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# CONTROL OF MODERN POWER PLANTS: RECENT TRENDS AND PROSPECTS

Kunyong Lee

Universität des
Saarlandes
F.R.Germany

Abstract: Power plants are being met by integrating more functions into fewer displays and control devices. The trend toward more efficient man/machine interface,together with developments in distributed type systems,could lead to simplicity of the control benchboard.

## Introduction

A brief review of the evolution of power plants and the forces behind it during the last two decades should help put the corresponding evolution of control and monitoring systems into better perspective. Over the last few decades,fossil-fired,central-station power plants in Germany have changed in many ways,yet the basic requirements for their control have remained constant in principle. These basic requirements include process control -modulating control of process variable such as pressure level,and flow,binary control-on/off control of the devices such as motors and two-position valves and dampers monitoring-involves no control function.Rather,it is the observation and documentation of the important events occurring in the plant.

Any typical power plant control system involves a combination of these generic functions./1//2/

The evolution of the fossil-fired plants has not affected the basic control requirements.It is,however, greatly affected how the requirements are met.Both the scope and techniques used to fulfill these requirements have changed considerably.During the last two decades, changes occurred that influenced how new power plants were designed. The main factor causing these changes was the large,sustained growth of demand for electric power.As loads have increased,so have the typical sizes of the new plants.

Another major factor that caused some of these changes was the worldwide oil crisis which started in 1973.This eventually caused the cost of all fossil-fuels to rise dramatically .As a result,the use of natural gas and fuel oil in power plants was essential discontinued. This was due to not only to high cost,but also to restrictions enacted to save gas and oil for other uses.Virtually all new power plants designed in recent years have been coal-fired,and some older plants have been converted to coal.Coal-fired plants are mere complicated than gas-or oil-fired plants because of coal storage and handling systems,ash handling systems and coal feeding,pulverizing and burning equipment required.Also,social and political pressures resulted in stricter requirements for environmental had major influences on new power plant design.Some of the significant effects were:reduced $NO_x$,flyash removal,flue gas desulfurization and waste treatment.

Control systems

The control and monitoring schemes for the simpler plants of two decades ago reflected that simplicity.Central control rooms were used to control and monitor major items.But many local process control loops were used that were not brought into the control room.Many pieces of equipment were started and stopped locally by roving auxiliary operators,who also had to walk through the plant constantly to read many local thermometers and pressure gages,and record the data hourly on clip boards.All these relatively schemes worked adequately for power plants of the past.However,the man/machine interface and eventually even the hardware itself were not adequate to provide the level of reliability and ease of operation required in the newr plants/3/. As the typical size of new power plants increased,more auxiliary system and equipment were needed and the physical sizes of the plants grew.These factors placed extra demands on the operating staff. They made it more difficult for the staff to adequately monitor all vital equipment and respond to emergencies. To help relieves this situations, more of the process variable data, alarms,etc.,were brought into the control room.This allowed the roving auxiliary operators more time to concentrate on operating valves and other local equipment,but placed more burden on the control room operator. The panelboards and control rooms became larger and more complicated making the more difficult to routinely scan for subtle trends that could lead to alarms or trips/1/. Another influence on control philosophy is that coal-fired plants are more different to operate than gas-or oil-fired plants.They have extra equipment,such as conveyers,feeders,pulverizers,primary air fans and ducts for conveying the coal/air mixture to the burners. They require pulverizer temperature controls and many interlocks,and have complicated ignitor/burner assemblies. Even with automatic controls and interlocks,this complex array requires constant monitoring by the control room operator.Some manual involvement during emergencies and pulverizer startup and shutdown is also required.The evolution of the size and operating requirements of power plants caused a corresponding evolution in the philosophy or process control,binary control and monitoring systems used in the plants.Significant specific developments that resulted include the following:Multiplexing schemes were developed to save wiring cost yet increase the amount of communication between the various areas.Relay type binary control systems were replaced by programmable binary systems to reduce capital costs,simplify maintanance and increase flexibility so that field changes could be made factor and easier.More sophisticated visual annunciators were developed to handle more alarms in a given space by sharing common windows and using first-out and reflash sequences. Sequential events recorders were added to provide permanent records of alarms in sequence as they occurred. This enabled the operators to more quickly diagnose the cause of trips. Data acquisition systems were developed to relieve the growing burden on the operators to monitor the increased process data flowing into the control rooms.These systems duplicated some traditional indicators and recorders and eliminated some/3/. They could also make performance computations and display additional information that could not be reasonably fitted to the panelboards when using the older techniques.Distributed control and monitoring schemes were developed to optimize overall plant operation and to improve the man/machine interface.

Future trends

All fossil-fired power plants will continue to become more complicated as fuel cost rise and as regulatory demands for environmental protection increase.This includes new plant currently being designed and existing plants being retroffited with new systems.As a result,even efficient man/machine interfaces will be needed to help the operators more effectively monitor coditions in the plant,make prompt decisions and take the actions needed to keep the units on line.To help accomplish this,the design philosophy of the control rooms/3//4/is being studied critically in the design of new units and retrofit of old units.The trend toward integrating more functions into fewer displays and control devices will continue. The use of soft video displays is expanding to include some control functions.Some routine startup/shutdown and other operating procedures may also be included as a guide to the operator.At least minor equipment,and probably some major equipment,will be started and stopped from these soft displays and their keyboards. Some process control loops will also be controlled with this soft system instead of using traditional discrete manual/auto selector stations.The new distributed systems have more computer power,which distributed among the control room operating consoles.The result is greatly improved capabilities for graphic displays,larger historical data memories,and less dependence on central components that create common failure modes/5//6/. These systems also provide more user friendly consoles which simplify operator training,reduce human error and allow faster operator reactions to emergencies.

## Summary

Plant control and monitoring system capabilities and flexbilities will increase.During the next ten years or so,the evolution of power plants toward more efficiency and complexity will probably continue.As a result, operators will be able to optimize the operation of each unit more effectively,shorten the startup/shutdown times and avoid dangerous conditions. Improvements in the overall control and monitoring system will make this possible by providing features such as:The man/machine interface will be improved by using more human engineering and other techniques currently available for space exploration.Large, flat screen type displays will allow one large graphic display or a group of smaller data displays to be presented on command by the operator. The graphics will be more active,and will be used to directly control at least some equipments by touch or light pens,with less dependency on keyboards.The more powerful computers behind the screens will assume more of the routine status monitoring duties.They will advise the operator when abnormal coditions are about to occur and display the available corrective action options.The capabilities of the new system may be enhanced by integrating some of the functions now being performed by the individual systems dedicated to certain equipment.For example,the turbine-generator supervisory and control functions may be performed by this system,using primary senses and detailed philosophy provided by the turbine manufacturer.Combustion controls and flame safeguard interlocks may be integrated into this system. The powerdispatchers may assume more direct control of unit loadings by communicating directly with this system.

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