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MICROCOMPUTERS IN PLANT ENGINEERING

Cuts natural gas use 60%

Facilities Automation System Monitors 1200 Points

The microcomputer network designed and installed by the facilities services department at Magnetic Peripherals, Inc. is used for five major functions.

A vivid illustration of just some of the many ways microcomputers can be used in plant engineering and facilities management comes from Magnetic Peripherals, Inc. (MPI) in Edina, MN.

There, Asim Gul, an energy engineer in the facilities services department led by AIPE member V. J. Evanoff, CPE, has developed a Facilities Automation System which consists of fourteen microcomputers strategically located throughout the 380,000 sq. ft. of office and production buildings. The entire project — from the design and installation of the hardware configuration to the development of the software — was handled in-house.

The microcomputers are supervised by a minicomputer which uses 80 megabytes of hard disk memory to store data. A CRT and band printer are attached to the system to retrieve and plot data. All fourteen computers use a communications network to exchange data.

The system monitors more than 1200 points and has been designed to ultimately perform five major functions:

1. Effective utilization of energy.
2. Plant engineering and maintenance;
3. Security surveillance;
4. Life safety; and
5. Production/process monitoring

In terms of payback, the biggest benefits have come from more effective use of energy. Without a reduction in comfort levels, and without the use of any additional mechanical devices or modifications to HVAC equipment, natural gas use has been cut by 60% since the system was installed two years ago.

Effective Use of Energy

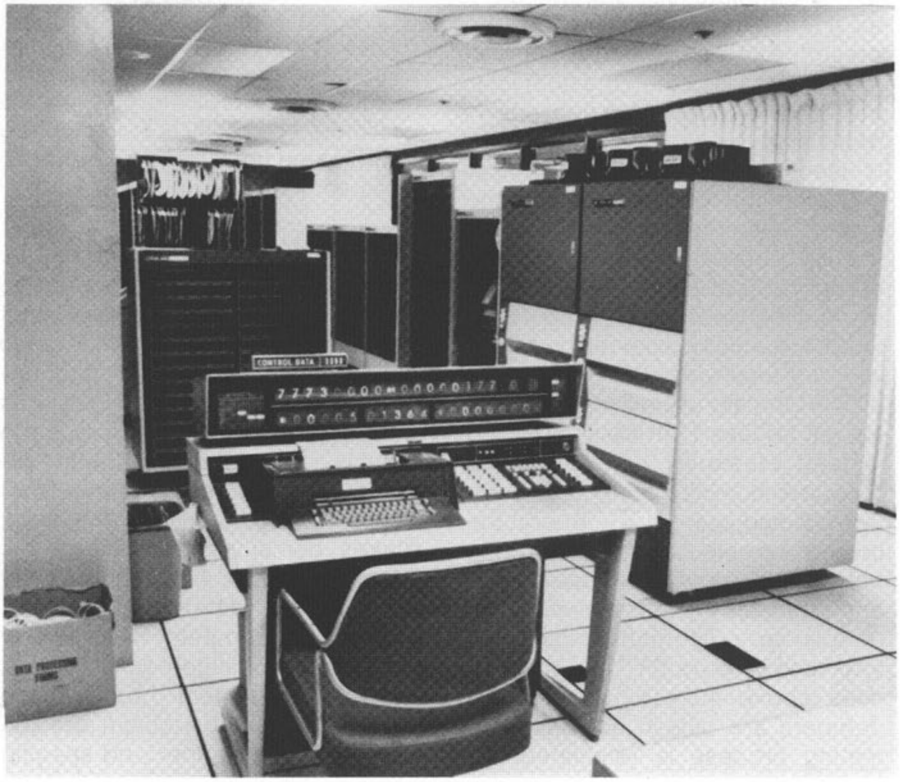
Because Magnetic Peripherals, Inc. manufactures computer memory storage supplies, the facility has very specific energy needs. Many of the computer centers, laboratories and production areas require precise temperature and humidity conditions. Plus, the harsh Minnesota winters mean that heating costs can add up quickly.

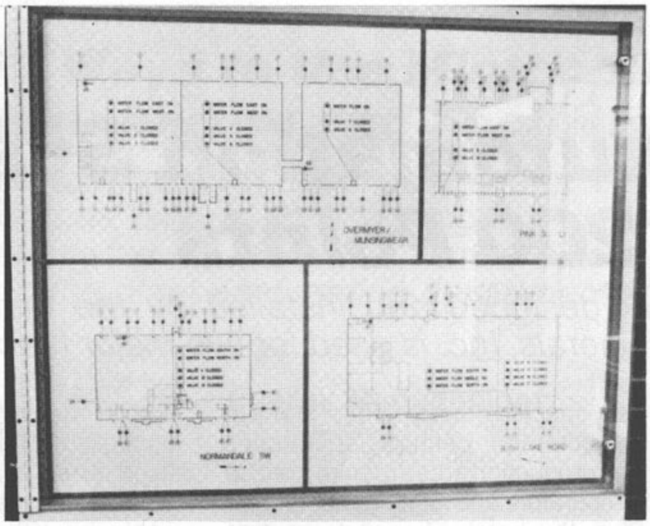
When rising energy costs first began to have a significant impact on operating costs, Mr. Evanoff rejected energy conservation as an acceptable alternative.

"To me, the term 'conservation' implies a sacrifice — such as sacrificing employee comfort," states Mr. Evanoff. "We believed that we wouldn't have to ask employees to sacrifice comfort if we concentrated all our efforts on the more effective use of energy."

When engineers at MPI first investigated the possibility of computer control of HVAC systems, they found that in many instances computer-controlled systems were simply being used to start and stop equipment and that the same results could be achieved with relays and timers at much less cost. Instead, MPI chose to develop an entirely different computer control strategy. The result is a system that monitors all pertinent analog functions of the HVAC equipment, makes real-time decisions based on pre-defined parameters, and controls all variables with an analog output based on "true" demand, not just on outside conditions.

In the clean rooms, labs and computer centers, critical temperatures, humidity levels, and air flow are maintained 24 hours a day to meet process requirements. In the office areas the system maintains a temperature of 72-74° F during working hours year-round.





A 4' x 4' graphics display board alerts security guards to any problems in the 150 door contacts, water sprinkler flow switches, and valve position indicators monitored by one of the microcomputers.

During non-working hours, the air handlers and all related equipment serving the office areas are turned off — as long as room temperatures do not fall below 65° F or rise above 80° F. Depending on the room conditions, the air handlers begin operating one to three hours before employees arrive. The computers have been programmed to recognize heat given off by people, machines and lights. In the morning, when work starts and room temperatures are at set-point, the computers stop the heating process and begin monitoring demand. If the heat gain due to the presence of people and the use of machines is equal to the heat loss, the air handlers just recirculate the air. If the heat gain resulting from the presence of people and the use of machines is less than the heat loss, then heat is added; if the heat gain is more than the heat loss, outside air is used to compensate.

During the cooling season, the system has substantially increased the use of outside air. The computers recognize that if outside air with a dry bulb between -50° and 65° F and 80-90% humidity is heated by mixing with dry and warm 70-74° F return air, the humidity of the mix/discharge air will be less than outside air. So instead of simply comparing the outside air humidity/temperature with the building humidity/temperature, the system calculates the difference between the dry bulb temperatures and estimates the mixed air humidity on a linear/proportional scale. If at any time, the return air humidity rises above 40-45%, the outside dampers are closed and the estimating process is reinitiated. By using these calculations, MPI is able to use as much outside air as possible.

Plant Engineering and Maintenance

Because the microcomputers monitor all the important points of the HVAC systems, MPI plant engineers have accumulated a wealth of data that can be used in evaluating the performance of equipment. The data are also used to troubleshoot problems, maintain equipment histories, and improve the use of maintenance manpower.

Plus, the information is used to check load profiles and evaluate system/equipment capacity. Instead of estimating load, MPI plant engineers can now use a real-time demand profile to size equipment. The system insures that all available equipment capacity is being utilized at the same time, and that no piece of equipment is overloaded.

Security Surveillance

The microcomputer network is also used in security surveillance. One of the microcomputers is dedicated to monitoring more than 150 door contacts, water sprinkler flow switches and valve position indicators. Each point is a separate loop. The microcomputer monitors the analog status of each loop, analyzes the data, makes decisions and shows the results on a 4' x 4' graphic display which is viewed by security guards.

The microcomputer can not only notify guards of illegal door breaches, but can also detect trouble in the loop, diagnose the problem and display the door number and specific problem. For instance, if the wire has been cut, if there is a short, if the power is off, or if there is an unidentified problem, the microcomputer will identify the specific trouble and alert the guard.

The processor also keeps track of 21 different time zones and at specific times, will disalarm certain doors for employee use. The doors are put back on alarm after the established time interval is over. But even if a door has been disalarmed, the microcomputer continues to monitor the door and in case of trouble will diagnose the problem and alert the guard. Water sprinklers, flow switches, valve indicators and emergency exits are monitored in this same manner, but are kept on alarm at all times.

Life Safety

The microcomputer network is also used to monitor the amount of flammable/combustible gases in laboratories. If the level of gases rises above the allowable maximum, a local alarm is sounded and the Security Control Center is informed.

The system also monitors air flow in vent hoods to ensure that noxious gases are being exhausted. If air flow decreases, alarms are sounded to alert employees and security guards. Critical fire alarms and smoke detectors are also monitored.

Process Automation

The microcomputers in the system have begun to monitor some of the production processes and log the data to determine whether or not process parameters are being met or not. This is the first step toward fully automating critical processes to improve quality standards and manpower utilization.

According to Mr. Evanoff, it took about three years to develop and install the system. Asim Gul approached the project in four steps: 1) learn the mechanics of the HVAC equipment; 2) study all available sensors; 3) establish the hardware configuration; and 4) develop real-time, multi-task software.

"Design of the software was the toughest step," says Mr. Evanoff. "It took the longest and was the most critical."

But from the results achieved already, it is clear that developing the system was well worth the time and effort spent.

Points Monitored by Microcomputer Network

These are just *some* of the points being monitored by the MPI's Facilities Automation System.

HOT/COLD DECK MULTIZONE AIR HANDLER WITH ZONE FACE/BYPASS DAMPERS

Points Monitored

Outside air temp (shared by all units)
Outside air humidity (shared by all units)
Return air temp
Return air humidity
Mixed air temp
Outside/return damper position (0-100%)
Hot deck temp
Hot water supply temp
Hot water return temp
Hot water flow
Hot water mixing (3-way valve position, 0-100%)
Cold deck temp.
Chilled water supply temp
Chilled water return temp
Chilled water flow
Chilled water mixing valve position (0-100%)
Supply fan current
Zone room temp. (each zone)
Supply air temp. (each zone)
Face/bypass damper position (each zone)

Points Controlled

Outside/return air damper
Chilled water mixing valve
Hot water mixing valve
Supply fan on/off
Face/bypass damper (for each zone)

DUAL TEMP MULTIZONE AIR HANDLER WITH ZONE FACE/BYPASS DAMPERS

Points Monitored

Return air temp
Return air relative humidity
Mixed air temp
Outside/return damper position
Dual temp supply temp (primary)
Dual temp return temp (primary)
Dual temp flow (primary)
Dual temp supply temp (each coil)
Dual temp return temp (each coil)
Dual temp flow (each coil)
Primary dual temp pump current (each coil)
Secondary dual temp pump current (each coil)
Supply fan currents
Exhaust fan currents

Points Controlled

Outside/return air damper
Primary dual temp pump on/off (each zone)
Secondary dual temp pump on/off (each zone)
Supply fans on/off
Exhaust fans on/off
Face/bypass damper (each zone)

CHILLERS

Points Monitored

Chilled water supply temp
Chilled water return temp
Chilled water flow
Condenser water entering temp
Condenser water exiting temp
Condenser water flow
Heat pump supply temp
Heat pump return temp
Heat pump flow
Inlet vanes position
Cooling tower bypass valve position
Condenser bypass valve position
Cooling tower fan currents
Chilled water pump currents
Condenser water pump currents
Heat pump water pump currents

Points Controlled

Chiller on/off
Cooling tower bypass valve
Condenser bypass valve
Chilled water pumps on/off
Condenser pumps on/off
Cooling tower fans on/off

CHILLED WATER CLOSED LOOP SYSTEM

Points Monitored

Chilled water primary supply temp
Chilled water primary return temp
Chilled water primary flow
Chilled water primary loop pressure
Chilled water secondary supply temp (each loop)
Chilled water secondary return temp (each loop)
Chilled water secondary flow (each loop)
Secondary loop chilled water pump currents (each loop)
Secondary loop mixing valve position (each loop)

Points Controlled

Secondary loop chilled water pumps on/off (each loop)
Secondary loop mixing valve (each loop)

DUAL TEMP MIXING TEMP

Points Monitored

Dual temp supply temp
Dual temp return temp
Dual temp flow
Chilled water supply temp
Chilled water return temp
Chilled water flow
Hot water supply temp
Hot water return temp
Hot water flow
Dual temp pump currents

Points Controlled

Dual temp pumps on/off

RADIATION MIXING TANK

Points Monitored

Radiation supply temp
Radiation return temp
Radiation flow
Radiation mixing valve position
Hot water supply temp
Hot water return temp
Hot water flow
Radiation pump current
Hot water pump current

Points Controlled

Radiation mixing valve
Radiation pump on/off
Hot water pump on/off

BOILER

Points Monitored

Hot water supply temp
Hot water return temp
Hot water flow
Hot water system pressure
Stack temp
Flue gas oxygen percent
Gas/air damper position
Burner flame out

Points Controlled

Boiler on/off
Gas/air mixture

HOT WATER CLOSED LOOP SYSTEM

Points Monitored

Hot water primary supply temp
Hot water primary return temp
Hot water primary flow
Hot water primary loop pressure
Hot water secondary supply temp (each loop)
Hot water secondary return temp (each loop)
Hot water secondary flow (each loop)
Hot water primary pump currents
Hot water secondary pump currents (each loop)
Hot water secondary mixing valve position (each loop)

RADIATION

Points Monitored

Radiation supply temp (each zone)
Radiation return temp (each zone)
Radiation flow (each zone)
Radiation mixing valve position (each zone)
Radiation pump current (each zone)

Points Controlled

Radiation pump on/off
Radiation mixing valve (each zone)

RADIATION MIXING TANK

Points Monitored

Hot water supply temp
Hot water return temp
Hot water flow
Hot water pump current
Primary radiation supply temp
Primary radiation return temp
Primary radiation flow
Primary radiation mixing valve position
Radiation pump current

Points Controlled

Hot water pump on/off
Radiation pump on/off
Radiation mixing valve