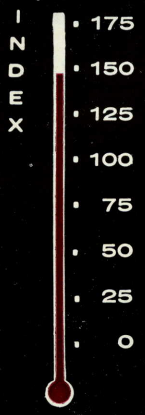

BUSINESS WEEK

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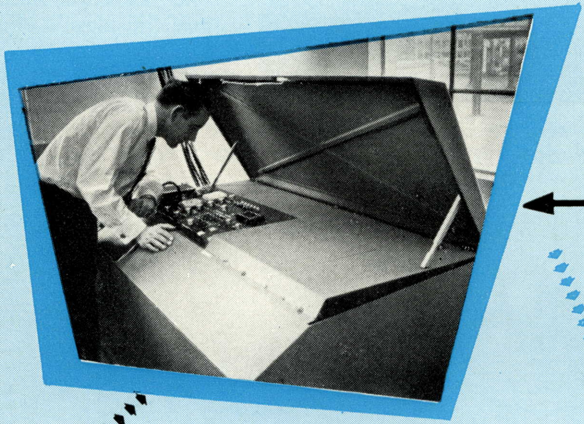
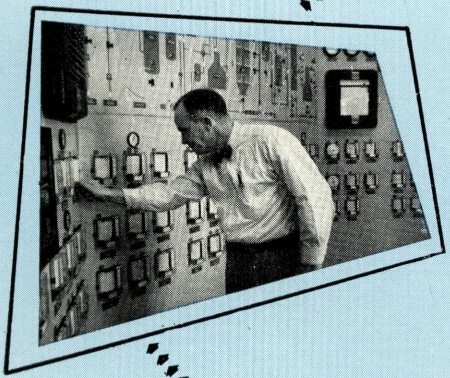
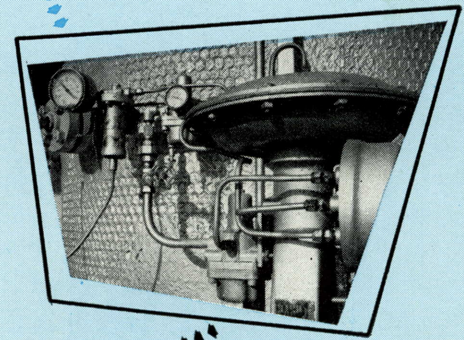
Texaco Closes the Loop

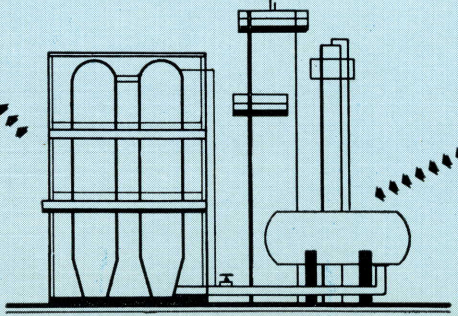


and COMPUTER Runs Port Arthur Refining Unit

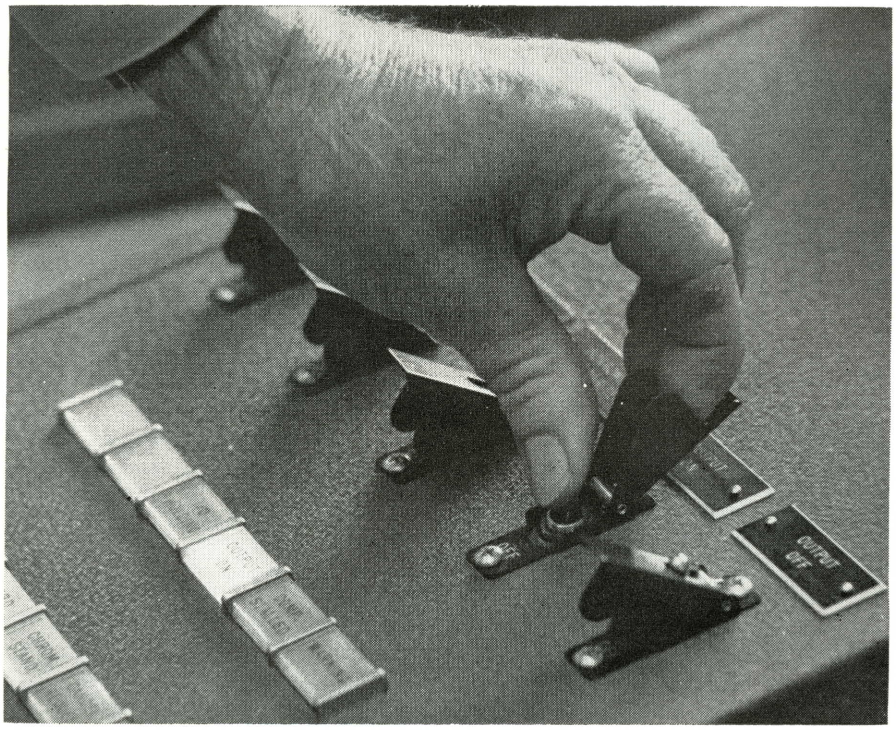
(Production)







Computer Runs Refinery Unit



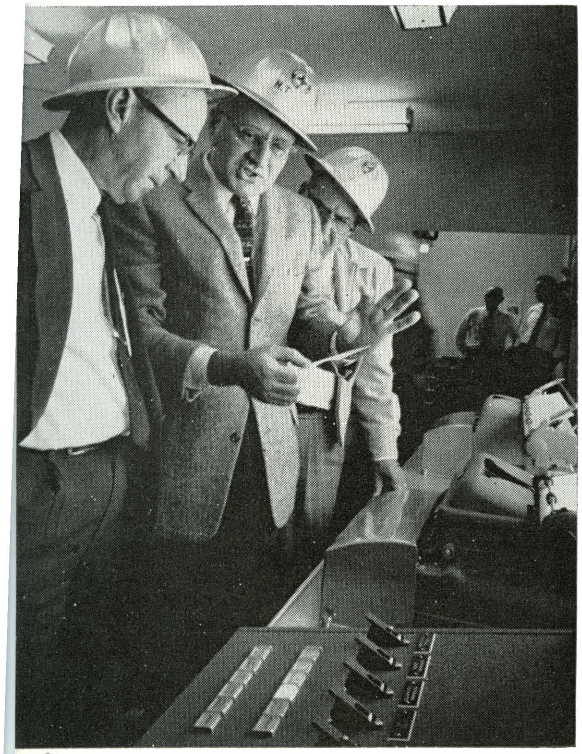
CLOSING THE LOOP, the master switch sends signals from the computer to the operating controls of Texaco's polymerization unit at its Port Arthur (Tex.) refinery.

For the first time, a computer is in charge of an industrial process. It promises a good payout in dollars and data.

Shortly before 11 a.m. on Mar. 12, a veteran Texas Co. process operator named Marvin Voight flipped the switch in the picture at left. The action closed the loop in the first fully automatic, computer-controlled industrial process (cover).

Moments later, the most vital parts of the 1,800-bbl.-per-day polymerization unit at Texaco's Port Arthur (Tex.) refinery were under the unblinking eye and almost instantaneous control of a Thompson Ramo Wooldridge Corp. RW-300, a desk-sized digital computer designed for just such control jobs as this. Texaco hopes the computer will raise the plant's efficiency by a healthy 6% to 10%.

• **Cause to Watch**—For the last year or so, the Texas unit, as the first plant scheduled for full-time computer control (BW—Nov.22'58,p64), has been



AUTOMATIC TYPEWRITER chatters reactions to computer's orders as Henry Flynn, H. T. Jones, J. E. Jeko watch.

COMPUTER, foreground, goes quietly about its business. Texaco and Thompson Ramo Wooldridge men check control charts.

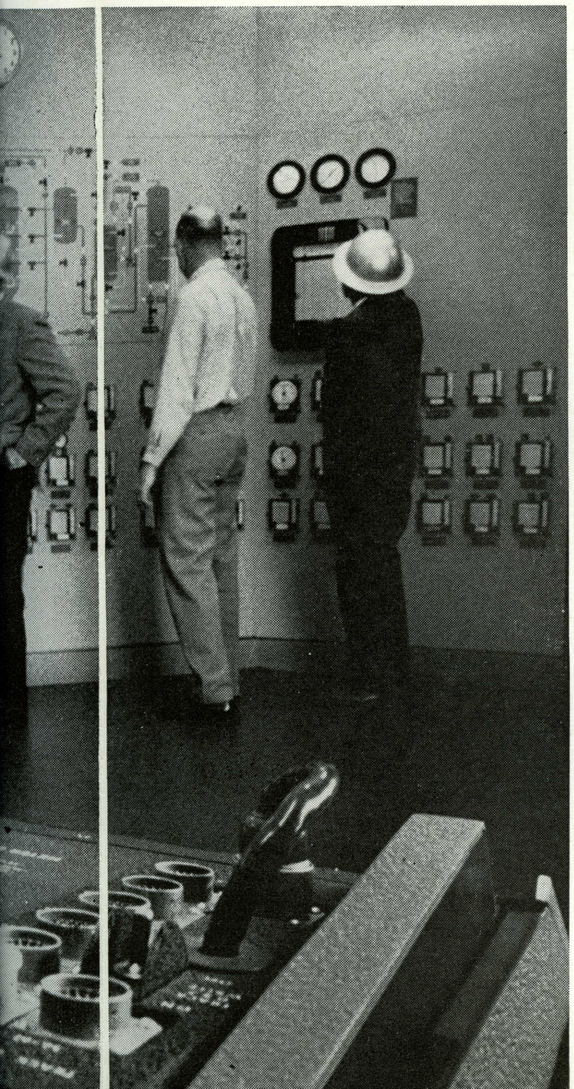
nit for Texaco

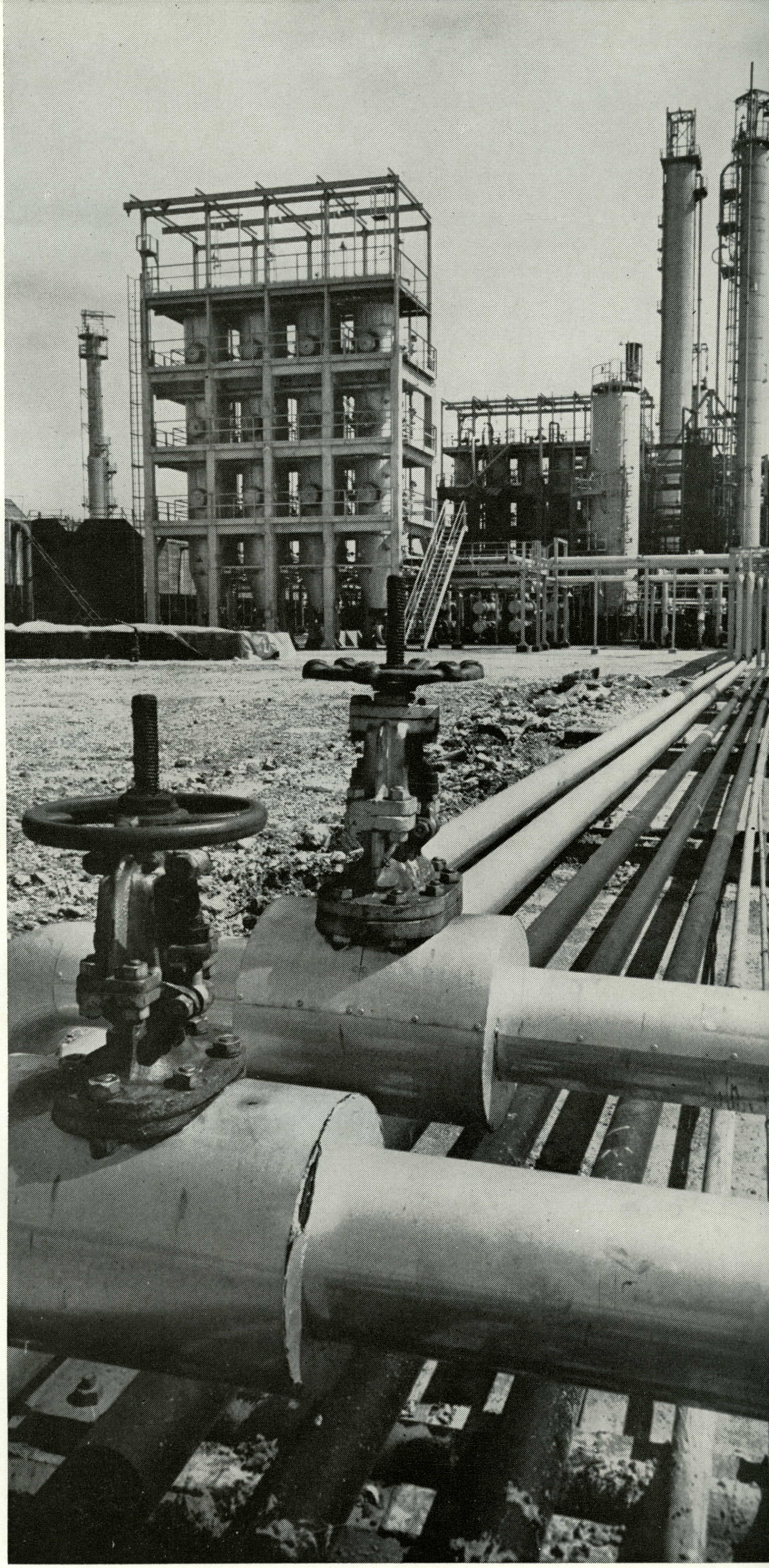
the center of attention in the process industries as well as among computer and instrument manufacturers. In spite of the plant's small size, it has generated more rumors and speculation, mostly inaccurate, than just about any industrial project since Oak Ridge.

There is good reason for the interest and gossip. Computer makers see a sales volume between $100-million and $200-million a year for control computers within the next few years. Chemical and oil processors visualize productivity increases anywhere from 2% to 15% for a host of processes that computers may be able to take over. And instrument manufacturers, eager to standardize production on new products, want to know what kind of gauges and controls their customers will want for computer-run plants.

How fast these markets develop, and how soon industry will know which of many control systems hold the most promise, depends a lot on how well the first computer-controlled plants perform in actual production, and how their costs figure up.

If they come out in the black, as





POLYMERIZATION PLANT turns refinery's gaseous byproducts into high-octane gasoline. Computer is in small building whose roof barely shows at right center.

most experts predict, there is likely to be a rush such as the industry has never seen. It will bring a shortage of particular types of talents. Engineers and mathematicians will be burning the midnight oil.

I. Texaco's Setup

The relatively short time that it took Marvin Voight to switch the Texaco plant "on computer" belies the intense efforts that both Texaco and Thompson Ramo Wooldridge put in to prepare for the day. It took more than 2½ years to ready the small plant for the big step to full automation.

First, Thompson Ramo Wooldridge engineers, with the cooperation of Texaco personnel, did a feasibility study, which ended as a 318-page report describing the system.

The study, based on operating records and process theory, analyzed the complex mathematical relationships between the elements the computer would have to control. From this analysis, the engineers worked out the specific design of the instrumentation and control system.

Other companies came in on the project, too. Instrument manufacturers put in special effort. Bristol Co. redesigned its recorder controllers to adapt to computer control, and Leeds & Northrup Co. supplied special on-stream analyzers to chart the chemical content of the raw material and product streams.

TRW estimates that it alone spent a total of two or three man-years on the feasibility study. And after Texaco accepted the TRW proposal, an equivalent amount of time went into the design of the installation. In addition, two to four Texaco personnel worked with the TRW team full time.

• **The Plant**—Texaco's computer-controlled polymerization unit, though relatively simple and small compared with some of the big cat crackers at Port Arthur, is still a sizable plant, worth about $4-million. Before the computer took over, the unit got a going over from top to bottom by Texaco engineers, ended up with an all-new control system and four new catalyst reactor cases added to the six that it already had.

The plant, which uses a relatively well-known Universal Oil Products Co. process to convert propylene—a byproduct gas from the cat and thermal cracking units—to high octane gasoline, has been operating at Texaco since 1942. It was due for a major modernization when Texaco decided to shoot for complete computer control. That makes it hard to isolate the exact costs of converting the plant. However, some are clear:

The computer itself cost $98,000. Input-output equipment that changes the voltages and pressure from instruments to the digital language of the computer added another $36,000. Engineering and extra instrumentation costs probably more than double the combined cost of the computer and its input-output gear. The total cost may run close to $300,000, but Texaco points out that at least one-third of that would have had to be spent on new instrumentation anyway. Texaco expects an early payout on its investment. "But even more important," says Jack Williams, head of Texaco's process and production div., "is the invaluable knowledge and experience we will gain from full-scale operation."

II. Why Computer Control?

Charles Richker, Texaco's chief process engineer and a fairly recent convert to the idea of controlling processes by computers, succinctly describes the job the computer does: "It gets an analysis of incoming gas and outgoing gas; it senses and measures pressure, flows, and temperatures; it calculates catalyst activity; then it weighs all these together and decides what the processing unit should do to get the most product for the least cost. Finally, it sets the controls and rechecks its figuring."

And the computer can do all that in just about the time it takes Richker to say it.

• **Speed**—High speed, plus the round-the-clock activity of the computer, is what makes it worth the trouble and expense. A human operator, regardless of his knowledge and skill, simply can't look at about 50 recorder-controllers that indicate pressure, temperature, and flow; then relate the readings that indicate the level of activity of the reaction or condition of the catalyst; then calculate the complex interrelationships of the process, all in time to reset the controls to keep the plant operating at maximum efficiency.

Texaco's RW-300 computer, on the other hand, has no difficulty doing that job every 5 minutes, 24 hours a day.

• **Human Element**—But that does not mean human operators are obsolete. The computer does the dull repetitive work of reading, calculating, and resetting. If something goes haywire, the computer detects its fact and yelps for help by sounding an alarm and setting an automatic typewriter clattering out the offscale reading. Texaco engineers believe it will always take a human operator to handle these situations as they crop up.

Automatic remote controls on the plant long ago cut crew requirements to three men per shift. A crew that size can, in a pinch, take over the hand operation of the plant and hold things together until plant maintenance men show up.

Whether or not computers result in a small net reduction in manpower is a minor consideration. Computers do a job faster and more dependably than human crews alone could ever hope to do.

• **Good Test Case**—Texaco's polymerization unit is a tough testing ground. But in many respects, it is almost ideal for the first trial.

The plant is large enough so that a sizable increase in efficiency could easily write off the expense of the computer installation. Yet its output is small enough, at 1,800 bbl. of gasoline per day, so that a shutdown or failure would not affect the main refinery operation.

III. Toward Perfection

When you look at the job the polymerization plant does, it is easy to see why better controls can pay big dividends. Refineries like Texaco's Port Arthur complex—its through-put capacity of 280,000 bbl. of crude oil a day makes it the fourth largest in the U.S.—produce an awesome variety of products from asphalt through greases and lubricating oils to gasoline and other so-called "light end" products, such as ethylene and propylene gas.

The refining process starts with distillation of crude, which separates the raw material into natural gasolines, kerosene, fuel oils. The distillates are processed in order to get a maximum yield of gasoline, preferably of the highest octane possible. The heavier distillates are "cracked," either in high-temperature units that break up the long chains of molecules into lighter products, or in units that use a catalyst. In both cat cracking and thermal cracking a lot of light gases such as propylene, and ethylene are produced. These are the feed stock for Texaco's polymerization plant.

• **Choice for Upgrading**—The gas is about 30% propylene, with the balance ethylene and propane, and sometimes a little butane. Propylene, in liquid form, is worth about $1.10 a bbl. But if you can hook the molecules of propylene together, they make a liquid that is a useful component of high-test gasoline worth $5 a bbl. That, simply, is the reason for the existence of the polymerization unit.

The plant handles about 15-million cu. ft. of gas per day. It comes directly from the cat and thermal crackers—there is no storage space in between—so if the polymerization plant isn't working full steam it has to pass raw material by, failing to recover full value from it. And there is no recovering a badly processed lot—the gas goes through the plant once and is then on its way to other processes or for use as fuel.

• **Catalytic Action**—The computer at the polymerization plant controls reactions that take place in beds of phosphoric acid on Kieselguhr packed in tall pressure vessels called catalyst cases. There are 10 cases, each with three beds of catalyst.

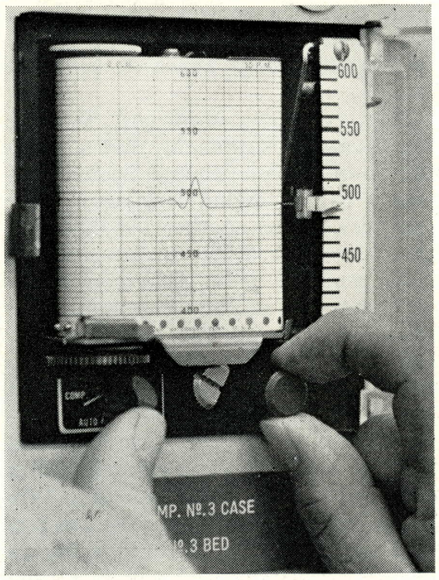
Since the polymerization reaction generates considerable heat, the temperature of each catalyst bed is critical. If the temperature is too low, the reaction doesn't occur. If the temperature is too high, the catalyst will deteriorate.

Ideally, the temperature should be held between 470F and 490F at a pressure of 700 to 740 psi. But that is a difficult job. A number of things can cause temperatures to fluctuate widely. The cat crackers may change feed, which alters the proportion of propylene in the raw material flow. Thermal crackers coming on stream will dilute the mix and drop the temperature.

• **Reacting to Bumps**—Fluctuations or "bumps" in feed set the pens on the temperature indicators in the plant control room jiggling like seismographs in an earthquake. It can take half a day or more to get the plant settled again, if the reactions of the operators aren't lightning fast. A computer, scanning readings at hundreds per second, can react fast enough to sooth the plant down quickly.

Closer control of temperature and quicker reactions to bumps—two of the chief objectives of the computer control system—will do two things at the Texaco plant:

• It will boost efficiency from the historical 85% to 87% conversion rate that processing experts consider tops, using the best operators and automatic record-controllers. The computer should run the plant at a minimum efficiency of 93%.



RECORDER CONTROLLERS can be set by hand, or directed by computer. Bump in chart shows effects of feed change.

• It will prolong catalyst life, because the reaction can be balanced for most economical yield. Right now, a catalyst bed lasts about three months. It could last up to six months. Such a reduction in catalyst renewal rate would save up to $75,000 per year. Catalyst replacement now costs about $150,000 annually plus the unaccounted cost of lost product while the unit is out of the running.

"If we realize both objectives," smiles Texaco's Richker, "we'll make some real money on this thing."

IV. A Big Start

After only a couple of weeks of running, Richker and other Texaco refining experts feel that there is little doubt that the plant will be a success.

"You know, it's a funny thing," muses Richker, "but when we first started fooling with computer-control ideas about three years ago, it looked like Buck Rogers stuff. Of course, then the hardware wasn't ready. But now, when we see the flare blaze when the cat cracker gets a little out of line—and that means dollars are burning—it's not too hard to see the reason for eventually putting the big catalytic units on computer control."

• **Still Horse and Buggy**—But the difference between putting a cat cracker on computer control and running Texaco's relatively simple polymerization unit is in about the same relationship as building a horse-drawn carriage and a supersonic airplane.

The computer at the polymerization plant automatically records about 34 values on its log sheets. Seven, such as catalytic activity level, are calculated from raw data, and 21 are hourly averages. The computer can gather information from 110 sources. And it's output controls 16 flows, pressures, and temperatures.

To do the same control job on a catalytic cracking unit that processes 100,000 bbl. daily would involve hundreds of complex interrelationships—many of which are only little understood—compared with only seven basic "loops" on the polymerization unit. Inputs might mount to a thousand or more for a cat cracker, and outputs to the controls in the many dozens.

"It's not a job we can do tomorrow," says Henry Flynn, works manager at Port Arthur, "but when you consider how much we could save by controlling one of the big units, it is beginning to look more than practical. Six years ago it was over the hill—absolutely out of sight. Now, it's just a matter of a few more years of hard work."

• **Other Entries**—Texaco won't for long be the only company with a computer-controlled plant. At least two others will start up before yearend—both under the guidance of RW-300 computers.

Monsanto Chemical Co. expects to have the first chemical plant under computer control sometime this fall. Its use and location are still a closely guarded secret, because, say Monsanto spokesmen, "We spent an awful lot of money to find out where the computer would work best, and we don't want to hand out free information to our competition."

B. F. Goodrich Chemical Co., not so shy about revealing its decision, is building a new plant "specifically designed for computer control" to produce vinyl chloride at its Calvert City (Ky.) plant.

The three plants neatly bracket the market for control computers. Monsanto's will be in an existing chemical plant, Texaco's in an existing refinery unit. They will both provide good evidence of the improvement possibilities in using computers to modernize older equipment.

The Goodrich plant, if it is indeed designed from bottom to top as a computer-run unit, may well be able to show even larger productivity gains. But until late summer, at least, when the next computer-controlled plant goes on line, industry's eyes will be on Texaco's polymerization unit.

COMPUTER CONTROL SYSTEMS

DATA-LOGGING AND SCANNING SYSTEMS

SYSTEMS ENGINEERING

RW-300 DIGITAL CONTROL COMPUTER

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

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