

INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications Processing, Warehousing, and Order Picking
Type of Industry Frozen Baked Goods Producer
Name of User Kitchens of Sara Lee
Deerfield, Illinois

Equipment Used Honeywell 610 Computer Control System

Synopsis

A Honeywell 610 computer controls production and inventory operations at the Deerfield, Ill., bakery of Kitchens of Sara Lee. This plant, one of the largest bakeries in the world, produces a line of 35 varieties of frozen baked goods. Management's objective is to achieve a smoothly operating line capable of making 120 cakes a minute--all under the supervision of the 610 system.

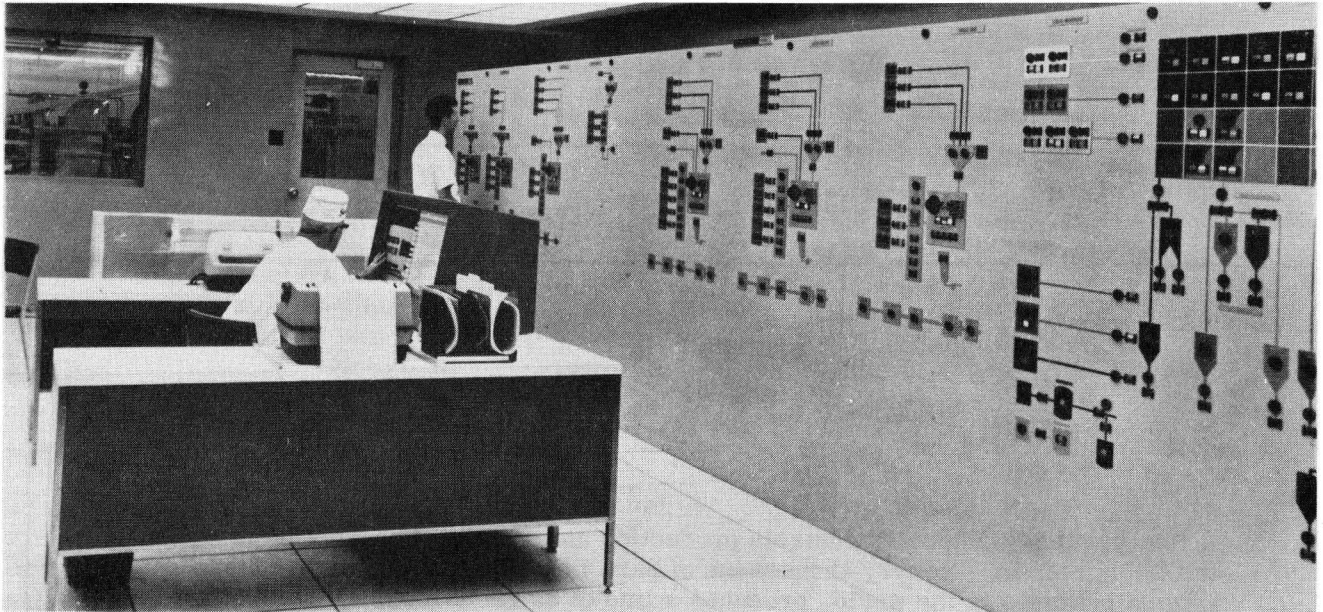
Computer control begins with batter mixing. Major cake ingredients are metered precisely into mixers, following recipes stored in computer memory. The batter is then automatically pumped into hoppers and metered into individual aluminum foil pans in which the cakes are baked and sold. The 610 supervises all aspects of cake baking, cooling, icing and blast freezing before pallet loads are stacked automatically in a freezer warehouse.

The computer directs giant stacker cranes and other materials-handling equipment inside the warehouse to deposit pallets. The location of each pallet load and its production data is automatically stored in computer memory for prompt retrieval on a first in, first out basis.

Founded in 1951 by Charles W. Lubin, Kitchens of Sara Lee has expanded its distribution -- originally limited to the Chicago area -- to cover all 50 U.S. states and Canada. Similarly, the volume of the company, now a subsidiary of Consolidated Foods, has increased steadily from \$400,000 in its first year to over \$65 million.

The product line includes 35 different types of baked goods, with other products being developed. Sara Lee originated the use of aluminum foil pans with laminated covers to package its products. Consumers receive Sara Lee cakes in the same aluminum foil in which they were baked and frozen.

Kitchens of Sara Lee also operates a 40,000 square foot plant in Bramalea, a suburb of Toronto, Canada. The bakery serves all Canada and is geared for a yearly volume of \$5 million.



HONEYWELL 610 COMPUTER CONTROL SYSTEM SUPERVISES PRODUCTION AND WAREHOUSING OF 35 VARIETIES OF FROZEN BAKED GOODS IN THE KITCHENS OF SARA LEE.

THE COMPUTER

The Honeywell 610 process control computer is built around a high speed, general purpose digital computer with input and output subsystems to perform on-line data acquisition and control. The computer is designed to operate in real time and has a basic cycle time of eight microseconds. There are eight distinct buffer systems to permit the processor to proceed with computations while receiving and dispatching multiple inputs and outputs.

The 610's magnetic core memory has a maximum capacity of 16,384 words of random access storage. Each word has a length of 24 bits plus parity. Digital inputs in the form of on-off contact closures are scanned and stored in core memory at a rate of 190,000 contacts per second. Analog inputs are scanned at the rate of 200 points per second. Up to 880 external interrupts can be handled by the system.

The Honeywell 610's principal functions are to (1) monitor bulk storage status and precisely meter the use of liquid and dry ingredients, (2) monitor and control batch blending and mixing operations using "recipes" stored in its memory, (3) compute and monitor the set points of time cycles, oven zone temperatures, oven conveyor speeds and other process equipment

to ensure uniform baking, (4) automatically monitor product changeovers and make counts of baked goods as they leave production lines, (5) direct the random storage of palletized frozen baked goods in the freezer warehouse, direct their retrieval for shipment on a first in-first out basis and direct assembly in an auxiliary freezer of mixed product pallets and (6) act as a data collection center to provide process engineering and accounting information.

These functions involve controlling and monitoring several hundred concurrent operations. For instance, some 300 process variables are monitored or controlled continuously. Every ten seconds, the 610 system scans inputs of temperatures, humidity, flows, pressures, levels and quantities from 200 sensors located throughout the bakery. It does this with an accuracy of one tenth of a percent.

There are back-up systems to monitor and control, either semi-automatically or manually, process and holding freezer functions in the event the computer is being serviced or other emergencies occur. Under certain conditions, operators can override the computer control system at any time.

The 610 system is under the control of a master program, the Executive Routine, that acts as a "traffic cop." It makes extensive use of priority interrupts--process-initiated signals that enable the computer to react automatically and on priority assignment to process and warehouse functions requiring special attention. These interrupts make it unnecessary for the 610 to search its programs or scan external events in order to determine what it should do.

Computer programmers for the Kitchens of Sara Lee's 610 system were trained at the computer center of Honeywell's Special Systems Division and assisted in writing the system's programs. The batch blending and mixing programs were generated by Sara Lee programmers. The hardware system is maintained under a service contract by Honeywell's Chicago branch office and the implementation and software maintenance is handled by Sara Lee personnel.

THE SYSTEM

Orders which come into Sara Lee's Deerfield, Ill., headquarters from food brokers are checked for credit and then sent, intact, to data processing. There, cards are punched for each order and the orders are printed out. These orders are then sent to the Traffic Department which sets up a truck schedule by grouping all the orders in truck load format (delivery locations and due date). This load format order schedule is then fed into the computer which regroups the orders into the sequence specified by the Traffic Department. This run creates a printout of the shipping schedule and, simultaneously, a shipping schedule tape. This tape is the instruction for the 610 and contains the order sequence and order-make-up of products to be moved into appropriate trucks from the holding freezer.

PRODUCTION SCHEDULE

The day's production schedule, or batter formulation, is derived from a combination of previous sales for the date, the orders in house, present inventory and considerations of material and personnel limitations. For instance, production might be somewhat limited by the available supply of eggs. The business office along with production control are responsible for determining the production quantity.

Each day, batter formulation begins at about 6 a.m. After consulting the day's production schedule, the operator requests the number of batches and the mixers to be used. He then presses an "execute" button. Standard batter formulas are also stored on magnetic drum memory. The 610 first checks equipment to determine if everything is in working order and initiates the mixing cycle.

Controlled by formulas stored in computer memory, main cake ingredients such as eggs, flour and dairy products are transferred in proper sequence to stainless steel mixers at the proper time. During transfer, the 610 system monitors and controls the weighing of dry ingredients and the metering of liquid ingredients, eliminating human error. Butter (in 60 lb. chunks) and trace elements such as vanilla, salt, yeast and so forth are added manually; the computer signals times at which this adding is to be done. When these additions are made, an operator presses a button on a console.

When the mixing cycle is completed, the computer orders the batch of freshly mixed cake batter to be pumped through stainless steel pipes to the batter depositors to be metered automatically into the individual aluminum foil pans in which the cakes are baked. Similarly, Danish pastry dough is fed by extruders in thick layers separated by layers of butter. The finished dough, with butter distributed evenly throughout, is automatically cut and fills the aluminum pans.

The computer monitors temperatures and relative humidities of mixing operations and records, for business office use, the amount of each ingredient in every batch. As batters are metered into foil pans, the 610 again takes over, making photocell counts of the number of individual cakes per batch.

The individual foil pans are automatically aligned, picked up in rows by an overhead fork and gently placed in the oven hearths of eight production lines (four for cakes, four for Danish pastries). Cakes and pastries are baked as they move continuously through oven rooms 110 feet long and 12 feet wide.

Control set points of baking cycles, speed of oven conveyors, and zone and profile temperature of ovens are set manually and monitored by the computer. Every 15 seconds, it monitors oven temperatures to make certain that they are correct for the particular cake being baked. If corrections are called for, under open loop procedures the bakers are alerted to make whatever adjustments in time cycles and oven conditions they judge necessary. Control clearances are necessary and a hard copy is printed during an open loop situation. On a closed loop basis, corrections are made automatically without any human intervention.

After the cakes are baked, they are continuously cooled to permit icing. Then, they are conveyed farther down the production lines through icing machines designed by Sara Lee engineers. After icing, they move in a continuous stream through blast freezers operating at -40°F where they are frozen within 50 minutes after they come out of the oven (instead of 12 hours as previously). This change is important, Sara Lee says, because fast freezing improves quality.

After freezing, the cakes are automatically capped and packed in corrugated shipping cases. These cases move on a conveyor to an automatic palletizing area. Here pallet loads of 80 cartons each are assembled and are carried automatically by conveyor to the Sara Lee holding freezer.

Freezer Operations

The freezer warehouse is completely computer controlled as it is kept permanently at -10°F . Cakes are moved in and out of the warehouse constantly and for the warehouse Honeywell 610 control system issues approximately 180,000 instructions every 15 seconds to giant stacker cranes and other equipment. These instructions direct the storing and retrieval of palletized cartons of frozen baked goods in and from 5,310 pigeon-holes on the floor-to-ceiling storage racks.

During these 15-second intervals, the computer in the main control center, 700 feet distant from the freezer, notes what conveyors and cranes are doing; what is entering and leaving the freezer area; updates its memory; makes new calculations; and issues instructions that are to be carried out in the next interval to optimize the movement on a first in-first out basis of up to 8 million cartons of frozen baked goods.



HOLDING FREEZER with a capacity of 7.8 million cakes stored in 650,000 pigeon-holes along 10 aisles is permanently maintained at -10°F . and is entirely computer-controlled. The 610 directs stacker cranes (at end of aisle) which stack pallets of 80 cake cartons apiece, remembers their location and directs cranes to retrieve proper pallets on first in-first out basis to fill orders.

To do so, the Honeywell 610 system communicates directly with the material handling equipment. It communicates in digital pulses with conveyors, cranes and buffers through electromechanical relays and standard control devices, and it receives messages from the equipment through the same electrical interfaces.

Complete control of moving equipment is maintained throughout. If a crane fails, for example, the computer is instantly made aware of this and assigns another unit to take over. Or, if a crane fails to reach its destination in the allotted preprogrammed time, the computer will also recognize a malfunction. In either case, an alarm is sounded in the freezer control room calling for dispatch of maintenance personnel. Every holding freezer operation, from the time palletized products are deposited on the warehouse conveyor until the computer-picked orders reach the shipping platform, is thus completely automatic. The process is monitored in the holding freezer control room on closed circuit television and a photoelectric cell reads and records the bar code on product cartons leaving the storage area. Both incoming and outgoing products are monitored.

Each carton of frozen baked goods is bar-coded as to date and product identity. When a pallet load of frozen goods is placed on the holding freezer conveyor, this information is "read" by photoelectric cell as the pallet enters the freezer. This information is entered by the computer to maintain a constant update of holding freezer contents.

Palletized products are assigned by the computer to pigeon-holes or bins in one of 9 aisles and stored at its direction by stacker cranes. The 610 then checks whether its command was properly executed and stores into memory the pallet information -- tier type of product, number of cases, date, time of storage and aisle and tier location -- for use in retrieval and inventory updating.

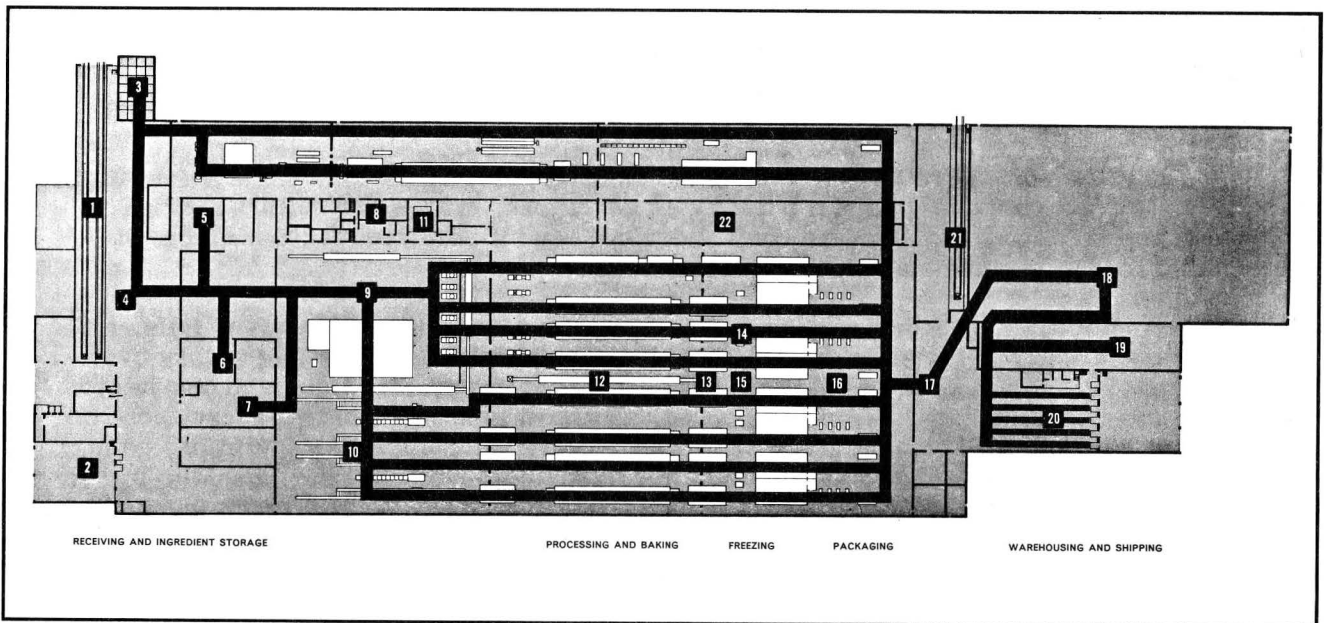
In the mixed product assembly area, where single product pallets are broken down into single product layers by suction lift cranes, elaborate computer programs and instructions in the 610 are involved. As for other computer operations, their primary objective is to optimize the use of capital equipment and to expedite orders.

The trucks arrive at the dock where the dock foreman announces his truck number by Victor Computer Corp.'s Electrowriter. He signs in on this tablet-device at the loading dock and this identification is duplicated in the holding freezer control room. This identification (in numerical form) initiates order picking.

When a shipment is to be filled, the computer first verifies the order, then commands stacker cranes in the main holding freezer area to "pick" the order. The order is assigned a preselected accumulating conveyor on the shipping platform, and by the time the truck has backed into its assigned bay, the customer's order will be waiting on the platform. The entire automatic operation takes less than five minutes. If necessary, this delivery tape--with strict controls and clearance--can be overridden.

A special automatic system is used to pick orders of less than full pallet quantities. This system allows the suction lift cranes in the mixed products freezer area to pick a tier of a variety of cakes and combine tiers of various varieties to make up a mixed pallet load.

At the end of the dock conveyor, an automatic stripping device removes the wooden pallet from the products and permits a specially constructed fork lift truck to pick up the goods without the pallet and place them in the truck. The entire materials handling system from the blast freezer to the freezer truck has been designed to minimize possibilities of damage to the products.



KITCHENS OF SARA LEE, DEERFIELD, ILL., PLANT'S NERVE CENTER IS THE HONEYWELL 610 SYSTEM IN CENTRAL CONTROL ROOM (11). It supervises dough and batter mixing (10, 11) and the processing of 35 varieties of cakes and pastries along eight production lines through ovens (12), coolers (13), blast freezers (14) and icing machines (15). Frozen baked goods then go through packaging (16) and palletizing (17) areas to main holding freezer (18) and mixed pallet assembly area (19). From freezer, they are conveyed on first in-first out basis to shipping dock (20) for shipment by freezer truck.

SYSTEM IMPLEMENTATION

Implementation of the Honeywell 610 system's capabilities to fully automate the operations at the Sara Lee bakery was designed to occur in four stages over a period of three to five years. The first stage -- startup of five production lines - was essentially a manual operation that even involved the pouring of ingredients into mixers by hand.

In the second stage, production was still manually controlled, with bakers pushing buttons on production floor consoles to initiate operations. Computer control appeared at the third stage with monitoring by the system of all variables on the production line. Under this open loop procedure, plant floor operators would be notified by the computer of any discrepancies in production parameters. The loop was finally to be closed at the fourth stage. Now, the 610 monitors the variables and compares them with standards incorporated into its program. If anything goes wrong, it signals the production equipment to actuate corrective action.

Outside the main production cycle, however, the computer controlled storage freezer was put on the air from the start. The freezer's cooling to a steady -10°F was carefully supervised since greater-than-planned, cold-induced metal shrinkage would have seriously disturbed the smoothness of automated operations.

RESULTS

Company management states that the Deerfield plant will be running at capacity by 1970. The bakery is located on a 52-acre site, providing sufficient land to double the size of the original production facility, should the need arise. This bakery is enabling the company to increase production to satisfy demand for its current line of frozen baked goods while expanding the line substantially to include many new frozen products that have been developed, and even test-marketed, but were not previously produced because of lack of capacity.

Steady growth of the company's volume will continue to be supported by the use of computer control. Transition to the Honeywell 610 was smooth and even, due largely to careful preparation. Thus, the company says that a joint training program with suppliers is successfully transforming production people who were once primarily doers into more highly skilled observers. The duties of supervisors have changed markedly only in that many of them now supervise machines instead of men, although not a single employe has lost his job because of the automation.

According to Douglass Mann, former executive vice-president, there are no hazard factors built into the company's automated bakery. Due to the cost of automation, the plant cost 40 percent more than a conventional bakery. An outlay of more than \$1 million was involved for computer systems alone. Yet, the operation's break-even point is below Sara Lee's current production rate.