to competitors. "The whole field is going underground," he says.

Large firms are also alleged to use trade secret techniques instead of patents. An ex-Boeing employee says that Boeing, like his subsequent smaller employers, sometimes sands off the identification numbers of electrical components it buys from subcontractors. These standard identification numbers are referenced in a public catalog so that with them, someone can look up how the component is put together. But the number of possible configurations for a circuit is so large that without the number, it is extremely difficult to learn the design of the circuit. Thus Boeing could assemble these masked components into its own device, stamp the device with its own identification number (not referenced in the industry catalog), and safely protect it from being copied.

A spokesman for General Electric, who maintains that GE is patenting its inventions and industrial processes as much as or more than ever, would not

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say conclusively, however, that the company never engaged in black boxing or sanding off numbers.

Interviews with representatives of larger firms indicated that companies are more likely to patent electronics inventions when they hold the promise of leading to mass consumer sales. A number of people cited not only the several thousand dollars it costs to obtain a U.S. patent, but also the $50,000 or more needed to enforce the patent through the courts once it is granted. "By a straight, 10 percent rule, you have to be able to make at least $500,000 in sales from something to justify the cost of a patent."

The ultimate mass-market electronics item has been the hand-held calculator, which is protected by hundreds, perhaps thousands, of patents, according to a spokesman for Hewlett-Packard Co. and a lawyer for the Bomar-Ali Corp. Jack Goldhammer, a lawyer with the Philadelphia firm of Seidel, Gonda, Goldhammer, which represents Bomar, explains that in the early days of the device, Bomar and the other companies in the forefront of the development obtained patents on every conceivable aspect. Today, Bomar (which has stopped making calculators), Hewlett-Packard, and Texas Instruments hold most of the key patents.

A spokesman from one of these companies estimates that the hand-held calculator sold in department stores or stationery shops may be covered by "a couple of hundred" patents and cross-licensing agreements. Everything is covered, including the plastic case, molding, design of the front, battery, battery charger, printed circuit, keyboard, input encoder, central processing unit, and whichever display technique it uses—crystal or light-emitting diode. The same thing is true, the spokesman noted, for many other mass-consumption items such as cars or hi-fi sets.

Science's interviews turned up no easy method for determining whether black boxing and other techniques are as widespread as some in the electronics field claim or whether their use has increased while patenting activity has declined. The interviews did, however, turn up a wide variety of complaints about the patent process. Sources of the complaints ranged from small inventors who maintained that it is useless in such a fast-moving field to a high GE official who wished patents were better suited to protecting industrial know-how and processes, which need safeguarding,too.

Government officials interviewed, who usually said they were unaware of potting, number sanding-off, and other techniques, nonetheless were uneasy with wholesale use of patent data as an index of innovative activity in any specific field. "I hadn't heard of black boxing," says an aide to Jordan Baruch, Assistant Secretary of Commerce for Science and Technology, who is heading the President's innovation study due in April. "But it's pretty commonly known that there's an increasing reliance on trade secrets instead of patents . . . that belies the use of patent figures as an index of innovation." Beyond that, the aide said, officials involved in the study know very little. Part of the study, headed by Robert Benson, director of the patent division of Allis-Chalmers Corporation, will examine patents.

Several government officials noted that the black boxing issue is only one of many criticisms of the patent system. Echoing the remarks of the GE official, they noted that the patent system is not well suited to protecting industrial know-how. There also has been a continuing controversy related to electronics, namely whether and how much computer software can be patented. Finally, innovative activity in the communications privacy field—that is, in encryption and voice scrambling—has been hampered in the last year by a little-known section of the patent regulations that allows the government (in this case the National Security Agency) to classify the work of private inventors.

So while policy-makers in Washington are having second thoughts about the patent system, some people in the electronics industry have made up their minds that for them, at least, patents are only marginally useful.—DEBORAH SHAPLEY

1976 Swine Flu Campaign Faulted Yet Principals Would Do It Again

The swine flu campaign launched by President Ford in March 1976 still defies any simple evaluation. Some 48 million citizens were inoculated, more than twice the number even reached before in a single flu season, yet the threatened new flu strain failed to show up. So was the campaign a necessary insurance policy nevertheless, or an empty triumph, or an avoidable fiasco, or none of the above?

The new Administration's health secretary, Joseph Califano, had among his first tasks on taking office a decision on whether to resume the swine flu campaign after it had been halted by discovery of the rare side effect known as Guillain-Barré syndrome. "This swine flu situation surprised and bedeviled me," Califano has written. He commissioned a review of the campaign from Harvard political scientist Richard E. Neustadt, a leading student of the presidency. Neustadt and a colleague, Harvey V. Fineberg, have written a beguilingly readable postmortem which was published last month.*

In the foreword of their report, Neustadt and Fineberg diagnose seven "leading features" of the decision-making for the swine flu program. They are:

Overconfidence by specialists in theories spun from meager evidence.

Conviction fueled by a conjunction of some preexisting personal agendas.

Zeal by health professionals to make their lay superiors do right.

Premature commitment to deciding more than had to be decided.

Failure to address uncertainties in such a way as to prepare for reconsideration.

Insufficient questioning of scientific logic and of implementation prospects.

Insensitivity to media relations and the long term credibility of institutions.

Flu, they say is a "slippery disease," meaning that the changing antigenic character of the virus makes it hard to produce an effective or long-lasting vaccine. It is also hard to estimate how much illness is caused by flu and how much by the many similar viruses with which it is often confused. Such uncertainties mock the objectives of a swine flu campaign, say Neustadt and Fineberg:

What a basis on which to build public consciousness and to seek support for preventive medicine! What a basis on which to risk the

**The Swine Flu Affair. Decision-Making on a Slippery Disease*. Richard E. Neustadt and Harvey V. Fineberg (U.S. Government Printing Office, Washington, D.C., 1978).

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