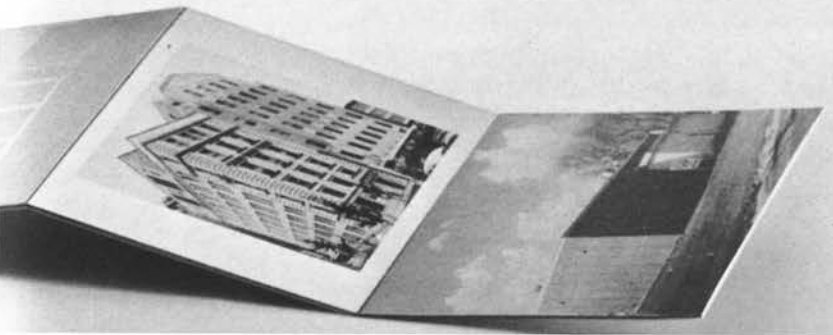

Phone Service Of Future Shaping
In New Succasunna Building

A Decade of ESS

W. H. C. Higgins

THE TRIAL OF THE WORLD'S first electronic central office at Morris, Illinois, proved that stored program control and electronic technology could be successfully applied to the switching process. In the ten years that have since elapsed, a family of stored program machines has been developed, manufactured, and introduced into the Bell System to fit a variety of switching needs. Here, W. H. C. Higgins, Vice President, Switching Systems at Bell Laboratories reflects on these developments.

The painting of ESS components by Paul Lehr in the background appeared as the cover of the June 1965 RECORD, which described the No. 1 ESS that had been cut into service at Succasunna, N. J., a month earlier. Well over a hundred new offices (some of which are shown here) have gone into service and an entire family of stored program machines has evolved since that time.



NOVEMBER 11, 1970, marked the tenth anniversary of trial service on the "world's first Electronic Central Office" at Morris, Illinois. In that same month—on November 28, 1970—regular telephone service was given to residents of Oswego, Illinois—some twenty-five miles north of Morris—with the cutover of the first No. 2 Electronic Switching System (ESS). The beginning of service at Oswego, occurring almost exactly ten years after the first trial of a new technology at Morris, provides a suitable benchmark for examining the progress—and the problems—of the preceding decade.

Morris was basically a trial of the application of a new technology to the telephone switching problem. It carried the sound concept of common control—evolved in electromechanical systems over the years—a giant step forward. But more fundamentally, it employed the inherently high speed of electronics to provide the flexibility of stored program control in carrying out the myriad functions necessary for handling telephone traffic.

During the ten years since Morris a family of stored program machines has been developed, manufactured, and introduced into the Bell System to fill a variety of switching needs. The No. 2 ESS at Oswego is the most recent addition to this family.

From the point of view of local central office switching, the decade may be conveniently divided into two almost equal periods. The first period was characterized by intensive invention, development, and preparation for manufacture by Bell Laboratories and Western Electric Company, culminating in the cutover to commercial service of the first No. 1 ESS at Succasunna, New Jersey, on May 30, 1965. That period is thoroughly reviewed in a special issue of the Bell Laboratories RECORD for June 1965. It is perhaps worth quoting here an excerpt from the lead article in that issue by W. A. MacNair, then Vice President of Transmission and Switching Development . . .

"In the final phase of No. 1 ESS development, our partnership with Western Electric has grown steadily broader and deeper as WE has produced, in hardware, Bell Laboratories' design of apparatus and equipment, and delivered on tough schedules to meet close deadlines. The understanding, the give-and-take, and the real cooperation in this undertaking have been marvelous to behold.

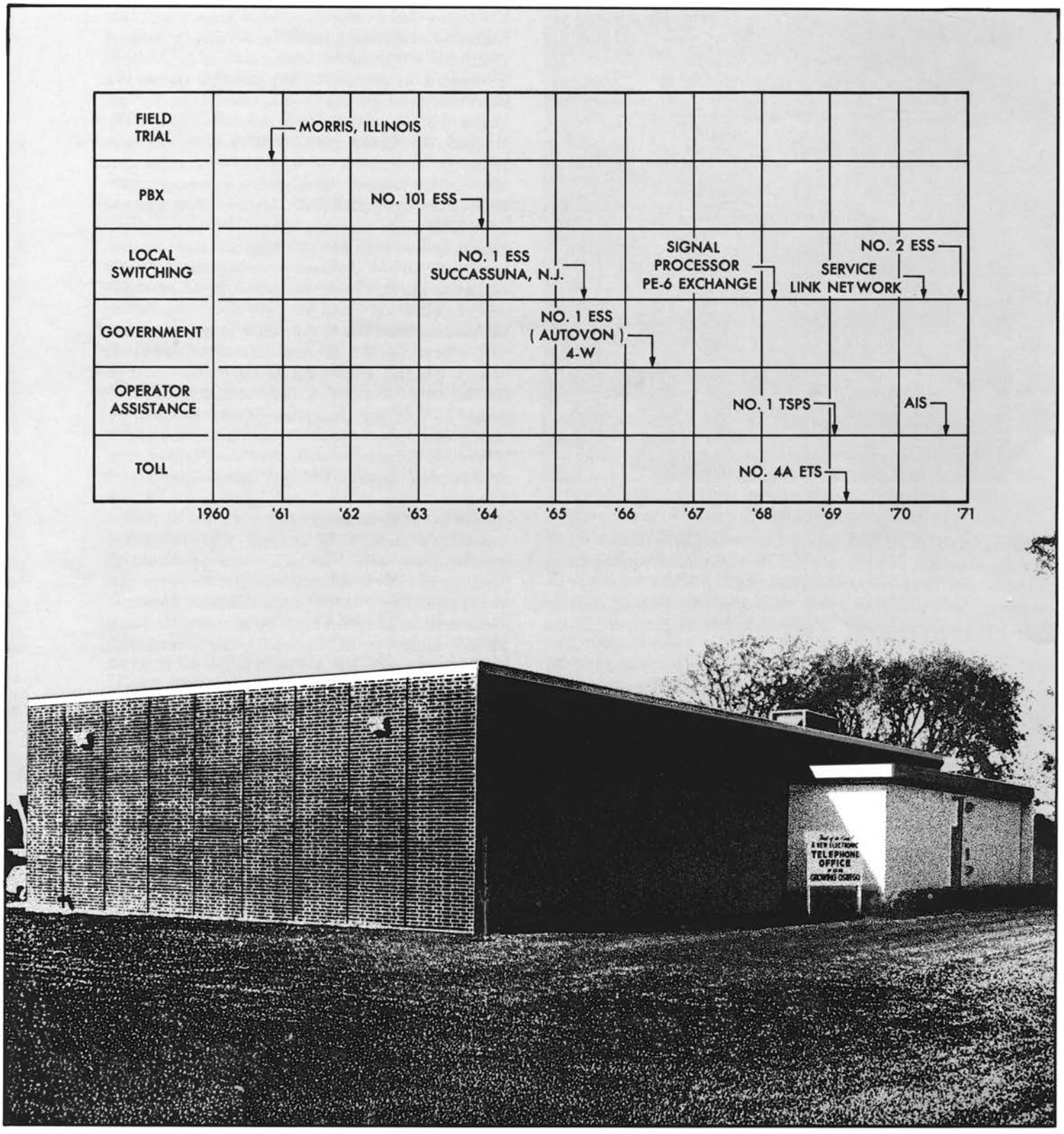
"While the big effort of the Operating Companies in the use of electronic switching offices to serve our customers better is yet to come, many Operating Company people have made individual contributions to the development and design effort. Others are preparing themselves to plan and operate No. 1 ESS offices in their territories. The significant contribution of the Operating Companies to date has been the coordinated planning to install No. 1 ESS offices throughout the country as fast as equipment is made available by the Western Electric Company."

The second half of the decade certainly bears out the statements by Walter MacNair. After a slow start, the pace of installations accelerated and is continuing the upward trend (see figure on page 322). By year end 1970, some 128 No. 1 ESS local central offices will be in service equipped with nearly 1¾ million customer lines.

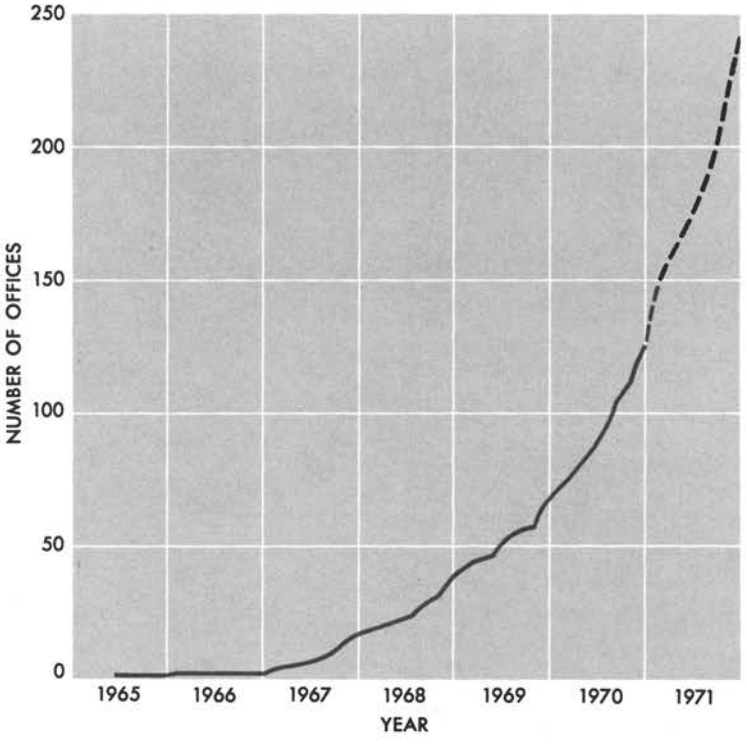
This has indeed been a period of intense activity on the part of Bell System Operating Companies in training their people in the new technology and in arranging their plant to accept this new type of machine. For some it has involved traumatic experiences caused not only by unfamiliarity with this new technology but also by program design problems. The latter were first exposed in situations involving live traffic from thousands of customers as well as problems of interconnection with a variety of existing electromechanical switching offices. These could not have been entirely foreseen or adequately tested in the laboratory. Thus, this same period saw a tremendous activity at Bell Laboratories in ferreting out the causes and evolving the cures for program problems as they arose. Here the flexibility of the stored program really paid off. Once the problem was identified and a cure determined, the introduction of the change in a particular office was a simple matter indeed. An accompanying chart (page 323) indicates that service-affecting problems from this source are now well under control and that problems from all sources are on a downward trend.

This second half of the decade was also characterized by a large development effort at Bell Laboratories, whose main thrust took two paths. One of these was the development of programs to provide new features for both call processing and maintenance. Important among the former was the addition of programs to provide Centrex service to business customers.

The second path dealt with increasing the traffic-carrying capacity of the office. A most significant development in this regard was the addition of a signal processor (see *The No. 1 ESS Signal Processor*, RECORD, *April 1969*) to take over many of the repetitive functions required in scanning lines and collecting dialed digits. The first office to use this new signal processor was a replacement of the panel office for the Pennsylvania 6 exchange in New York City, on March 2 of 1968. Since then most of the offices have been of the signal processor type for use in the large metropolitan areas.



During the ten years since the trial of an electronic central office at Morris, Illinois, a family of stored program machines has been developed, manufactured, and introduced into the Bell System. The No. 2 ESS *at Oswego, Illinois, is the most recent addition.*



The first half of the decade was characterized by intensive invention, development, and preparation for manufacture culminating in the cutover to commercial service of the first No. 1 ESS *at Succasunna, New Jersey, in 1965. Since then the pace of installations has accelerated and is continuing on the upward trend.*

Traffic-handling capacity was also increased by careful examination and modification of the programs themselves and by the addition of a Service Link Network—first cut into service in Calumet City, Illinois—earlier this year. Still further improvements in the traffic-carrying capacity are in the offing through program changes alone.

No. 1 ESS has now reached a stage of maturity where it meets most (though not all) of the needs of the Bell System in the medium-to-large office applications. New generic programs are now issued annually to incorporate groups of new features agreed upon in advance with AT&T and developed during the preceding year. The programs include not only new service features of value to the Bell System Operating Companies but also various improvements in overall program efficiency determined by past experience.

For the medium-to-smaller size offices, No. 1 ESS cannot yet compete with electromechanical offices in first cost of equipment; No. 2 ESS can. Before discussing No. 2 ESS, however, it is appropriate to digress from local switching to a parallel development carried out in the late 50's and early 60's. This was the development of a stored program controlled switching machine to supply modern electronic telephone switching service to business customers. Known as No. 101 ESS, this system has been described in previous articles (see, for example, *The No. 101 Electronic Switching System,* RECORD, *November 1963*). Suffice it to say here that it consists of a stored program control unit (processor) located on telephone company premises which, over data links, controls a number of switching units on the premises of various business customers. To meet this market it was necessary to develop a low-cost processor and a family of switch units. The processor employed an architecture differing from that of No. 1 ESS—more adapted to the market for which it was intended.

The first No. 101 ESS went into service at Cocoa Beach, Florida, on November 30, 1963, thus predating Succasunna by some seventeen months. Its acceptance by the Operating Companies until recently has been somewhat less than enthusiastic. There were several reasons for this. Perhaps foremost among them is the fact that the Operating Company must invest in the entire control unit before the first of many customers can be served. Another reason, however, was that the initial switch units were limited in size to customers having no more than 200 extensions. Since that time, a family of switch units has been developed to cover a range of line sizes up to the full capacity of the control unit. An additional arrangement called "main-satellite" has been developed in which various size switch units in several locations (satellites) of a particular customer can be treated as a single PBX or Centrex operation with centralized attendants at one of the multiple locations. If the customer's needs are still greater, more than one control unit can be used with this arrangement. These new developments have significantly increased the demand for this system. As a result, orders are currently straining Western Electric's capacity to produce.

The significance of this digression from local switching is that No. 2 ESS evolved as a "marriage" of the simpler control unit principles of No. 101 ESS with the ferreed switching network principles of No. 1 ESS. This results in a system economically competitive with its electromechanical counterpart for the smaller size and lower traffic offices—the needs for which are numerous throughout the Bell System. At the same time it provides the flexibility of stored program control for the addition of new features, enhanced capabilities for traffic measurements, and reduced maintenance costs.

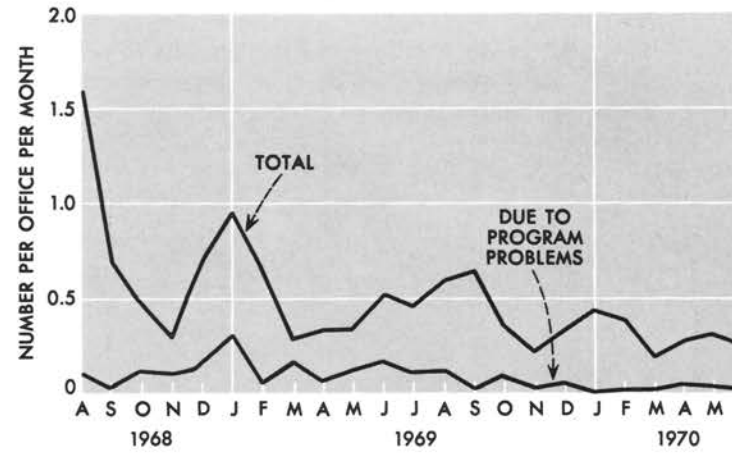
At the time of cutover, the Oswego office served 1740 customer lines and 250 trunks. Other installa-

tions now undergoing test prior to cutover are located at Tucson, Arizona, Grand Island, New York, and North Madison, Connecticut. The capacity for growth in these offices is such that the higher end of No. 2 ESS will overlap the lower end of No. 1 ESS. The choice of which system to use in a particular application will depend importantly not only on size and traffic characteristics at the time of cutover, but on the expected growth in the number of lines and traffic over the ensuing years.

Even before No. 1 ESS was ready for commercial service, the Bell System was approached by the government to provide a four-office complex of electronic switching systems for a special application, which later became part of AUTOVON (Automatic Voice Network) serving the military throughout the country. That was late in 1962. The government wanted four-wire offices as opposed to the two-wire switching networks used in commercial local central offices. The need for the system was urgent. Its overriding importance was such that development was undertaken in spite of the already overtaxed demands of Bell Laboratories for meeting local switching needs.

Through the use of the No. 1 ESS stored program processor and a specially developed four-wire ferreed crosspoint using the existing sealed contact, we were able to develop the system in a much shorter interval than would have been possible had an entirely new development been undertaken. And we were able to save time in the program development as well. For example, a substantial fraction of the maintenance programs for the processor could be lifted intact from the local office development. Other programs required modification, and some new maintenance programs were required. Very little could be adapted from the operational programs for the local office since many special features such as "pre-emption" and "priority" had to be provided for military use. As in the case of local switching, new program issues have been generated periodically to add operational features desired by the government. Here again the flexibility of the stored program has proved to be of immeasurable value in the rapid introduction of new features.

The first four offices were placed in service May 16, 1966, in the Eastern part of the United States, followed on July 1, 1966 by a special adaptation of the system to the communication needs of the North American Defense Command in Cheyenne Mountain, Colorado. Over the subsequent years, additional offices were added to the network, and there are now forty-one of these four-wire No. 1 ESS switching offices in service throughout the United States. These are interconnected by a poly-



System initializations have decreased markedly as experience has been gained with operation of this new switching system. Those due to program "bugs" are now under control. Problems from all sources are expected to continue the downward trend.

grid routing network to provide enhanced survivability essential for military communication.

Stored program control has also proved to be of value in providing translation and routing instructions in No. 4A toll crossbar offices. An Electronic Translator System (or ETS as it is called) was developed to perform these translations and routing functions much more efficiently, at higher speeds, and with substantially less floor space than was possible with its electromechanical predecessor. Moreover, ETS provides expanded capability for gathering traffic statistics and other administrative data important in the overall control of the vast Bell System toll network. In contrast with the previous electromechanical card translator, which used perforated metal cards and light beams to perform translations, the ETS uses a new type of memory called the "piggyback twistor." With this memory both the control program and the translations are electrically changeable.

Manufactured by Western Electric at its plant in Columbus, Ohio, the first electronic translator system was installed in a new 4A crossbar toll office in Grand Rapids, Michigan, on April 20, 1969. By the end of that year eight were in operation, and by the end of 1970 the total will have grown to twenty-two. In some cases (as in Grand Rapids), ETS was a part of a new No. 4A crossbar toll office; in other cases, it is being used to replace the electromechanical card translator in existing offices because of efficiencies to be gained by so doing. As in the case of the other stored program systems, the development of new features will be a continuing activity at Bell Labora-

tories. These can be introduced simply, quickly, and at low cost in operating systems in the field.

Still another application of stored program control is in a system designed to improve service on calls from coin telephones, person-to-person calls, calls for which charges are to be made to a third party, or other types of calls requiring operator intervention. Known as Traffic Service Position System No. 1 (TSPS for short), this system utilizes the same processor that was developed for the electronic translator system in toll offices. Moreover, it embodies a ferreed switching network to gain access to toll trunks and new operator consoles designed for efficient handling of operator calls.

In developing TSPS, a number of technical difficulties arose. Some of these involved the new electrically changeable piggyback twistor, which requires precise manufacturing control of two types of magnetic material as well as novel fabrication techniques. In addition, the programming required to provide the various features desired in the system, including those needed for automated maintenance, proved to be considerably more time-consuming than was originally anticipated. As a result, there were a number of disappointing delays in previously established target dates. Nevertheless, through hard work and perseverance these problems were overcome and the first system went into service in Morristown, New Jersey, on January 19, 1969. By year-end 1970, twelve will be in service with many more under construction and test.

A valuable feature of TSPS, in addition to its prime function of improved service to the customer and reduced operating costs for the telephone companies, is the fact that the operator positions may be located remotely from the switching centers they serve. This permits the Operating Companies to select an operating locale in favorable labor markets, which may be fifty or more miles away from the basic switching equipment. It is expected that this feature will result in reduced operator turnover, which has been a significant problem with the Operating Companies. At Bell Laboratories, work continues on TSPS to introduce new stored program features and to correct program problems as they arise in the field.

Still another development using stored program control is known as the Automatic Intercept System. As in the case of TSPS, the Automatic Intercept System (AIS) provides more satisfactory service to the customer at a lower cost. As the name suggests, AIS automatically intercepts calls to "nonworking" or changed telephone numbers. The system automatically assembles words and phrases recorded on an announcement machine into sentences, which inform the customer why his call was not completed as well as the new number to be called. Information concerning the numbers to be intercepted, together with information on their status, is entered daily into a magnetic disk file by Operating Company personnel. Under stored program control, this information can be automatically extracted and assembled into the appropriate recorded message. If the customer wants further information he can remain on the line and an operator will respond. In addition to providing better service, the number of operators required with AIS to meet the traffic demands is substantially reduced over prior arrangements.

From the physical and program design viewpoints AIS takes advantage of the processor developed for No. 2 ESS. The savings inherent in both hardware and program development, manufacture, and field training by such commonality of processors in this and other systems are quite clear. This trend toward commonality among various systems is expected to continue.

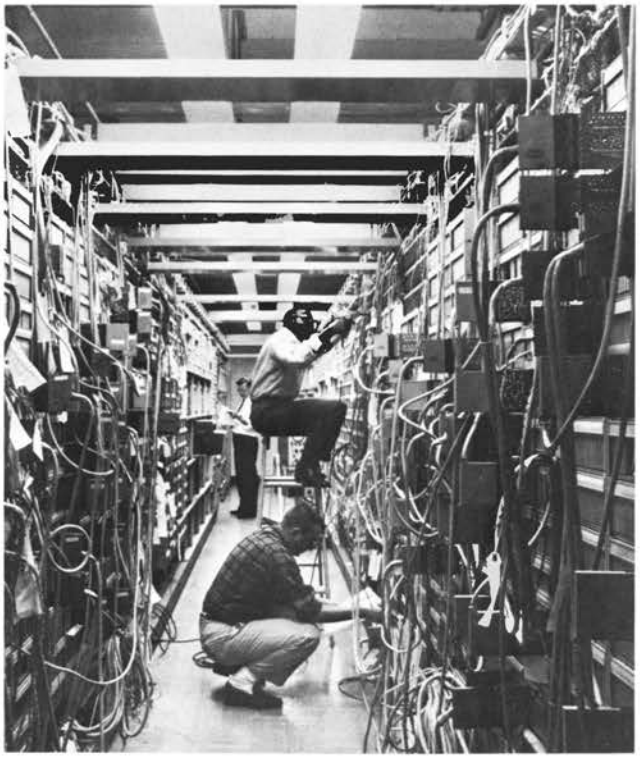
The first Automatic Intercept System, and the only one currently in service, was cut over at Hempstead, Long Island, on September 13, 1970. Other installations will follow in 1971, and some are in the process of being installed and tested.

The decade of the 60's has been a full one for the partners in the Bell System enterprise. Bell Telephone Laboratories, Western Electric Company, and the Bell System Operating Companies have each played a vital role in bringing new technology to bear on the problems of offering improved service to our customers under the overall guidance of AT&T. The decade has been an exciting and challenging one for all organizations playing their parts at the appropriate points in time. As we look ahead to the coming years, we will see the continued flowering of the systems introduced in the past decade as well as new ones as yet unborn.

Electronic Switching Systems—the biggest single commercial effort in Bell System history—has required the closest intra-system cooperation ever . . .

From Bell Labs designs . . .

through manufacture and



installation by Western Electric . . .

and culminating in cutover to commercial service.