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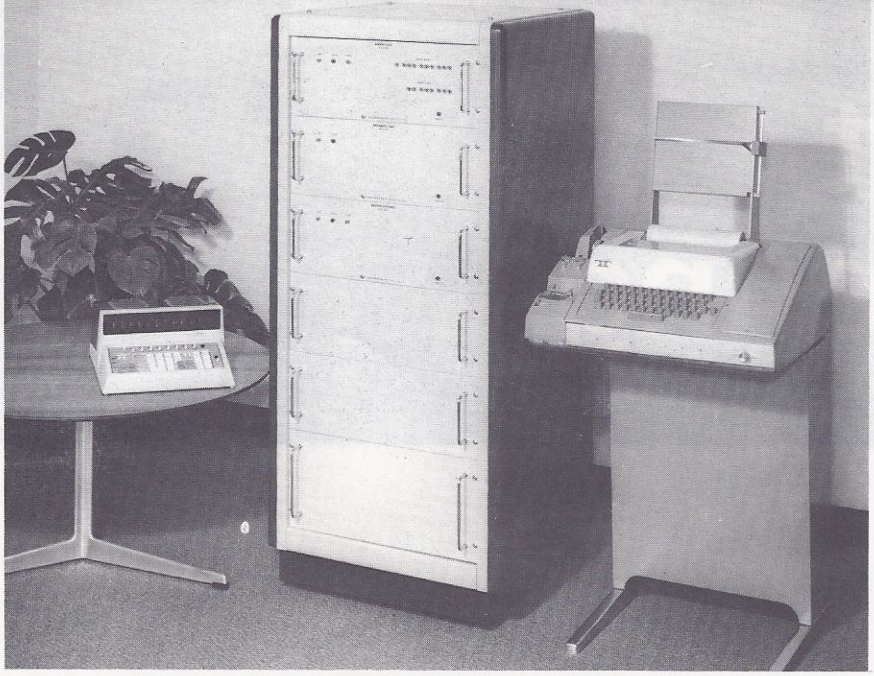

Computer sub-components (cabinet) switch on and off system party line as needed.

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A new small-scale computer system resembles a party-line telephone system, with tape programmers, input keyboard, arithmetic unit, data acquisition, and core storage modules all switching in and out as needed. Any two or more modules can communicate with each other directly through the interlinking "busline" without having to go through a central unit.

Traditionally, computer systems are pictured with data-handling equipment grouped around the memory and processing modules—and with good reason. Such elaborate systems can communicate only through their central sub-system.

The "4000," recently introduced by Wang Laboratories, Inc., Tewksbury, Mass., is made up of a "democracy of equals," as Frank Trantanella, originator of the busline concept, describes it. This means that each module or box is potentially capable of functioning as an input or output device—or even as a control—depending on the requirements imposed by the taped program being followed.

The increased flexibility, relative capacity, and speed inherent in a table of organization that makes it unnecessary to channel all inter-module communications through a central processor are self-evident.

Indicative of its flexibility, the 4000 can be used by itself for various combinations of data processing, control, and calculating operations, or it can be coupled "on line" with a large-scale computer to take advantage of the larger machine's greater memory capacity.

Reduces manpower. The busline concept originally occurred to the Wang staff as a means of solving an engineering manpower problem.

The company had long sensed a pattern in customers' requirements for various types of data-handling, engineering computation, process controlling, recording, printout, and other computer elements and specialized systems. But it had never proved feasible to apply the development work done for one system to the designing and building of the next. Worse, customer requirements were demanding more and more special functions and programming techniques.

Simply expanding the engineering staff was not the answer, primarily because enough designers of the necessary caliber were not available.

The only way to generalize the staff's experience among all or most of the systems on order was to develop a means of flexibly linking up various combinations of computer components, so that all conceivable customer requirements could be fulfilled by assembling the required components from stock.

Such a concept is not entirely new in the computer industry. The most comprehensive systems are always made up of such primary sub-systems as core and processing units, punch-card machines, tape-handlers, and counters.

The Wang system is unique because the functions of such primary components can be easily varied to suit special purposes simply by varying sub-components (called "boxes") such as arithmetic units, counters, storage registers, printers, and keyboards.

Togetherness. Such "boxes" must be mutually compatible and must be usable on the standardized busline that connects them. Although special boxes must be developed for particular functions from time to time, in a sense they become standard immediately, because they are compatible with all other boxes.

In the same way, 4000 systems are unlikely to be outmoded by new developments or new data-processing needs. They can be expanded or modified by providing the standard or special-purpose boxes needed. It is even proving feasible to modify already installed Wang systems, which were not designed on the same basis as the 4000.

All this has cut down considerably on expensive field engineering, and downtime for changing new or existing systems has been virtually eliminated.

The design of the 4000's busline and interface circuits is the key to the new Wang computer's success. Yet, essentially, it is predicated on a standard, widely available unit common to many computer systems, the Teletype Corp. page printer.

This component makes available to users a device that can be operated manually or by punched-tape input, with either punched-tape or typewritten output. But more than that, the teleprinter is based on a simple two-wire telephone connecting system, which is compatible with standard data-input sets using either telephone or teletype lines for remote input or output.

Coding does it. Wang was able to take advantage of this ready-made communications system by standardizing all busline coding and logic levels in forms compatible with the serial form required for handling data in and out of the teleprinter.

It was necessary to design circuits for the busline and interface connections between boxes able to recognize coded commands addressed to particular boxes that other units would ignore. This was followed by automatic actuation of the teleprinter or keyboard readout.

Circuits were developed that transfer data between boxes in serial form by digit and in parallel by bit. To interface in and out of the teleprinter, it is then necessary only to convert data into serial by-bit input and output—basically a two-wire configuration.

The circuits developed to do this are fairly straightforward in design, being "nothing more than a collection of diode coincidence circuits and gates," says Stuart Roberts, Wang's marketing manager.

Address and command signals are intermixed with data so that all instructions can easily be made integral parts of taped programs or keyboard input. A specially developed octal code makes it possible for all boxes to act as input, output, control, or processing units as needed.

The new Wang computer provides a storage capacity of 1024 characters per core storage box. Each character is of 8 bits, so that the box unit can be used to store programs of up to 1024 steps with looping and branching capability, to store up to 256 4-digit readings from input devices such as digital voltmeters, or up to 128 16-digit words from the arithmetic work register. All types of stored data can be intermixed and selected by the program used, and the words stored can be variable in length.

High speed. In all likelihood, for logarithmic operations, the 4000 provides the fastest computing speed of all general-purpose computers now available. This is primarily because of the circuit designed by Dr. Wang, company owner and president, who worked at the Harvard Computation Laboratory when the digital computers were developed.

This circuit digitally generates the logarithm of a number directly in one step, whereas other computers must do this in a series of digital steps, perhaps as many as 1000.

Thus the 4000, like the Wang engineering desktop calculators introduced about two years ago, multiplies and divides by adding or subtracting base *e* logarithms and taking the anti-log of the result. Squares are obtained by multiplying the logarithm of a number by two and taking its anti-log; square roots by taking one-half a logarithm of a number and deriving the anti-log.

The base *e* logarithm of a number is immediately available, and *e* may be taken to any power entered into the anti-log circuit. The anti-log circuit works as well with bases other than *e* in that the logarithms to the base *e* are multiplied or divided by the logarithm of the base used, as taken to the base *e*. (For example, to convert a base *e* logarithm to base 10, divide the base *e* by the base log of 10—about 2.3.)

Variety of applications. Introduced at the recent meeting of the IEEE in New York, the 4000 has been purchased for a variety of applications. Most of them are in manufacturing or processing plants where the computer's capability for acquiring and processing data at a number of control points in a system can be utilized. These include automatic process control, recording of processing data, generation of control, or data-processing programs for plant operations ranging from bookkeeping to the development of new production methods.

In addition, at least two new customers will have keyboard units installed in research and engineering departments, making both stored and on-stream production data available for new design and development programs.

Typical installations for new orders include arithmetic storage, data acquisition, program, keyboard, and teleprinter units. These cost about $10,000. Comparable systems, operating at lower speeds, are priced at about $15,000 to $25,000.

Although these new applications include industrial operations as wide-ranging as color computing, steel and glass rolling, capacitor testing, and meat packing, all of the 4000 systems supplied will be based on various combinations of the standard boxes already developed by Wang engineers.

—John Kolb

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