Mobil news release

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COMPUTER AT MOBIL CONTROLS PRODUCTION TO MAINTAIN HIGHEST PROFIT LEVEL

PAULSBORO, N.J., May 24 . . . A team of scientists and engineers has developed a computer-based production system at Mobil Oil Corporation's refinery here that responds automatically to changing feed stocks and shifting prices for petroleum products.

Pricing information, which reflects anticipated demand, is entered into an IBM 1800 data acquisition and control system that also controls production of products such as liquid petroleum gas, gasoline and heating oil. The computer then determines the most economical way to procduce these products and automatically adjusts controls in the refining process.

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Oil Refineries were among the first industrial processes to be controlled by computers. But until now the effect of projected market demand on specific production units has been calculated "off-line" by computers other than those controlling the process. With the 1800 system, Mobil is now able to include market demand among the many other variables that affect procduction. In this way, refining equipment can be operated as profitably as possible at all times.

The basic production equipment under computer control is called a Thermofor Catalytic Cracking (TCC) unit. In order to "crack" big molecules into small ones and increase the yield of gasoline, the TCC unit passes heated oil through a Mobil-developed catalyst. The mixture of hot vapors and oil is then distilled and the various products are drawn off. The unit, which operates around the clock, processes up to 20,000 barrels of oil a day.

The 1800 system is capable of simulating the entire TCC process mathematically. This technique -- called mathematical modeling -- enables the computer to calculate the required combinations of temperature, pressures and other variables and adjust the TCC controls accordingly.

Mobil's mathematical model of the process is based on fundamental principles of physics and chemistry, and it is more reliable than models based solely on observations of the actual production process.

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Sensing devices such as thermocouples and pressure guages are attached to the TCC unit and continuously monitor the process at 250 points. The computer collects data from these devices and makes any necessary adjustments to keep the unit operating at peak efficiency.

The IBM 1800 is also used to produce routine reports and solve engineering problems, without interrupting routine process-control operations.

Members of the Mobil team that developed the system presented a paper on "Modeling and Optimization of TCC for Computer Control". at the American Petroleum Institute on May 15.

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Computerized MICS system is asset at Joliet

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AT Mobil's new facility in Joliet, Ill., a two-level management information and control system (MICS) was "designed in" to support operations at the refinery. Ready at start-up time, MICS has proved a valuable asset.

This article taken from paper presented before NPRA Computer Conference, Nov. 5-7, Chicago.

The Joliet plant is the largest (164,000 b/sd) grass-roots refinery ever built in the United States. It is also the newest, having gone through a remarkably smooth start-up, leading to full production early this year.

But this refinery is more than just big and new. It:

- Can handle both sweet and sour crude.
- Uses proven processes and large single-train units.
- Is a big fuel maker (high conversion of crude to gasoline and distillates).
- Has excellent environmental-protection and energy-conservation systems.
- Is aesthetically pleasing.
- Was designed, built, started up, and now operates taking full advantage of the computerized MICS.

MICS objectives. Before ground was broken at the Joliet site, the idea was well established that computers could assist in raising the productivity and efficiency of operations. Objectives for the MICS system were set forth, and remain unchanged. The system shall provide:

- A management information and control system for the entire refinery.
- Closed-loop control capability for individual units.
- Capability to integrate stand-alone support computers into the overall system.
- Facilities to permit communication with other computers (remote or local) for administrative and technical applications.

These objectives were to be achieved in a manner consistent with the following operational philosophy:

- The refinery should be operable without the computer. Conventional analog instrumentation, computer compatible, should be used for the lowest control levels.
- Provisions for advanced control technology (e.g., supervisory and DDC) should be made where choices exist. There should be no built-in constraints to growth or enhancement.
- Proven hardware and software should be used to minimize downtime and development work.
- On-line material and yield calculations should be limited to those situations which require on-line data. Off-line work should be done off-line, on separate equipment.

The hardware. In the MICS hardware (Fig. 1), note that there are two levels of operation. The control level gathers discrete data. The management-information level interprets and refines the data into useful information.

At the control level, an IBM 1800 is directly connected to some 800 process signals (flows, pressures, stream analyzers, etc.). In addition, about 500 temperatures are remote-multi-

Fig. 1

MICS hardware

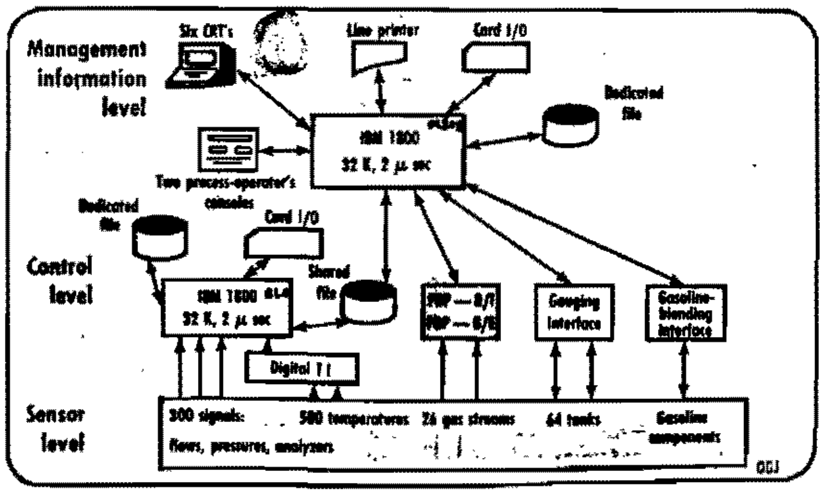


Fig. 2

Quick look at entire refinery

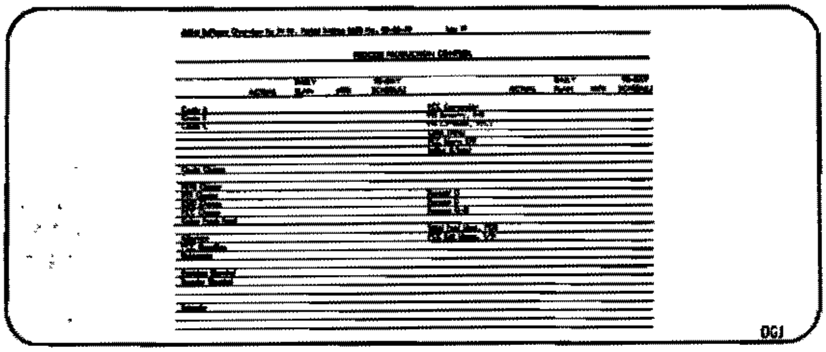


Fig. 3

Detailed morning report

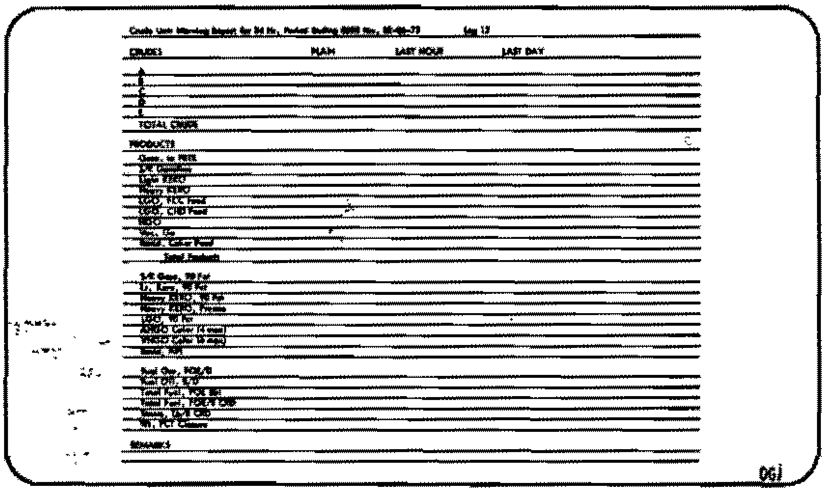
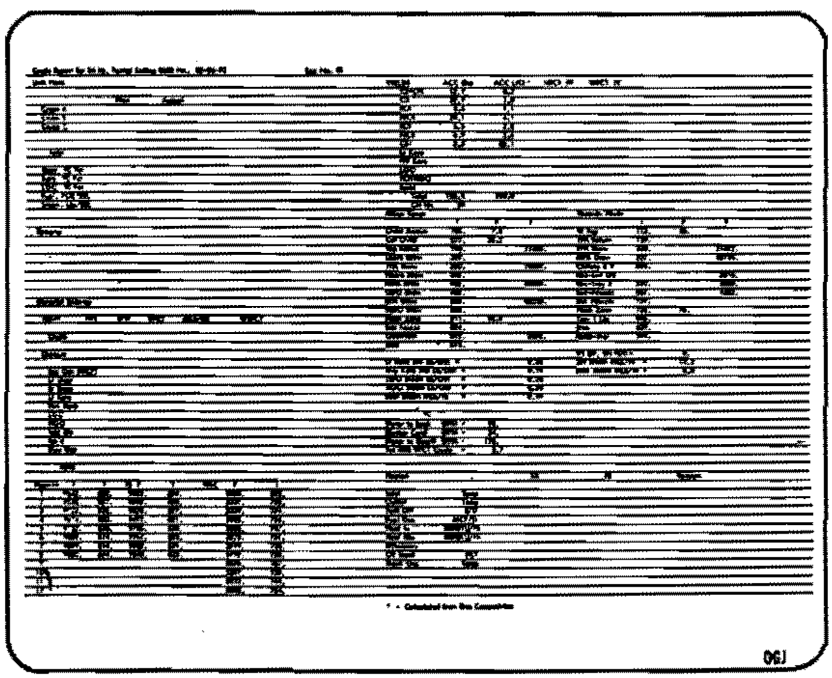


Fig. 4

Unit summary



plexed to the 1800 via digital temperature indicators. The control level 1800 has its own card reader-punch and disk storage.

An important part of the data base is the analysis of refinery light ends. This is accomplished with a Mobil-developed process chromatograph package. This stand-alone system consists of two Digital Equipment Corp. PDP-8 computers, 10 gas chromatographs analyzing 26 streams, and the requisite interface equipment. Stream analyses are transmitted directly to the upper (management-information) level 1800 using digital input-output. In a similar manner, tank-gauging and gasoline-blending data are tied to the upper-level system.

A sophisticated communication path is provided between the upper and lower-level 1800's in the form of a shared disk file. Either 1800 can read from or write to this common mass-storage area totaling 7.5-million characters. It is not necessary for the 1800's to interrupt each other ("shake hands") before communicating. Instead, the sending computer leaves its message in the shared file and goes ahead with other work. The receiving computer picks up the data as needed.

In short, shared disks permit fast, asynchronous data transfers in substantial volume, with minimum system overhead and programming.

Data from all the control-level equipment cited converge into a single management-information-level computer. This second IBM 1800 has dedicated card input/output, disk storage and a high-speed line printer, plus the shared file already described. The prime function of this level is to interpret, classify, and organize data into meaningful information for a broad spectrum of users in the refinery.

Displays. Random inquiries are made through the keyboards of cathode ray tube terminals (IBM 2260). The CRT displays are organized to provide as much as or as little "coaching" as the user wants. He will usually know how to call for frequently used displays. He can also request a "menu" or procedures to guide him when necessary.

Keyboard manipulation is held to a minimum; the user is never required to press more than five keys to call forth a display. Response time (the period between request and display) is normally 3 to 5 seconds.

Information is formatted to "net out" answers to user questions. For example, when a tank gauge is called for, the display gives not only the instantaneous level (in feet, inches, and sixteenths), but also:

- Temperature.
- Total inventory in bbl corrected to 60° F.
- Available inventory in bbl (volume above pump suction).
- Net change in inventory, since start of the refinery day (6 a.m.).
- Identity of product or material.
- API gravity.

This is an illustration of the distinction, previously alluded to, between raw data and information. Wherever possible, displays provide associated information and carry out calculations (equipment efficiency, fouling factors, variance from plan, etc.) to tell the user what he really wants to know.

There are six CRT terminals located throughout the operating area. Addition of terminals for the administration building and for the laboratory are currently planned.

Two special-purpose "process-operations consoles" are provided in the control room to augment the CRT's. These use small neon lamps for displays and use "function buttons" (rather than a keyboard) for input.

It should be noted that consistent nomenclature has been maintained between the computer and the instrumentation throughout the plant to keep a "one-name, one-variable" relationship. This has helped immeasurably in the area of user acceptance.

Fig. 5

MICS plan development

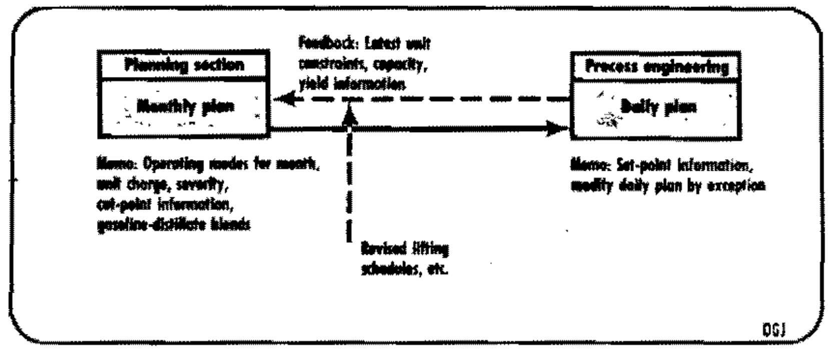
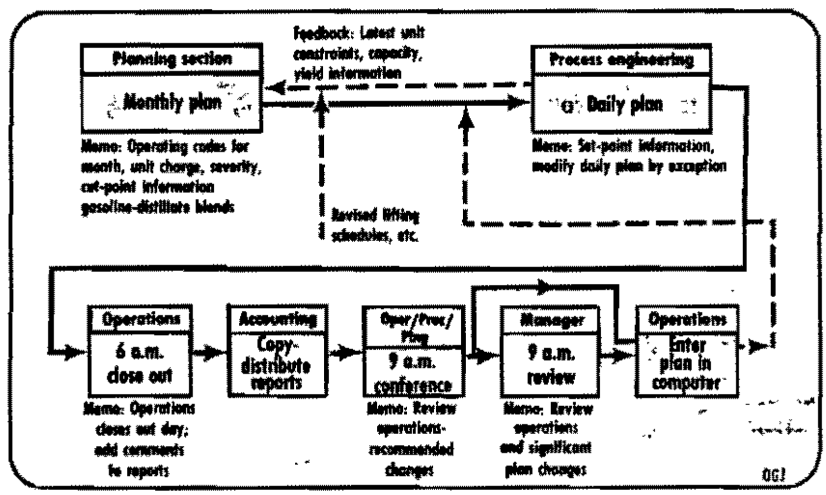


Fig. 6

MICS report development



Software. Operating systems for the two 1800's are:

- TSX (time shared executive) for the control level.
- MPX (multi-programming executive) for the management-information level.

IBM "Prospro II" software does the scanning, alarming, conversion to engineering units, and performance of calculations such as correction of flow rates for temperature, pressure, and gravity. Prospro II also provides an organized data base from which the display terminal responses are drawn, and from which daily reports are prepared.

Closed-loop control facilities are inherent to Prospro II at both the supervisory and direct-digital-control level. The use of packaged software greatly facilitated implementation and was consistent with the Joliet objectives and philosophy.

The fill-in-the-blank features of Prospro simplify variable specification and processing, and make it easy to install changes.

Gas-chromatograph control and analysis on the PDP-8's are done by a Mobil package program which had been developed and tested at other locations.

Levels of information. Data displays, whether by CRT or printed reports, are designed to give the user as broad or narrow a view of the refinery as he needs. Figs. 2-4 are typical printed reports. (For confidentiality, most of the data has been deleted).

For a quick look, there is a single-page overview with critical measurements for the entire refinery (Fig. 2). This is valuable to everyone, especially refinery top management, as critical unit-throughput rates and key operating variables are highlighted.

More detailed "morning reports" for each of the major units show performance figures (Fig. 3). Further levels of detail information are provided by a unit summary (Fig. 4) and other special reports, where needed.

Note that "variance from plan" is a critical measurement, as seen in Figs. 2-4. Comments and remarks pertinent to such variances are entered through terminal keyboards for inclusion on most daily reports.

In addition to the process-oriented facilities, an IBM 1130 computer extends MICS by performing administrative and technical application off-line. Except for certain periods when the 1130 is dedicated to scheduled work (such as communication with the corporate data center), this machine is available on an "open-shop" basis to all comers. Already developed are applications for personnel records, accounting work, engineering calculations, project evaluation, etc.

Planning cycle. The MICS system is

an integral part of the daily planning cycle (Fig. 5). The beginning of the cycle is development of a monthly plan by the economics and planning group. This monthly plan contains various operating modes depending on crude input, type of distillate produced, etc.

As a starting point for the daily plan, an appropriate mode is selected from the monthly plan by process engineering. As the month progresses, changes in the planning assumptions, such as revised lifting schedules, new unit constraints and capacity, and unexpected yield patterns, are factored in. Fig. 6 shows the method by which the plan is implemented.

The refinery day closes out at 6 a.m. Before generation of the reports, the operating group adds appropriate remarks and explanation of variance from plan. Accounting collects the computer reports, copies, collates, and distributes them prior to 8 a.m. At 9 a.m., representatives of operating, planning, and process engineering confer to review the previous day's operation and to make appropriate plan revisions for the next day.

Simultaneously, the refinery manager and his staff are reviewing the computer reports. Recommendations of significant changes in the plan are presented to the manager at this time for concurrence. All plan changes are then entered into the computer by an operating clerk.

This scheme has allowed Joliet to achieve the goal of dynamic target setting.

Benefits during start-up. The most important benefits realized to date have been in the area of dynamic goal-setting and control as described in the previous section. Other benefits arose during start-up, when the MICS system was able to provide and document critical operating information. For example, a detailed log could be produced on demand to show the status of selected variables at 5-min. intervals for any period during the preceeding 24 hrs. This proved to have important value in developing event sequences for troubleshooting. Also, visual display of stream analysis allowed operating personnel to "line out" the operation of light-hydrocarbon fractionators quickly and maintain recovery of light ends to economically acceptable standards.

The Joliet start-up was unusually smooth. It would be presumptous to give MICS much of the credit, but there is no doubt it made a positive contribution.

Benefits today. MICS gives time-correlated information. All tanks are gauged within a very brief interval, adding greatly to the accuracy of, and confidence in, material-balance and yield reports.

MICS relieves the operator of logging chores. The Joliet emphasis is on computer reports, not manually prepared logs. There are good reasons for this:

- Logging, as the least-important activity, is the first to be dropped when things get hectic. "Too busy" is the familiar inscription found by troubleshooters who try to analyze manual log sheets covering difficult periods of operation.
- We can get more complete and more accurate information from MICS than from manual logs. Spot inquiry and trending are standard functions.
- Operating technicians are freed to perform more important tasks.

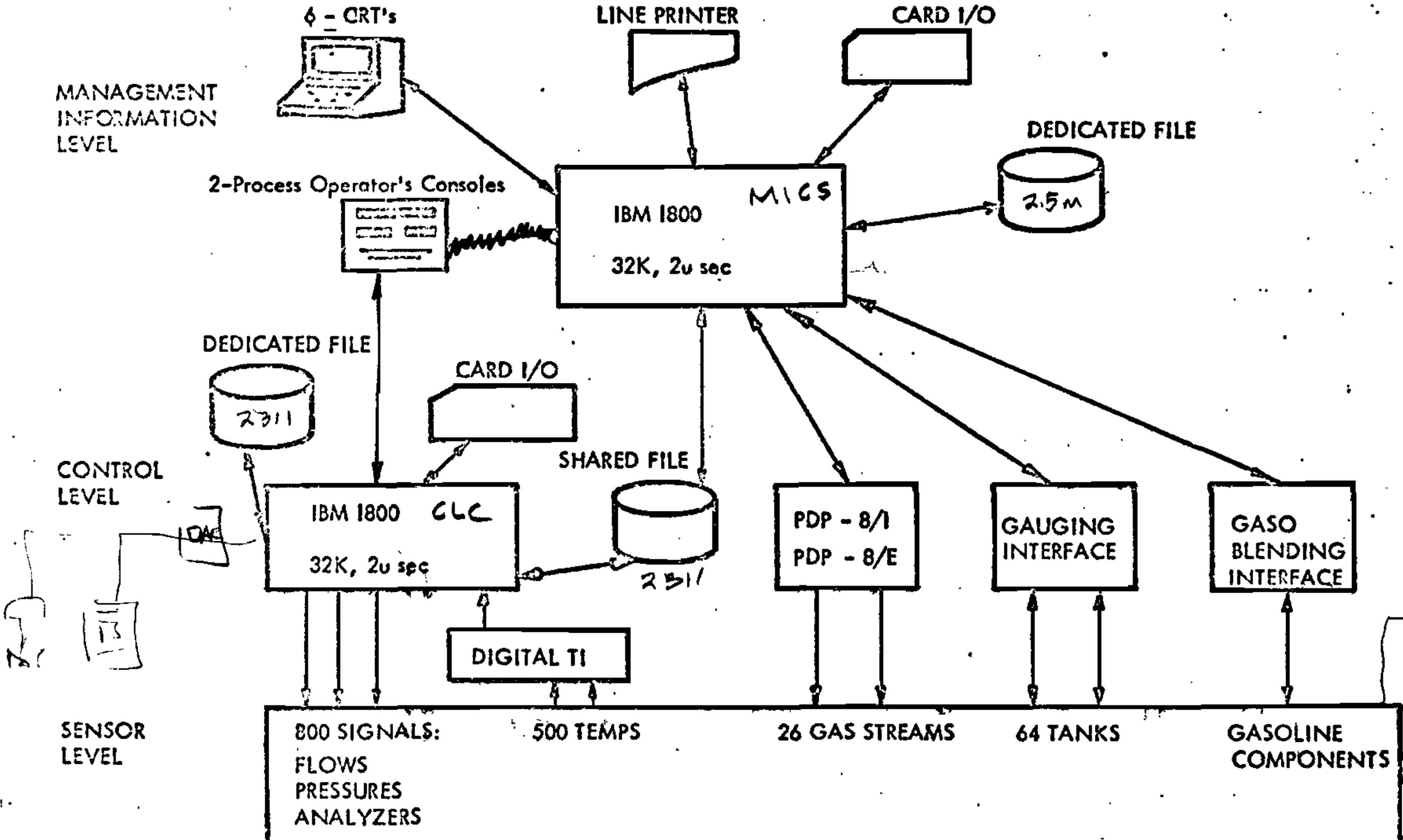
Many of the benefits of MICS could be obtained manually, but like most manual work, it would then be subject to bias and human error. Not so the the computer. Here, everyone in the organization, managers, unit supervisors, engineers, and operating technicians, sees the same plan and results. There is little chance of miscommunication.

MICS helps our employees find pride in their work. Joliet is a modern and attractive work place; tools like MICS provide an added level of challenge and excitement.

Future plans. MICS will continue to undergo minor improvements and adjustment, as our requirements shift, and as we continue to gain skill in using the system. Benefits are expected not only from enhancements to MICS, but also from our work in closed-loop control.

Gas-plant distillation towers (light ends) have been chosen as the most promising first application. These towers interact strongly, are often heavily loaded, and are subject to cycling in feedstock quality. Computer control here should give us a greater incremental return than might be expected from a more stable but, less dynamic application.

We are pleased with the results so far achieved from MICS, and plan a continuing commitment towards full exploitation of this powerful tool. END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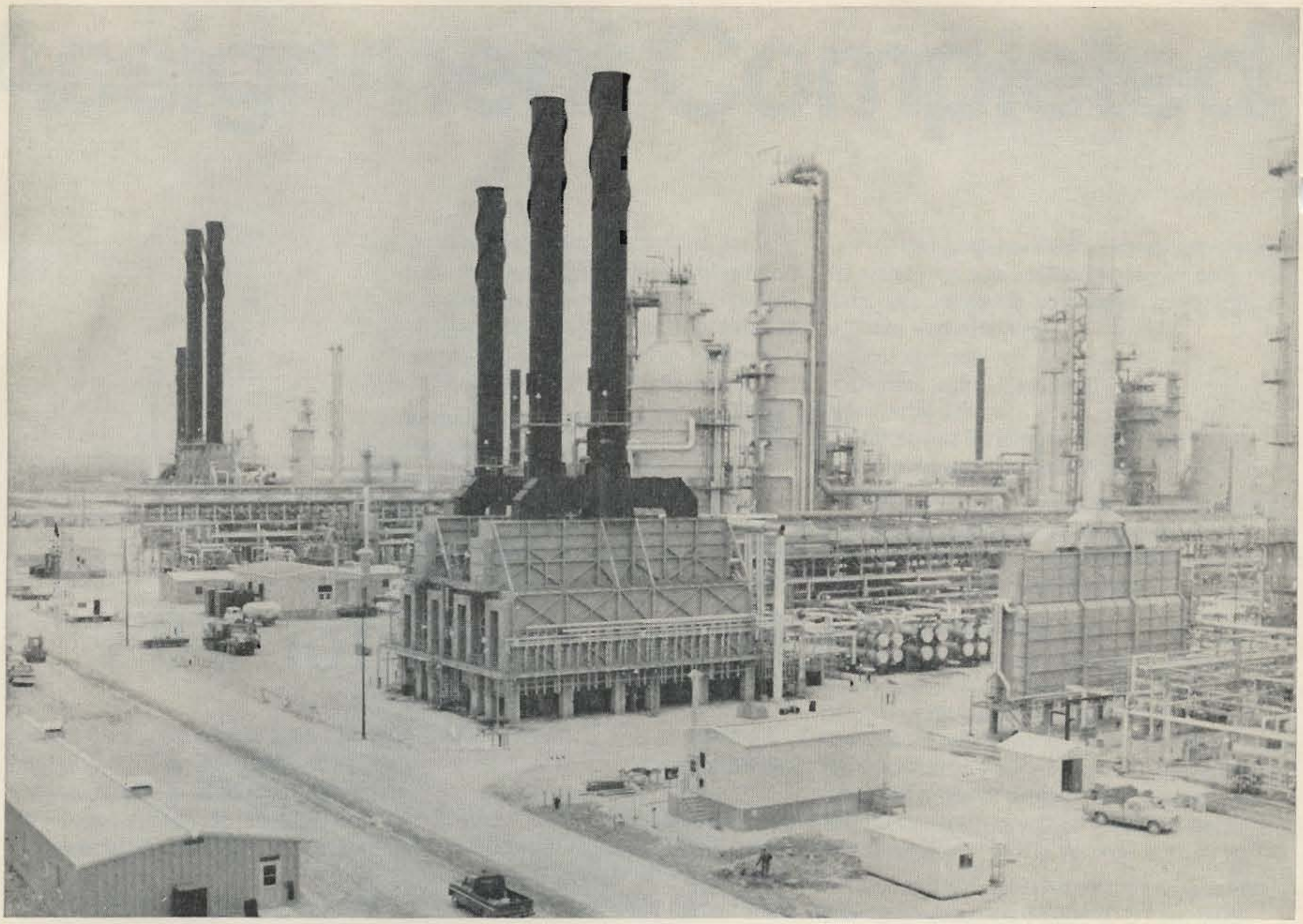
LINE PRINTER
CARD I/O
MANAGEMENT INFORMATION LEVEL
DEDICATED FILE
2.5 M
2-Process Operator's Consoles
IBM 1800
MICS
32K, 2u sec
DEDICATED FILE
2311
CARD I/O
SHARED FILE
2311
CONTROL LEVEL
IBM 1800
CLC
32K, 2u sec
PDP - 8/I
PDP - 8/E
GAUGING INTERFACE
GASO BLENDING INTERFACE
DIGITAL TI
SENSOR LEVEL
800 SIGNALS:
FLOWS
PRESSURES
ANALYZERS
500 TEMPS
26 GAS STREAMS
64 TANKS
GASOLINE COMPONENTS

Figure 1



MOBIL'S big new refinery at Joliet, Ill., is now on stream.

Fig. 2

Plot plan of refinery