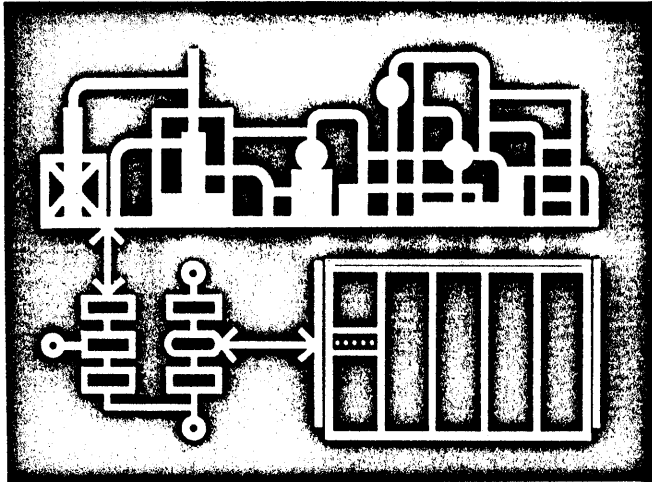


**COMPUTERS
IN
CONTROL**

THE COMPUTER CONTROL CONCEPT



An industrial process can be operated more profitably under computer control. Even the most experienced operators cannot take into account all the complex interrelationships between process variables, and thus cannot consistently determine the most profitable control settings. The digital computer, on the other hand, because it can perform thousands of operations a second, can make use of every interrelationship and then adjust controller setpoints for the most profitable operation. Furthermore, a computer is not subject to the fatigue and distraction that lead to process upsets, yield losses, and substandard product quality.

As early as 1955 TRW recognized and began work on this concept. This work resulted in the development of the first digital computer designed specifically for process control. The first TRW control computer went on line in March 1959.

Since then, TRW computers have closed the loop in industry after industry. By the fall of 1963, TRW computers had logged over one million hours of operation, and had established a reliability record of better than 99 percent. By maintaining product quality at minimum cost, these TRW computers are returning customer investments, on the average, in less than three years.

Together with its associates — International Systems Control Ltd. in Great Britain, Compagnie Europeenne d'Automatisme Electronique in Europe, and Mitsubishi-TRW in Japan — TRW has applied the computer control concept to more operating installations than all other computer manufacturers combined. This comprehensive background of experience in automatic control is illustrated by the applications described in this booklet, applications that are typical of many others now in progress throughout the world.

Applications In CEMENT and GLASS

DRY-PROCESS CEMENT KILNS

At the Riverside Cement Company plant at Oro Grande, California, a TRW computer is controlling kilns No. 6 and 7, two 310-foot dry-process preheater kilns. The computer also makes daily calculations for quarrying and blending raw materials, keeps a complete record of the origin, weight, and chemical composition of these materials, and logs kiln data. This was the first digital computer to be applied to process control in cement manufacturing.

WET-PROCESS CEMENT KILNS

Chichibu Cement Company's new plant at Kumagaya, near Tokyo, is the world's first cement plant designed and constructed for computer control. Four wet-process rotary kilns are controlled and optimized by the TRW computer system. In addition to determining optimum kiln control setpoints, the TRW computer system schedules raw materials from hoppers to mills, from mills to slurry tanks, and from slurry tanks to slurry basins.

GLASS CUTTING

A major overseas glass producer has installed three TRW computers in a system to automate a glass cutting plant. The computer system has made it possible to integrate all factory operations, from the receipt of the order from the customer to the delivery of the completed job to the customer.

WET-PROCESS CEMENT KILNS

Tokuyama Soda Company, Ltd., Tokuyama City, Japan, has installed a TRW control computer system at its Nanyo Works, one of the most modern cement plants in the world. The two rotary kilns are nearly 650 feet long and over 17 feet in diameter. The TRW computer system provides integrated closed-loop control of the wet-process kilns, the continuous slurry blending system, and the clinker burning operations.

DRY-PROCESS CEMENT KILNS

Riverside Cement Company has ordered a second TRW computer system, for delivery in mid-1964, to control kilns No. 1 through 5 at the Oro Grande plant. The computer system will control nine subloops for each of the five kilns.

Applications In ELECTRIC POWER

NUCLEAR POWER PLANT

At its nuclear power plant near Chinon, France, Electricite de France is using two TRW computers on the EDF-1 reactor. These two computer systems continuously monitor the radioactivity of carbon dioxide cooling gas as it flows through 1149 channels in the nuclear reactor. On a rise in radioactivity — which denotes a rupture of the uranium fuel cases — the computers are programmed to initiate immediate corrective action.

STEAM POWER STATION

Two TRW computers are being used by Electricite de France to control a 250-megawatt steam power generating station at St. Ouen, France. The computer system monitors more than 600 process variables and automatically controls plant operation to minimize power output costs.

NUCLEAR POWER PLANT

For its second reactor at its Chinon, France, nuclear power plant, Electricite de France is using two TRW computers to monitor radioactivity. This reactor, EDF-2, like the EDF-1 reactor uses carbon dioxide cooling gas flowing through 1149 channels in the reactor. The computers continuously monitor the radioactivity of this gas, and, on a rise in radioactivity — which denotes a rupture of the uranium fuel cases — the computers are programmed to initiate immediate corrective action.

ELECTRIC POWER DISPATCH

Electricite de France is using a TRW computer for control of national power dispatching in France. The computer is located in Paris, at the center of the EDF grid that carries power throughout France.

STEAM POWER STATION

Two TRW computer systems have been installed at the Tennessee Valley Authority's Paradise Station near Drakesboro, Kentucky. Each computer system performs closed-loop control on one of the two 650-megawatt, coal-fired boiler-turbine-generator units.

The control functions of each computer system include cold start, hot restart, and emergency shutdown, as well as control of the turbine and steam generator. Other computer functions include sensor scanning, alarm monitoring, trend recording, and control optimizing.

Applications In ELECTRIC POWER

STEAM POWER PLANT

A TRW digital control computer is being used on the Tennessee Valley Authority's Colbert steam plant No. 5 in Tuscumbia, Alabama. For this 500-megawatt unit, the TRW computer is a vital part of the automatic combustion control and digital data system.

STEAM POWER PLANT

The Tennessee Valley Authority will use a TRW computer control system for its new Widow's Creek steam plant Unit No. 8 near Bridgeport, Alabama. This steam unit, scheduled to begin operation in mid-1964, will produce 500 megawatts of power. The computer system will automatically perform sensor scanning and alarm monitoring, data logging, trend recording, and performance calculations.

STEAM POWER PLANT

To perform closed-loop control on its 900-megawatt Unit Number One at the Bull Run Steam Plant — at Edgemoor, Tennessee — the Tennessee Valley Authority has ordered a TRW computer system, to be installed in 1964. Computer system control functions include cold start, hot restart, and emergency shutdown, as well as control of the turbine and steam generator. The computer system is capable of being expanded to closed-loop control of a second, identical, steam unit.

STEAM POWER STATION

An electric utility company overseas has ordered a TRW digital control computer system for a new power station. The computer will be used initially to monitor the operation of two 250-megawatt turbine-generator units. Delivery of the computer system is scheduled for early 1964.

NUCLEAR POWER PLANT

Electricite de France has ordered two TRW digital computers to be used for integrated control of the third nuclear reactor, EDF-3, at the nuclear installation near Chinon, France. With the delivery of these two computers, in 1964, a total of six TRW computers will be monitoring and controlling the reactors at the Chinon nuclear site.

ELECTRIC POWER DISPATCH

Electricite de France has ordered a TRW computer system for controlling local power dispatching, in the Paris area, off the national EDF power grid.

Applications in CHEMICALS and PETROCHEMICALS

Applications in CHEMICALS and PETROCHEMICALS

PETROCHEMICAL PLANT

Union Carbide Olefins Company is using a TRW computer for closed-loop control of a chemical plant at Seadrift, Texas. The plant produces petrochemicals.

VINYL CHLORIDE PLANT

The B. F. Goodrich Chemical plant in Calvert City, Kentucky, uses a TRW computer system for closed-loop control of two process units, one producing a high-purity vinyl chloride monomer, used in vinyl plastics, and another producing acrylonitrile, an ingredient of special-purpose rubber compounds.

AMMONIA PLANT

A TRW computer has been controlling the production of ammonia since January 1960 at Monsanto Chemical Company's Luling, Louisiana, plant. Using adaptive control, the computer automatically revises the mathematical model of the process to make it conform to plant performance characteristics as they change. The Luling plant's production is approximately 500 tons/day.

NATURAL GAS PURIFICATION

At Lacq, France, Societe Nationale des Petroles d'Aquitaine is using a TRW computer system for controlling the purification of natural gas. The computer system receives 80 analog inputs from plant instrumentation and exercises control of the sulphur removal process by means of 10 analog outputs. The Lacq plant is one of the largest sulphur producers in Europe.

PRIMARY OXIDATION UNITS

Celanese Corporation of America is using a TRW computer system to control two of the four primary oxidation units at its CHEMCEL plant at Bishop, Texas. The computer increases the throughput and yield of the non-catalytic vapor-phase process that converts propane and butane to formaldehyde, acetaldehyde, methanol, ethanol, acetic acid, acetone, and other chemicals.

CHEMICAL PLANT

In December of 1960, a TRW computer was the first control computer to be installed in a chemical plant in Europe. Badische Anilin- und Soda-Fabrik AG, West Germany's second largest chemical company, uses this TRW computer system for closed-loop process control in their plant at Ludwigshafen am Rhein. The computer monitors more than 75 variables and controls 15 variables of the chemical process. It also performs regular logging functions.

INDUSTRIAL ALCOHOL PLANT

A TRW computer system keeps a constant check on plant conditions and operations at Continental Oil Company's new ten-million-dollar "ALFOL" industrial alcohol plant at Lake Charles, Louisiana. The products are used principally in the synthetic detergent and plastics industries. The control computer system is used primarily to compute various unit operations factors, to monitor and log data during and after startup of the plant, to follow trends through digital printouts of both measured and calculated variables, and to monitor and check instruments and equipment.

STYRENE BUTADIENE RUBBER

Firestone Tire and Rubber Company has installed a TRW computer at its Lake Charles, Louisiana, styrene butadiene synthetic rubber plant. In addition to assuring high product quality and uniformity, the closed-loop computer system aids in reducing operating costs by decreasing the amount of off-specification rubber and by maximizing production capacity.

ETHYLENE PLANT

At Lake Charles, Louisiana, Petroleum Chemicals, Inc. has installed a TRW computer to control the ethylene plant. This computer system performs a number of control calculations, including material and energy balances, conversions, and yields. Other functions of the system include scanning of instruments, alarming of off-normal variables, and logging of operating records.

Applications in CHEMICALS and PETROCHEMICALS

AMMONIA PLANT

A TRW computer has been installed by Allied Chemical Corporation to control the 900-ton/day ammonia plant at Ironton, Ohio. The computer system senses more than 300 process variables and controls more than 60 process variables, including temperatures, critical flow rates, and other operating conditions.

ETHYLENE

Nippon Petrochemicals Company, Ltd. has installed a TRW computer to control the Chidori ethylene plant in Kawasaki, Japan. The computer system has over 400 analog inputs and more than 40 analog outputs. The fundamental objective of the computer system is to operate the entire plant for maximum profit during periods of either maximum or limited demands in production.

STYRENE BUTADIENE RUBBER

For the styrene butadiene synthetic rubber plant at Borger, Texas, Phillips Petroleum Company has installed a TRW control computer. The computer system exercises closed-loop control over the SBR process, maintaining high product quality while at the same time minimizing production costs. Phillips Petroleum is also using a TRW "Computermobile", described later in this booklet.

VINYL CHLORIDE

Kureha Chemical Company, Ltd. has installed a TRW computer system to control its vinyl chloride plant at Nakoso City, Japan. The 30,000-ton-per-year plant is scheduled to go on stream in January 1964.

AMMONIA

A TRW computer is being used for closed-loop control of the 800-ton/day ammonia plant at El Dorado, Arkansas, by Monsanto Chemical Company. This is the third TRW computer used by Monsanto, and the second Monsanto has installed to control an ammonia plant.

Applications in STEEL

BASIC OXYGEN STEEL FURNACES

A TRW computer system, at the Detroit plant of Great Lakes Steel Corporation, is controlling the world's largest basic oxygen steel furnaces. The TRW computer determines the amounts and types of additives required for each heat, and the flow rate and duration of the blow.

L-D CONVERTER

Usinor Steel Company has installed a TRW computer system to control an L-D converter at its Denain, France, plant. The computer system calculates and controls the charge and the oxygen blow.

COLD ROLLING MILL

A TRW computer system is being used by the Steel Company of Wales on a 4-stand tandem cold rolling mill at its Port Talbot, England, plant. The control computer sets up the mill automatically, and in addition supervises an advanced system of automatic gauge control.

BASIC OXYGEN PROCESS

A TRW computer system, installed in a plant of a major steel producer, is being used to conduct dynamic process studies of the basic oxygen furnace process.

OXYGEN STEELMAKING FURNACES

Early in 1964, U. S. Steel Corporation will install a TRW computer system at its Duquesne, Pennsylvania, works to control two 200-ton oxygen steelmaking furnaces. The computer will determine the amounts and types of raw materials required, and will control oxygen flow rate, duration of the oxygen blow, and lance position.

BASIC OXYGEN FURNACES

A TRW computer system will be installed at the Taranto, Italy, plant of Italsider Steel Company. The computer will calculate and control charging and oxygen blowing for a pair of 300-ton basic oxygen furnaces.

BASIC OXYGEN FURNACES

Italsider Steel Company has ordered a TRW computer system for a pair of 300-ton oxygen furnaces at its Bagnoli, Italy, plant. The computer system will calculate and control charging and oxygen blowing for the furnaces.

Applications In PETROLEUM

Applications in PETROLEUM

CATALYTIC POLYMERIZATION UNIT

On March 12, 1959, Texaco's Catalytic Polymerization Unit Number One became the world's first industrial process to be controlled by a digital computer. This unit -- at Port Arthur, Texas -- converts light hydrocarbons to polymer gasoline. Besides adjusting process variables to maximize conversion, the TRW computer checks instrumentation, calibrates chromatographs, and logs process variables. For this accomplishment, Thompson Ramo Wooldridge, jointly with Texaco, Inc., was awarded, in 1961, a KIRKPATRICK MERIT AWARD.

FLUID CATALYTIC CRACKER

A TRW computer at the Gulf Oil Corporation plant in Philadelphia, Pennsylvania, controls a 60,000-barrel-per-day fluid catalytic cracking unit. The cracking unit, one of the largest in the country, produces high octane motor fuel, liquid butanes, liquid propanes, and fuel oils. The computer control system employs information on feedstock characteristics, catalyst characteristics, and market factors to control operating conditions, such as reactor temperatures and recycle rate, to achieve a significant increase in value of products.

ALKYLATION UNIT

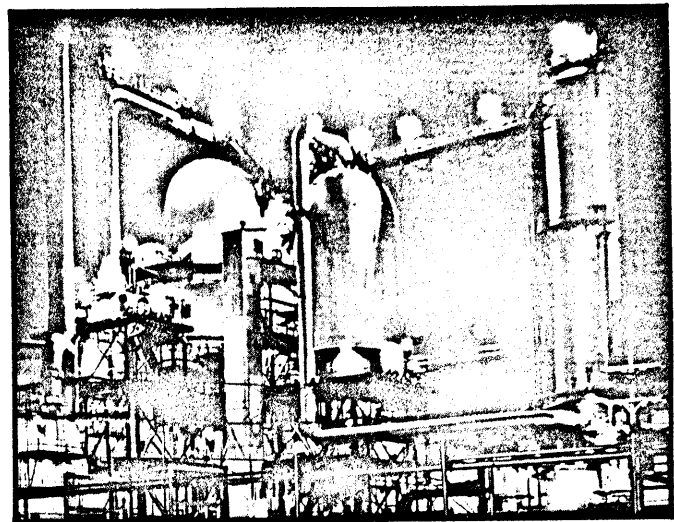
At American Oil Company's 35,000-bpd refinery at Salt Lake City, the alkylation unit is being controlled by a TRW computer. The computer exercises control in both the reactor and recovery sections. In the reactor section it determines the optimum acid discard strength; in the recovery section it optimizes the recycle rate, the fractionating tower pressure, and the composition of the product streams. The optimization provides additional capacity, reduces acid consumption, increases octane number and yield of light alkylate, and reduces steam costs.

OIL REFINERY

In British Petroleum's new refinery at Belfast, Northern Ireland, a TRW computer system will be used in a major control engineering project. One of British Petroleum's objectives in this project is to investigate the feasibility of integrating the control of an oil refinery. In this installation, British Petroleum will seek to apply the benefits of coordinated computer control to every aspect of the refining process.

CRUDE STILL

Sunray DX Oil Company is using a TRW computer system to perform on-line, closed-loop control of the crude oil distillation unit at the Tulsa refinery. This 85,000-barrel-per-day unit is a three-stage distillation process producing straight run gasoline, naphtha, kerosene, heating oils, fuel oil, asphalts, cracking stocks, and stocks used in the production of lubricating oils and waxes.



Gulf Oil's Philadelphia refinery, F.C.C. unit No. 1202

THERMOFOR CATALYTIC CRACKER

Early in 1964, Socony Mobil Oil Company will install a TRW control computer on a thermoform catalytic cracking unit at its Paulsboro, New Jersey, refinery. With this computer system, Socony will undertake a major research project to study and evaluate the merits of on-line computer control of the TCC unit. The project will also investigate the feasibility of using the control computer to integrate refinery operations.

FLUID CATALYTIC CRACKER

A TRW computer control system, to be delivered in 1964, will be used by Texaco, Inc. to control fluid catalytic cracking unit No. 3 at the Port Arthur, Texas, refinery. This is the second TRW computer system purchased by Texaco.

Applications in APPLIED RESEARCH

PETROCHEMICAL PILOT PLANT

Union Carbide Olefins Company is using a TRW computer system to control a pilot plant in South Charleston, West Virginia. A petrochemical process is being studied.

PETROCHEMICAL PILOT PLANT

A TRW computer system has been installed by Union Carbide Olefins Company for a petrochemical process pilot plant at South Charleston, West Virginia. This is the third TRW computer purchased by Union Carbide, the second for pilot plant control.

WEATHER FORECASTING

Bendix Corporation has used a TRW control computer to collect and process meteorological and geophysical data for the United States Air Force. Airborne in a Boeing 707 jet, the computer took geophysical data from sensors, reduced the data in real time, and displayed the results during flight for on-the-spot weather forecasts.

EXPERIMENTAL NUCLEAR REACTOR

For the RAPSODIE nuclear reactor at Centre de Cadarache, the French Atomic Energy Commission has installed a TRW computer. The computer monitors and logs operation for the experimental RAPSODIE reactor.

EXPERIMENTAL NUCLEAR REACTOR

At its Clamart, Seine, France, installation, the French Atomic Energy Commission is using a special TRW computer system to monitor PEGASE, an experimental nuclear reactor. This system continuously monitors 200 analog inputs from the reactor.

EXPERIMENTAL NUCLEAR REACTOR

The French Atomic Energy Commission's CABRI reactor, at Centre de Cadarache, is monitored by a TRW computer recording system. Within a few hundred milliseconds, the reactor's power level can be varied from milliwatts to thousands of megawatts. The computer system scans and records variables at high rates, and thus permits high-precision analysis of the phenomena that take place in the atomic pile.

PROCESS STUDIES

At the University of Florida, in Gainesville, a TRW computer is being used for process studies. One of the objectives of this research is to investigate a broad field of control computer applications, with particular emphasis on the computer's role in papermaking.

Applications in APPLIED RESEARCH

AIR TRAFFIC

At the Federal Aviation Agency's Experimental Center in Atlantic City, New Jersey, a TRW computer has been used extensively to simulate complex air traffic control problems. TRW has provided advanced engineering support of this project since February 1959.

SURFACE TRAFFIC

Traffic on Los Angeles' Sunset Boulevard is being controlled by a TRW computer system. The computer analyzes and directs traffic patterns to maintain maximum flow, reacting instantaneously to changing traffic conditions on the crowded thoroughfare.

PROCESS CONTROL RESEARCH

In Cleveland, Ohio, Case Institute of Technology uses a TRW control computer in industrial process control research and education. For the studies at Case, analog computers are used to simulate process operations. These analog signals provide a great number of variables for the TRW digital computer to sense and control.

MOBILE COMPUTER

TRW has delivered an advanced mobile computer center to Phillips Petroleum Company in Bartlesville, Oklahoma. The "Computermobile" is a process control center, complete with a TRW digital control computer, housed in a custom-built, 40-foot trailer. This unit can be moved readily and connected rapidly to equipment in any of Phillips' plants.

DIRECT DIGITAL CONTROL

A TRW on-line digital control computer has been successfully connected directly to the control loops - rather than to subloop controllers - at Monsanto Chemical Company's Texas City, Texas, ethylene plant. Each of the ten control loops used responded as well or better under computer control as under conventional control.

NUCLEAR REACTOR TESTING

The German Atomic Energy Commission has ordered a TRW computer system. The computer will be used to control reactor testing at the Karlsruhe Research Center.

NUCLEAR REACTOR TESTING

Three TRW computer systems have been ordered, for delivery in 1964, by the French Atomic Energy Commission. These computers will be used on-line to control and monitor testing of nuclear reactors.

DIGITAL Applications

DIGITAL Applications

ENVIRONMENTAL TEST LAB

Missile components and subsystems are tested by a TRW computer system at Sperry Utah's Salt Lake City environmental test laboratory. The computer collects data directly from test instrumentation, calculates test results, and prints out results for immediate use. If necessary, the computer can change test chamber environmental conditions, alter test parameters, and adjust special apparatus.



Missile testing at Douglas Aircraft

MISSILE SUBSYSTEM TESTS

Douglas Aircraft uses a TRW control computer system at Santa Monica, California, in closed-loop developmental testing of hydraulic components of missile subsystems. Computer testing does not impair the performance of short-life, high-tolerance components, as does time-consuming manual testing. The Douglas computer feeds test signals to missile controls, samples and analyzes responses of missile control surfaces, and prints out test results on an automatic typewriter.

COMPUTING CENTER

A TRW control computer has been installed in a large computing center in Belgium.

TV PROGRAM SWITCHING

TASCON is a special purpose computer system developed especially for the television industry. Since January 1961, station KNXT — the CBS-owned station in Los Angeles — has been using a TASCON system for automatic sequencing control of TV program switching. The TASCON system can switch audio and video sources on the air for a complete program day, including the high-activity periods just before, during, and after station breaks. TASCON permits immediate changes in switching orders if there is a change in the program schedule.

TV NETWORK SWITCHING

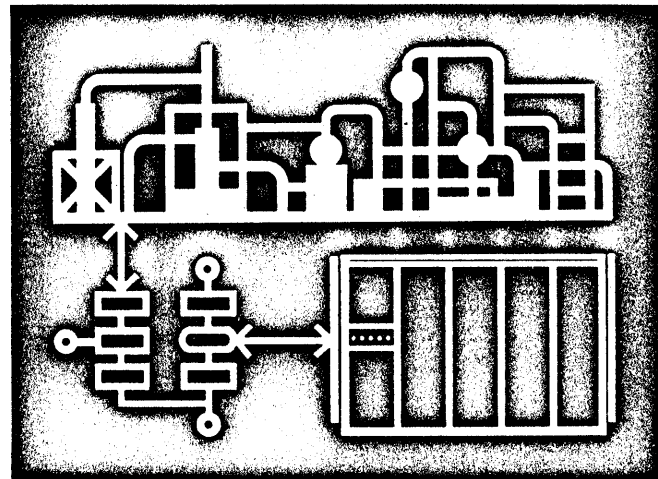
For their Television Productions Center in New York, which goes on the air early in 1964, the Columbia Broadcasting System has ordered two TRW control computers to perform all routine, preplanned switching operations. The computer system will perform on-air continuity switching, facilities assignment switching, and lighting preset storage and retrieval. These will be the second and third TRW computers to be used by CBS. The first has been operating in Los Angeles since the beginning of 1961.

TOLL REGISTRATION

Two TRW computers are being used by a government agency in a toll registration and traffic data collection system. This computer system is operating on one of the nation's most heavily travelled thoroughfares.

ENGINE TESTING

A TRW computer system has been installed at the French government's Centre d'Essais de Propulseurs, where it is being used in engine testing. The computer collects and reduces data while tests are in progress.



OTHER APPLICATIONS

Over a hundred more TRW computer systems have been sold to government customers for various data handling and control problems. Many of these installations are real-time control applications, such as ocean floor mapping, fire control simulation, and satellite tracking.