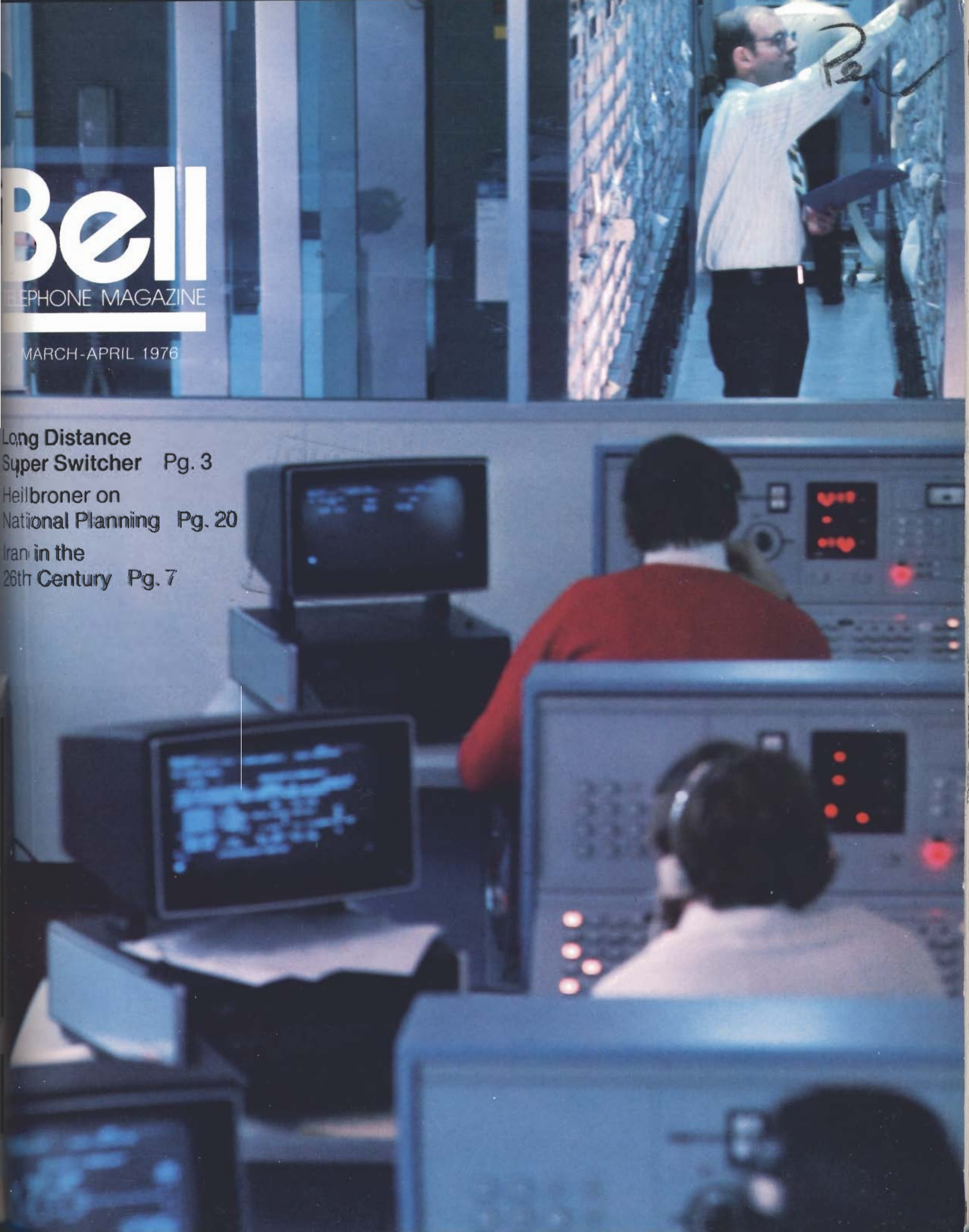

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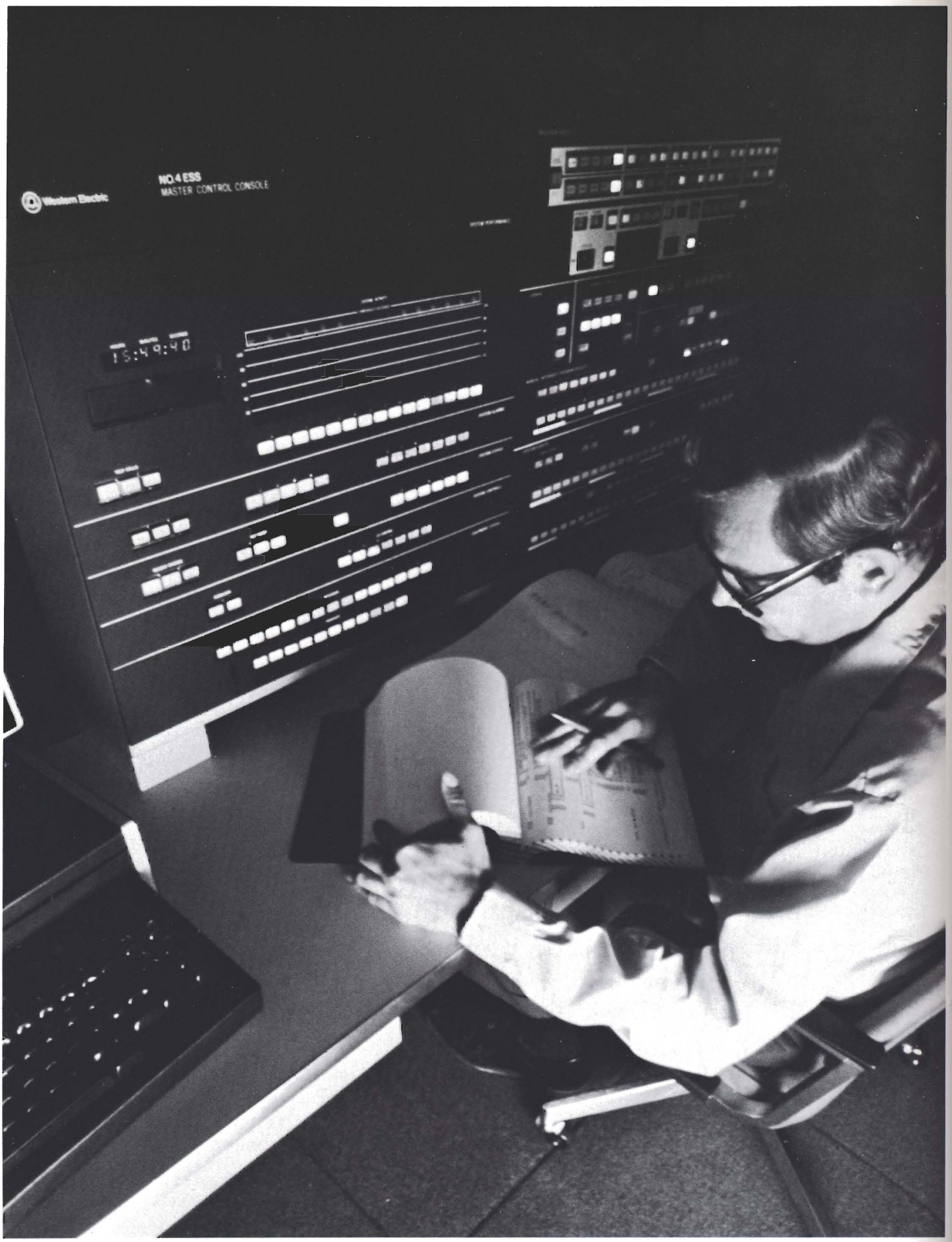
Western Electric
NO.4 ESS
MASTER CONTROL CONSOLE
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Long Distance Superstar

by Mike Zeaman

It has that take-me-to-your-leader look, resembling a prop from a science fiction movie. It's intelligent, immaculate, quiet, almost alive. Most important, the No. 4 Electronic Switching System moves long distance calls like all get out.

After a full year of field trials and testing, the Bell System's first all-digital No. 4 ESS (or 4E as it's commonly called) joined the nationwide long distance network this January in Chicago. Subsequent 4E cutovers in Kansas City, Dallas, Atlanta, and Jacksonville should take place by January, 1977.

Bell Labs, Western Electric, and AT&T Long Lines—working with specialists from all over the Bell System—spent more than five years on the project. Out of this cooperation has come a super switcher that will meet long distance switching needs for decades to come.

With a flourish of superlatives, the Chicago cutover has been described as one of the most significant events in the 100-year history of the telephone.

Yet electronic switching is no newcomer to the Bell System. The No. 1 ESS, introduced in 1965, serves local exchanges in metropolitan areas. No. 2 ESS was introduced in 1970 for use in suburban central offices. And No. 3 ESS, slated to go into service this year, is designed for rural exchanges.

But electronic switching is new to the long distance network. And the 4E machine is far more advanced than any of its electronic kin built for local switching.

Using solid-state technology and a sophisticated memory, 4E puts telephony on the threshold of a new era: that of the all-digital, total-service switched network. Many Bell System jobs will change too, as 4E becomes both the nerve center and the backbone of the country's long distance network within the next few years.

Like most Bell System technology, the No. 4 ESS has been designed to promote long-term compatibility and operating economy within the telecommunications network. That compatibility is insured by Bell Labs systems engineering, Western Electric manufacturing techniques, Long Lines and associated company planning and implementation procedures.

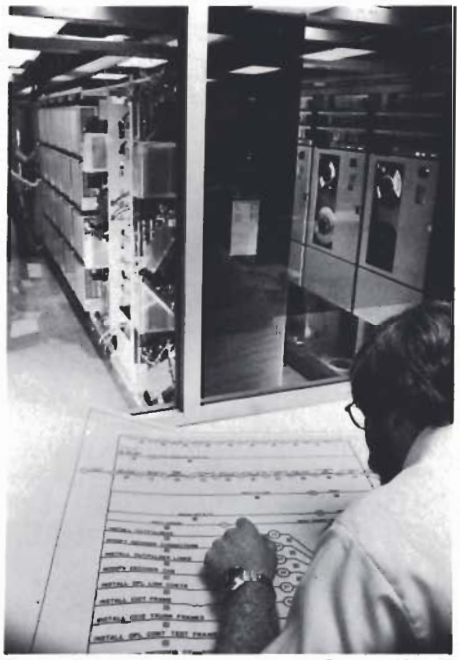
But just what is this super switcher and what makes it so grand? The 4E is an *intelligent* machine, using computer programming and electronic technology. To do its job, the machine is given a set of instructions.

The 4E has the same basic function as existing electromechanical toll switching equipment: connecting one particular telephone to another particular telephone (out of the more than 100 million telephones in the nation). But this new switcher processes up to 550,000 long distance calls an hour. That's more than four times as many as the 4A crossbar machine that handles most toll traffic today.

A billionth of a second is hard to perceive. But for the 4E, this incredible rate of speed is a way of life. In the 12 seconds a customer normally spends dialing a phone call, the 4E can complete two million tasks without even breathing hard.

"This machine is fast because it has practically no moving parts," says Marty Nienhouse of AT&T Long Lines, chairman of the Chicago cutover.

Electromechanical machines can process calls only as fast as the physical movements of their parts will allow. But instead of relays and switches, the 4E uses plug-in circuit packs—about 50,000 of them in the Chicago machine. On the average, each pack holds 35 integrated circuit chips that measure



Opposite page: master control console of Chicago's No. 4 ESS. Above: in the glass-enclosed maintenance center, employee goes over a schematic.

No. 4 ESS, with its vast call capacity, inaugurates a new generation of electronic switching

Mr. Zeaman is a staff writer for Long Lines *magazine.*

about .04 square inches. There are 60 resistors and 60 transistors in a chip the size of a grain of sand.

"Integrated circuitry is new to toll switching," says Nienhouse. "The local offices have had it in their No. 1 and No. 2 ESS machines. But one of these plug-in ceramic packs (for the 4E machine) can do the job of 38 similar circuit boards in the No. 1."

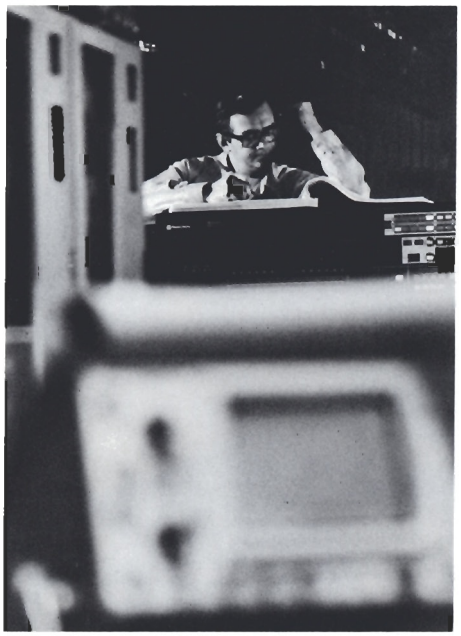
Adding to the speed of its electronic circuitry, the 4 ESS uses its time very wisely. It does this through time-division, digital switching techniques.

In previous long distance switchers, two phones involved in a call have a dedicated continuous connection through the switching machine. With 4E, the same phones are connected only intermittently. They're connected and disconnected thousands of times per second. There are spaces or gaps as the call goes through the 4E, but these are so small in time that the quality of transmission is not diminished. The 4E can exploit these time gaps to connect other calls.

Al Spencer Jr., executive director of toll electronic switching at Bell Labs in Naperville, Ill., further explains time-division digital switching:

"The electrical signal that represents a phone conversation actually consists of a group of pulses. Pulse groups of several different calls are positioned in time slots along a single physical path within the switcher. Thus, each path through a 4E carries pulse groups of many calls, separated only by time—less than a millionth of a second. Switching is accomplished by timing the release of pulses so that they reach the proper outgoing channels, like passengers getting off a train at their station."

Each important part of the 1A processor (the controlling element or brains of the No. 4 ESS) is duplicated for reliability. The duplicate parts operate at the same time, checking out themselves and each other—two electronic hypochondriacs telling each other, "I'm okay, you're okay." If one fails, it is taken out of the system, and its mate takes over so quickly that there is no interruption in service.



Oscilloscope is used for checking pattern of electrical pulses.

The need for the No. 4 ESS arose from the rapid growth of Direct Distance Dialing (DDD). Several years ago, Bell System studies showed that by the year 2,000, customers probably will be making 40 billion interstate calls a year. Although 4A crossbar machines could handle all those calls, it would cost a lot of money. Today, the 4A systems in service number 180; an additional 820 would be needed by the end of the century to handle the expected traffic. Chicago, for example, now has five 4As, but would need 31 by the turn of the century. The same traffic could be handled by only eight 4E machines.

Besides its mindboggling speed and unprecedented call capacity, there are other characteristics that make the 4E super. It takes up less space than a 4A machine. A thousand frames of 4E equipment can serve 107,000 trunks; the 4A needs 2,600 frames to do only one-third of that job.

The No. 4 ESS is the most powerful member of the Bell System's long line of stored-program-control switching systems, but it doesn't take much power to operate. It requires only two-thirds of the electrical power that would be needed to run a 4A system handling the same number of calls.

By itself, the 4E does not provide any new services to telephone customers. Local electronic switchers will be the workhorses for customized services. But 4Es ultimately will tie all these local machines together in an all-electronic network, meaning great service flexibility.

Obviously, the speed of 4E allows faster call set up. And because of Common Channel Interoffice Signaling (CCIS), a development related to No. 4 ESS, call connection time may actually drop to one or two seconds. That's about as much time as it takes the customer to raise the handset to his ear before beginning to dial.

CCIS actually will be a new data network to carry those beeps, clicks, and tones (that transmit a call from here to there) now carried on the voice paths. CCIS will free circuit time now consumed while switching equipment hunts for an available call route. It will also give the Bell System an opportunity to provide customized services—like specialized data traffic—on a common user basis.

CCIS is scheduled to debut on a limited basis about mid-year. While a 4A switcher can be modified for CCIS, it comes much easier for 4E, which only needs to be programmed to divert signals to the new data paths.

Western Electric has spent in excess of $400 million for the 4E, a cost exceeding Western's entire net earnings in 1974. This makes it one of the costliest projects ever funded by the Bell System. It is estimated, however, that by 1985, capital savings attributable to 4E could reach $500 million per year, and expense savings could approach a billion dollars annually.

If the cost of 4E is scary, its potential is certainly super. But as much as any development in recent years, the No. 4 ESS raises this question:

What if the Bell System didn't have the capability to innovate within its own organization? □

Over coffee in a back room at the Chicago No. 4 ESS office:

"One of these days, our managers are going to say, 'We need to enrich our craft jobs,' " says Mike Morel, a Long Lines operations supervisor. "When we get into a situation where the craft is 75 to 95 per cent dependent on the computer, and it leads you by the hand and does everything for you. How do you enrich that job?

"I don't have the answer. I hope someone comes up with a way of doing it. I don't think there's much reward sitting behind a Teletype, and that thing. . . ."

He gestures toward the equipment room.

". . . that thing says, 'Ah, yes, I just had a hiccup, and to get things right again, go out and change this circuit pack and I'll be okay.' "

Jim Hill, Long Lines communications craftsman, scoots his chair up to the table. He blows on his steaming coffee for a moment.

"I think the job is exciting," says Hill. "Maybe it's too new to tell, but I can't see the 4E making my job unchallenging or any less interesting. There's so much to learn about this machine, I don't see many so-called routine days on the job."

Employees working on the Bell System's first No. 4 ESS have anxieties about the winds of change. With the computer becoming an ever-increasing influence in the test room, this new world of solid-state switching means easier maintenance work and a whole new ball game regarding job skills.

With 4E, the tools of trouble-shooting have changed. There isn't a jack or patch cord in the entire office. Finding a screwdriver or a pair of long-nose pliers would be difficult. No ladders, no trouble tickets. Electronic wizardry has made all these things obsolete.

Communicating with a toll center to test a circuit.

Instead, employees work in closed-in rooms separated from the equipment by walls and showcase windows. Most of the employees work behind Teletype machines, cathode ray tubes, and test consoles with scores of push buttons.

"In the 4E environment," says Morel, "the biggest piece of test equipment is deductive reasoning power. And the ability to decipher machine language printouts. No longer are the craft people going to be the doers in a work center. They're going to be the thinkers."

Barbara Reed, communications craft, worries that electronic switching may dehumanize jobs.

"Working on a 4A, you deal with people to get things done. Here, you are isolated. Sure, I have to talk with someone out in the peripheral office while running a test. But overall, you seem to be fighting a machine over a case of trouble. You're sharing your ideas with the computer. People you can please, but a hunk of metal with a program error you can't."

Another viewpoint from Bob Gaynor, Long Lines vice president and general manager in Kansas City—home of the second 4E:

"Maintenance in a 4E environment requires the craft to use in their daily jobs those characteristics that are uniquely human—reasoning, insight, judgement. This doesn't mean we need different or better educated employees. As the craft become thinkers, using their minds and intellect more than their feet and their hands, they will gain a better understanding of a very sophisticated and complex system. This will be job satisfaction in itself."

The easier maintenance requirements of the 4E unquestionably mean that fewer employees will be needed in the future. So is the 4E after the craft job?

"Advanced technology is having an impact on all kinds of jobs," says Emmet McMahon, Long Lines director of network operations. "It's not just 4E.

"But to answer the question, we don't expect any layoffs even though fewer people are required to maintain the new system. However, I don't see a lot of new jobs either.

"Jobs will change substantially. But the 4E was anticipated in Long Lines manpower forecasts. We have reduced hiring levels to compensate for the different employment requirements.

"If the 4E or any electronic dimension of our network becomes so refined that the craft cannot be kept productive, we might form centralized maintenance crews who would troubleshoot maybe three or four machines."

Change in the craft job is inevitable. Some see the new technology making monkeys out of employees. Others feel the job will be more satisfying because employees will use their brains more than their brawn.

The jury is still out. □

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