Process Control

Special Short Course, 2006

Agenda

1. Introduction - Historic Perspective
2. Field Devices and Wiring
3. Documentation of Plant Control and Instrumentation - *Test*
4. Characterizing the Process, Terminology - Workshop
5. Control System objectives - *Test*
6. Manual and Feedback Control - Workshop
7. Feedforward Control – Workshop, *Test*
8. Cascade Control - Workshop
9. Override Control - Workshop
10. Split Range, Valve Position, and Ratio Control –Workshops, *Test*

Plants Organization and Layout

- In cooler climates or to meet special processing conditions, the plant equipment may be contained in buildings.
- The equipment associated with larger plants may be located in the open.

Plants are Divided into Process Areas

- Areas are defined based on equipment or process grouping e.g. Tank farm, boiler house, pulping, etc.
- A number or identifier may be assigned to each area e.g. 177, MMB
- Plant operators are responsible for the operation of one or more process areas

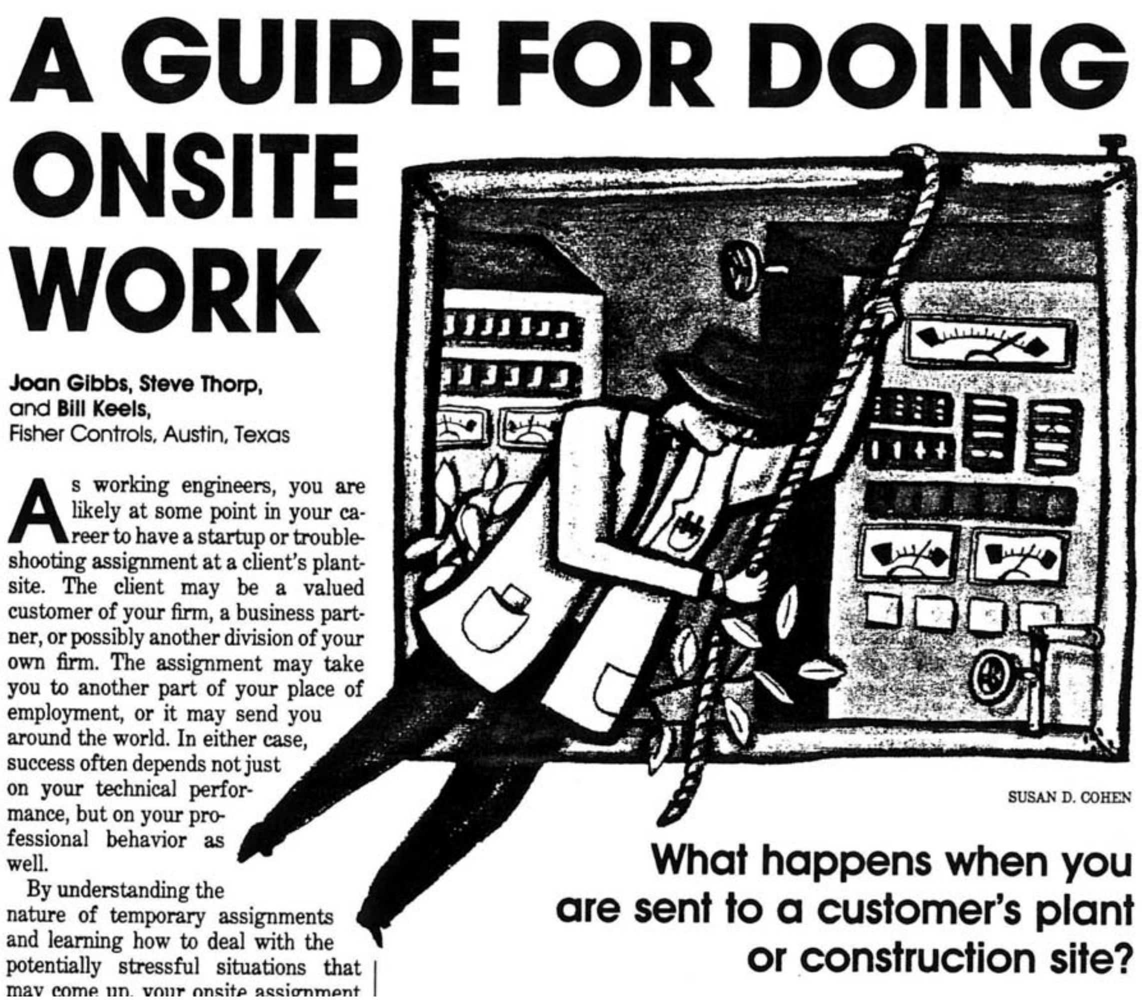
Process Area Breakdown

- Multiple units of similar equipment may be located in one process area.
- For example, the boiler house area may consist of one of more boilers.

Labs and Instrument Shops May be Distributed Throughout The Plant Site

- Lab test are often required since some parameters of the product can be measured on-line
- Instrument technicians are responsible for calibrating and repairing field devices and may also be responsible for maintenance of the control system.

Visiting or Working at a Plant Site



A GUIDE FOR DOING ONSITE WORK

Joan Gibbs, Steve Thorp, and Bill Keels, Fisher Controls, Austin, Texas

As working engineers, you are likely at some point in your career to have a startup or troubleshooting assignment at a client's plantsite. The client may be a valued customer of your firm, a business partner, or possibly another division of your own firm. The assignment may take you to another part of your place of employment, or it may send you around the world. In either case, success often depends not just on your technical performance, but on your professional behavior as well.

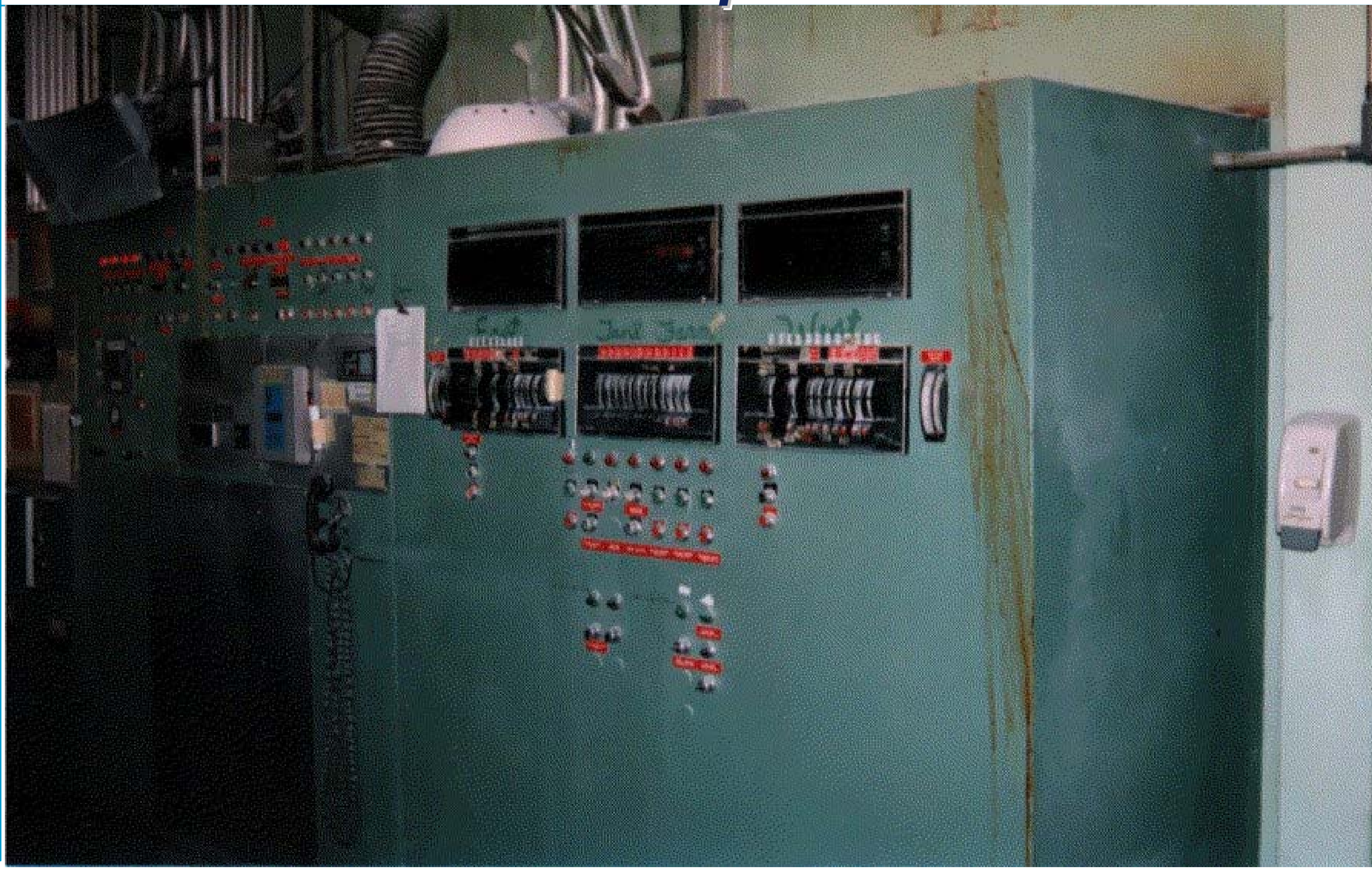
By understanding the nature of temporary assignments and learning how to deal with the potentially stressful situations that may come up, your onsite assignment

SUSAN D. COHEN

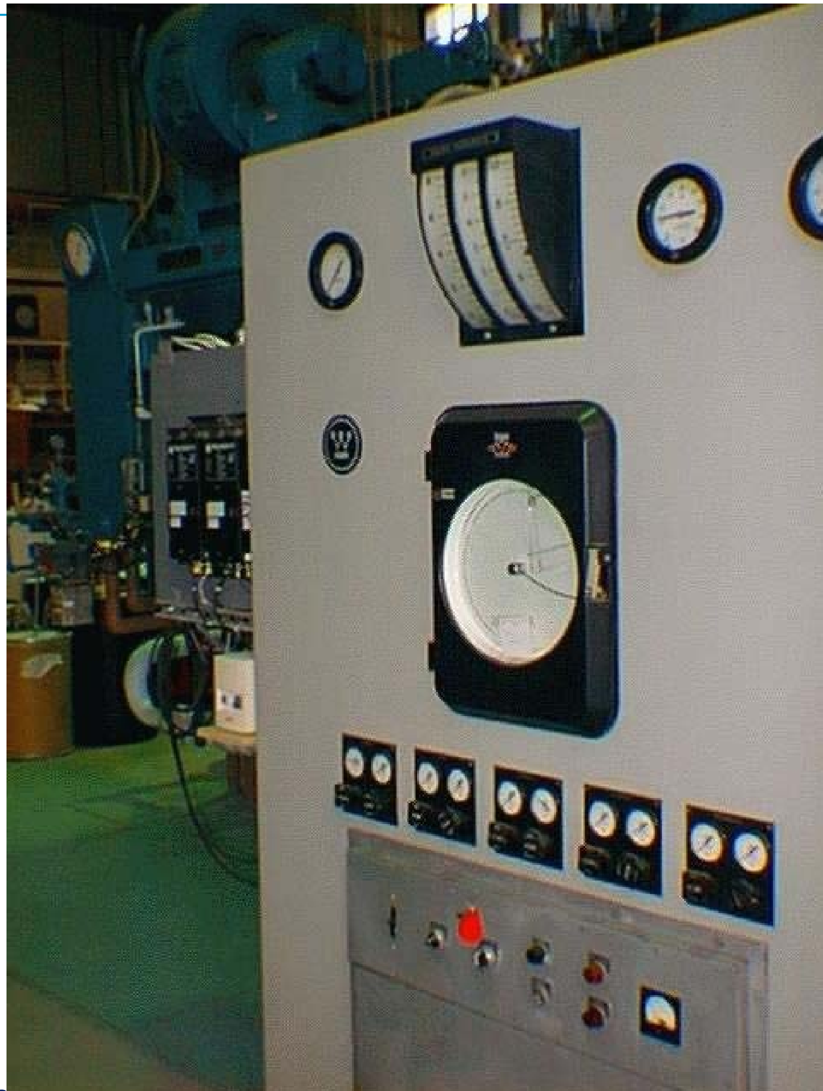
What happens when you are sent to a customer's plant or construction site?

- Paper (will be handed out in class) provides rules to follow when visiting or working at a customer site
- Homework: Read paper before tomorrow

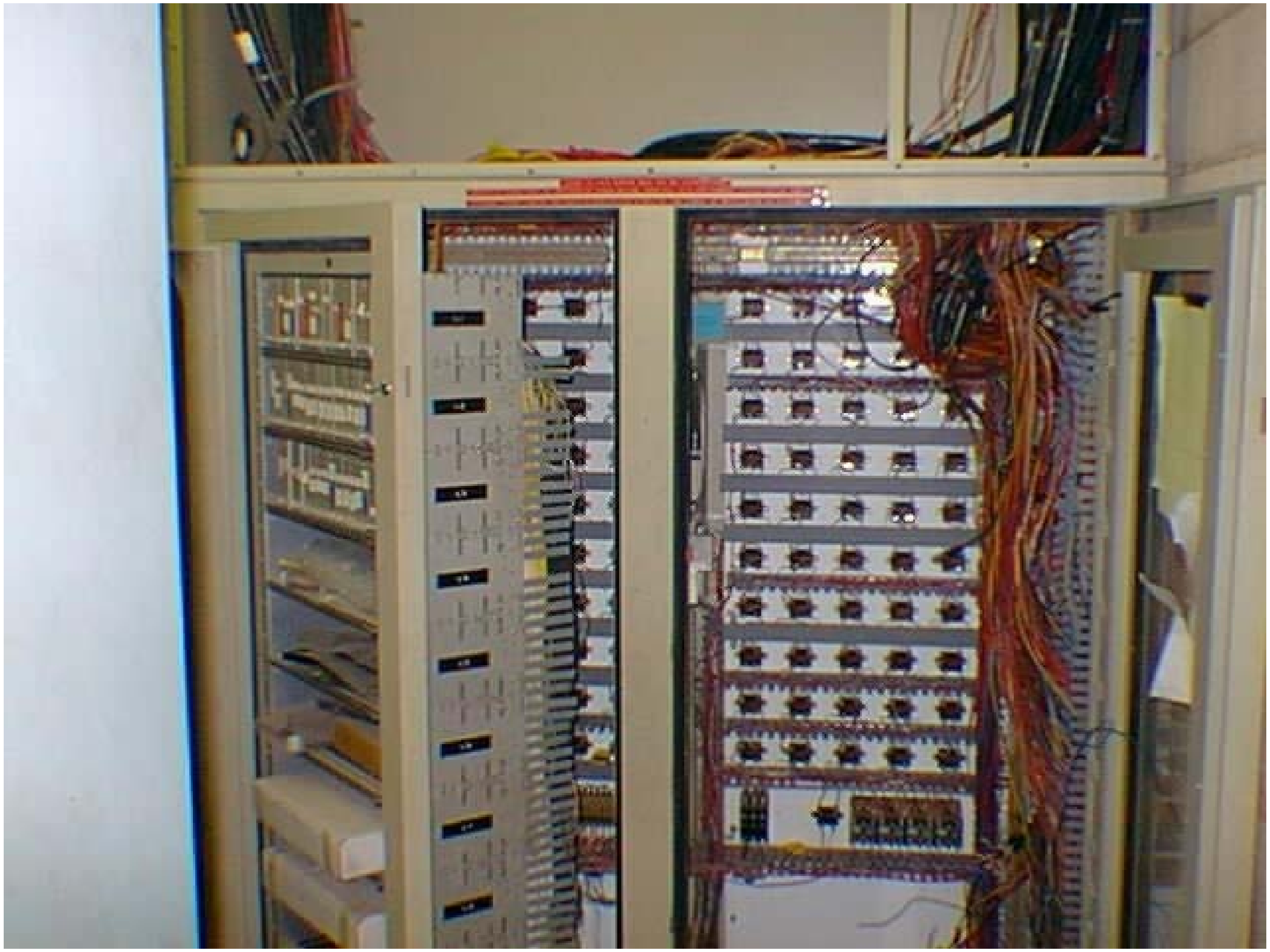
Analog and Pneumatic Control Systems Were Built Around the Concept of A Control Panel

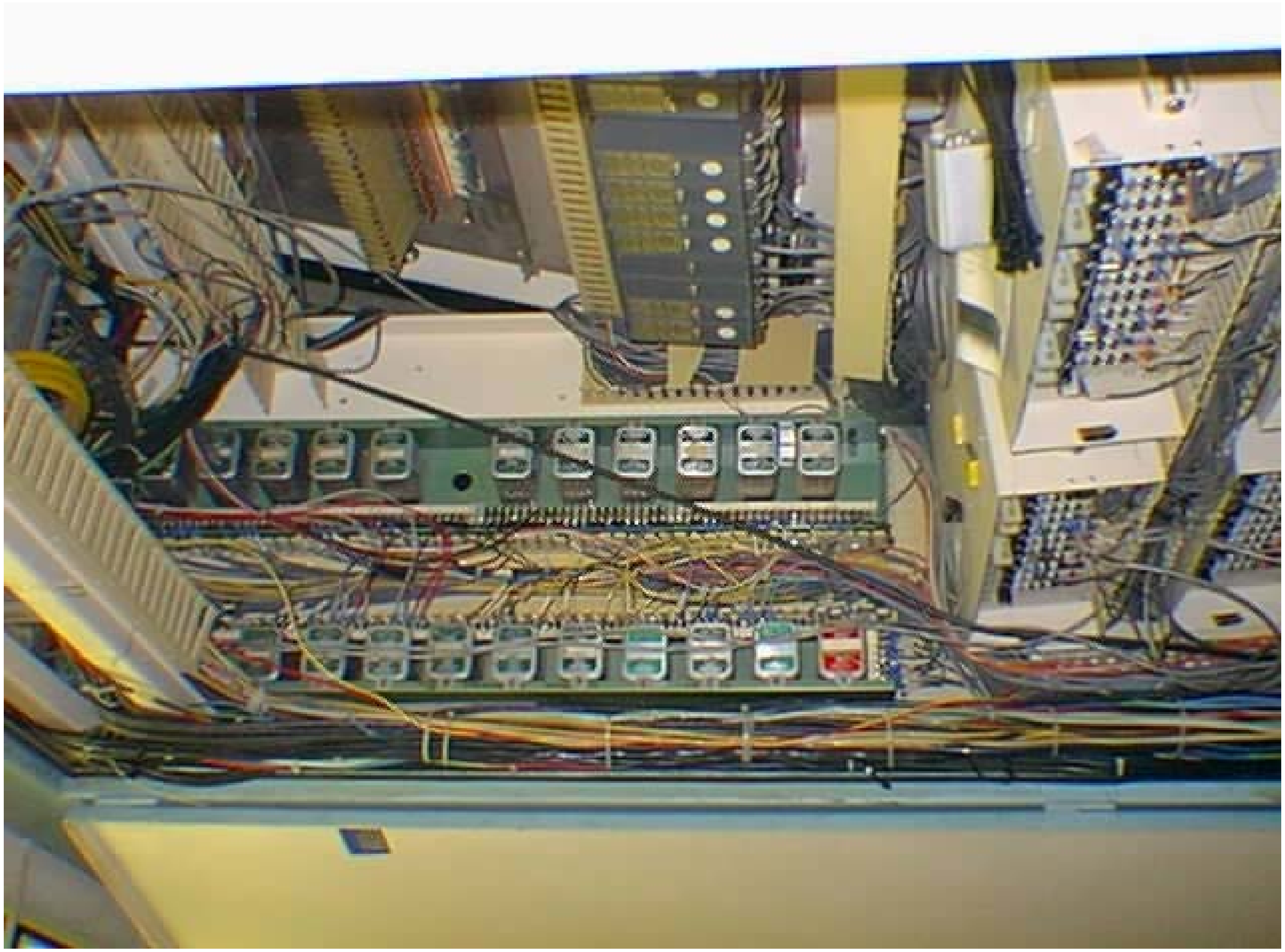


The Panel Incorporated a Variety of Components to Support Operator Access, Alarming, Recording

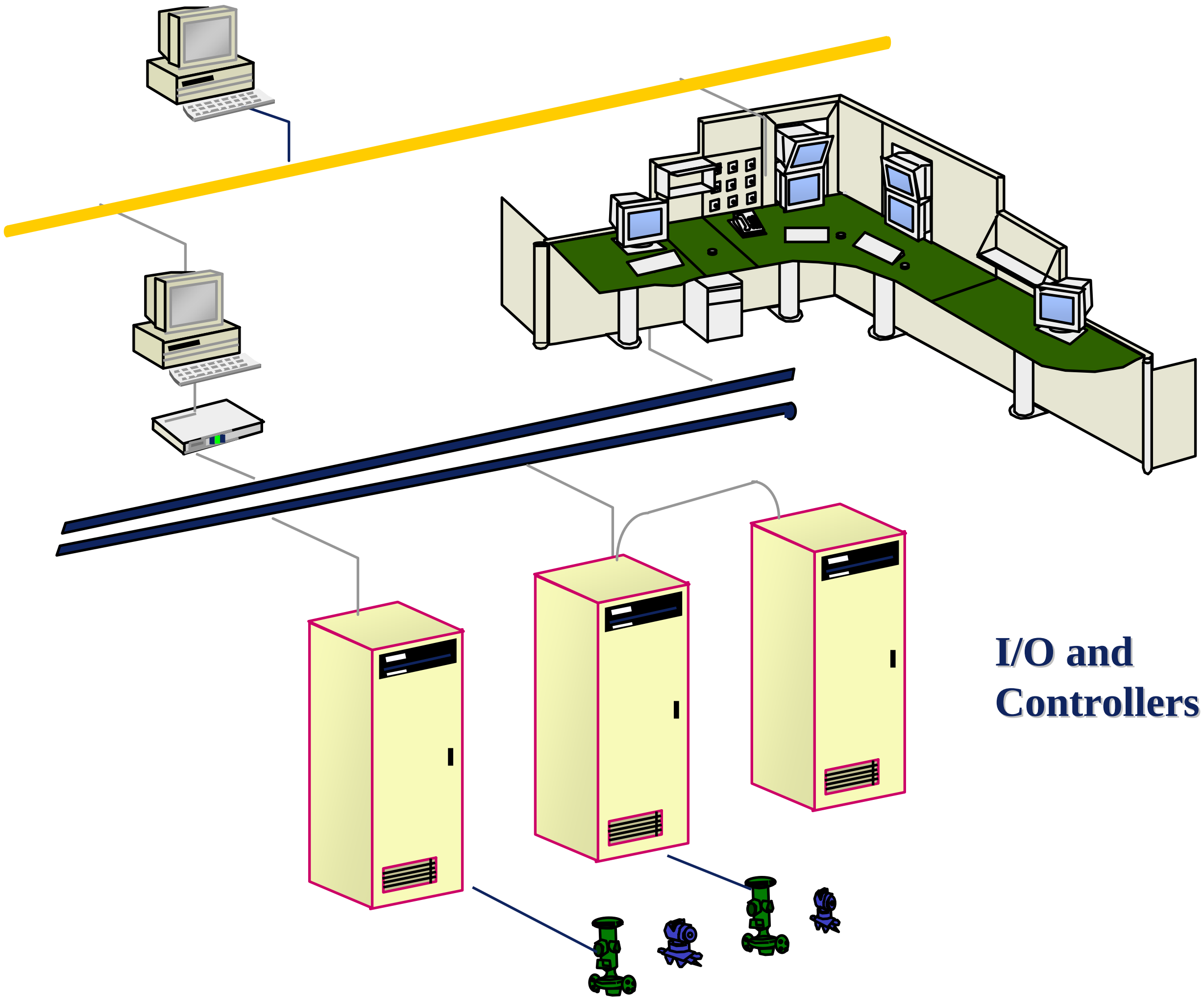


Panel Wiring Was Often A Challenge to Maintain



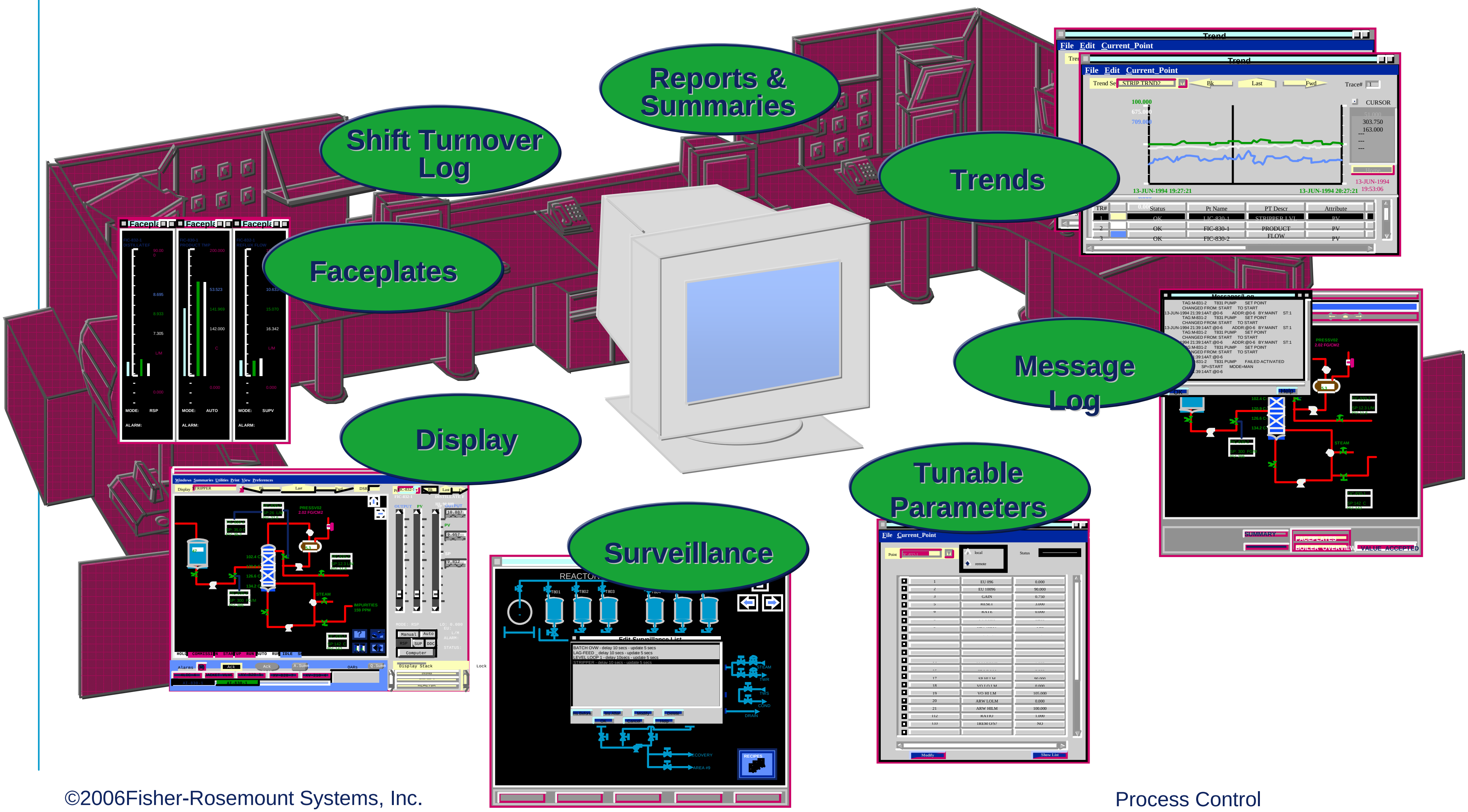


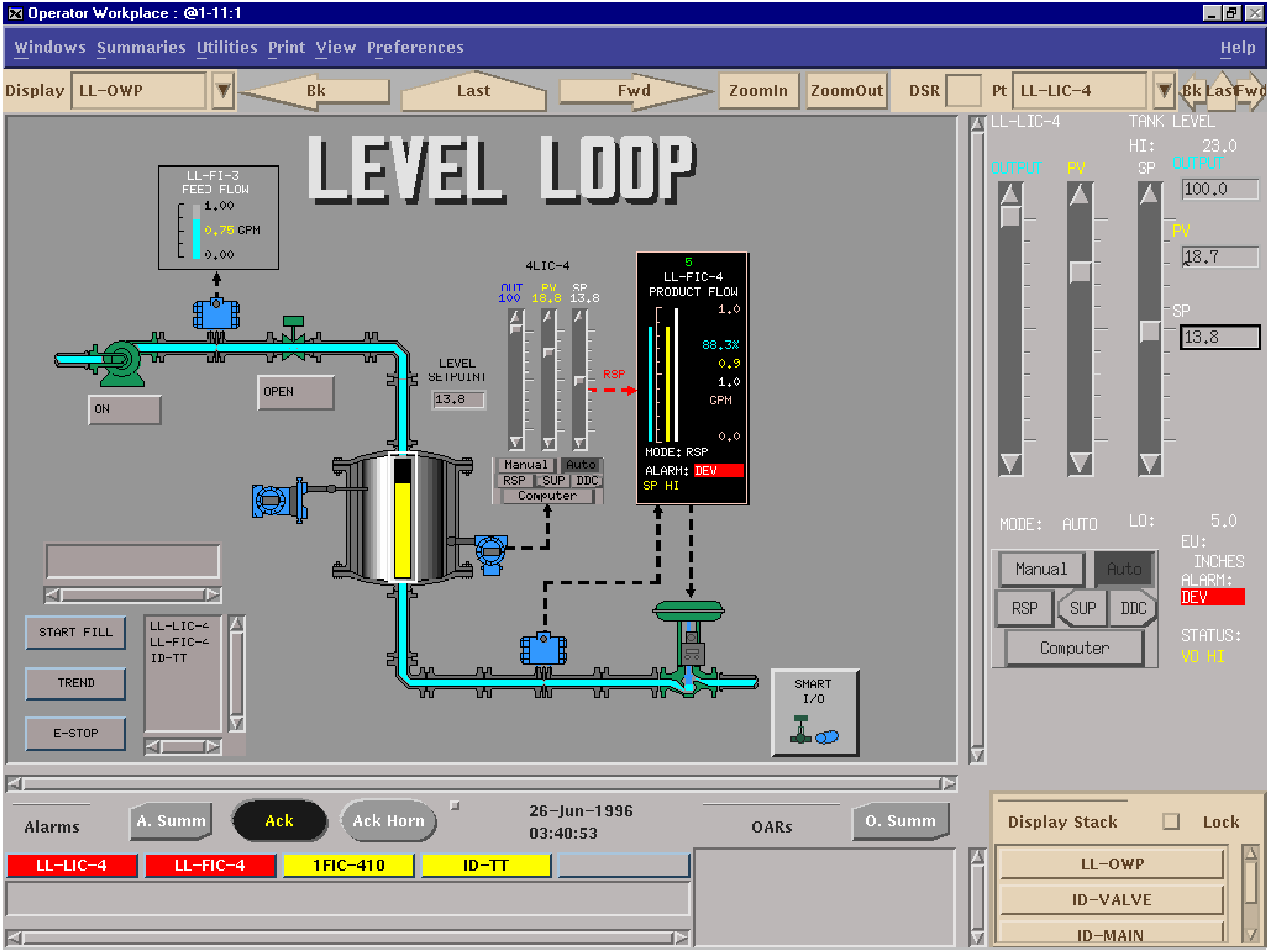
Distributed Control System



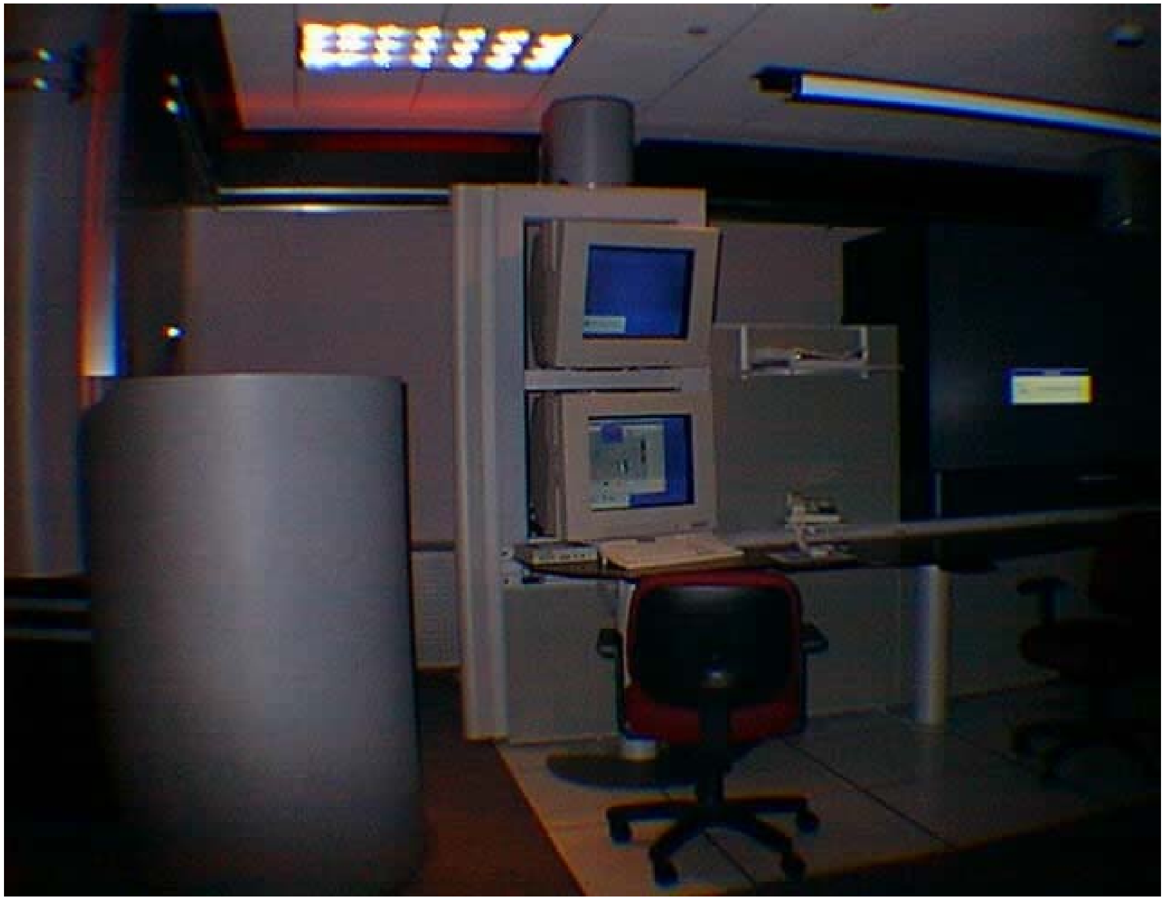
- First introduced in the late 70's
- Allowed control rooms to be centralize and control distributed throughout the plant.
- Built around custom hardware and interfaces

Features of Today's control systems may be traced to early DCS system



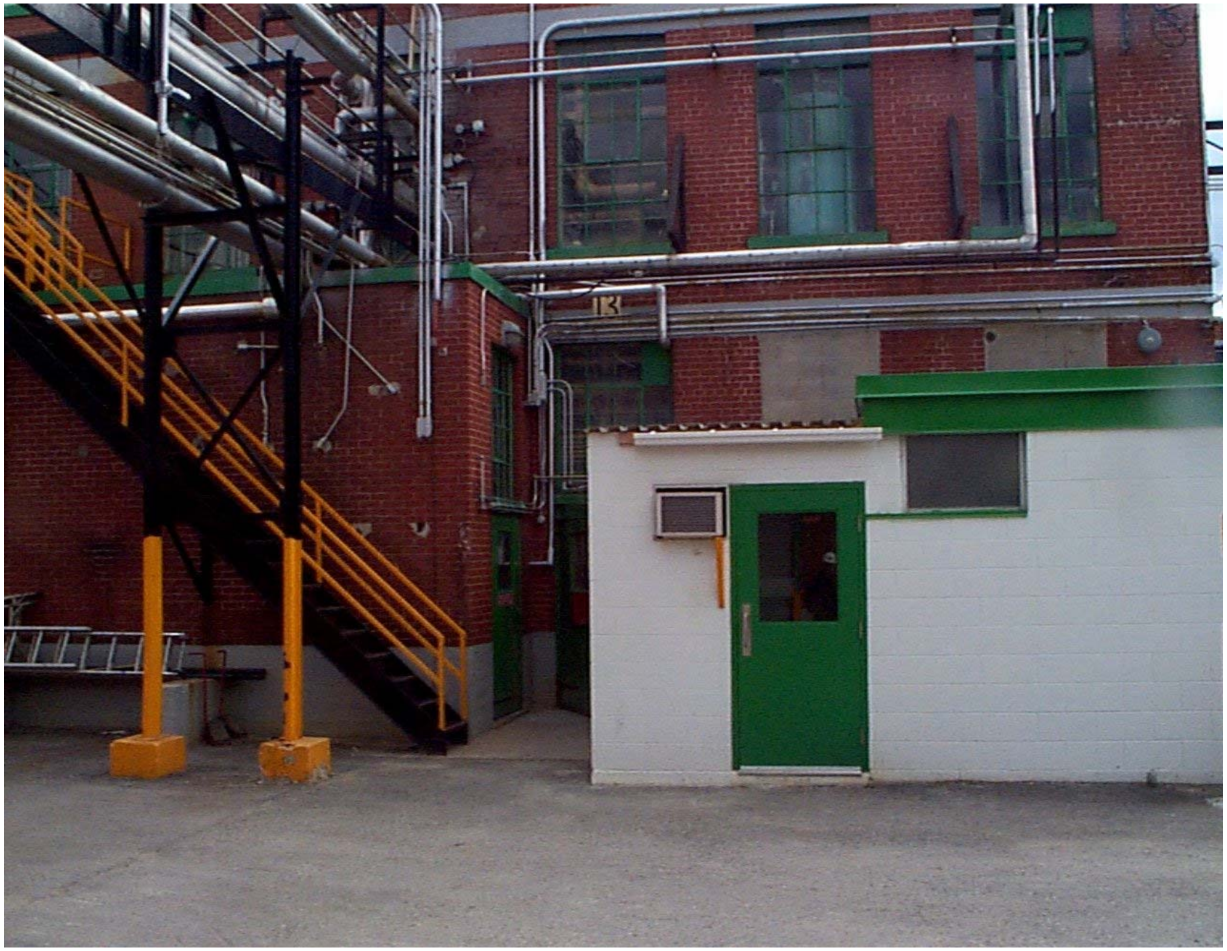

Operator Workplace : @1-11:1
Windows Summaries Utilities Print View Preferences Help
Display LL-OWP Bk Last Fwd ZoomIn ZoomOut DSR Pt LL-LIC-4
LEVEL LOOP
LL-FI-3
FEED FLOW
1.00
0.75 GPM
0.00
ON
OPEN
LEVEL SETPOINT
13.8
4LIC-4
OUT 100 PV 18.8 SP 13.8
Manual Auto
RSP SUP DDC
Computer
RSP
5
LL-FIC-4
PRODUCT FLOW
1.0
88.3%
0.9
1.0
GPM
0.0
MODE: RSP
ALARM: DEV
SP HI
START FILL
TREND
E-STOP
LL-LIC-4
LL-FIC-4
ID-TT
SMART I/O
LL-LIC-4
TANK LEVEL
HI: 23.0
OUTPUT PV SP
OUTPUT
100.0
PV
18.7
SP
13.8
MODE: AUTO
LO: 5.0
EU: INCHES
ALARM: DEV
STATUS: VO HI
Manual Auto
RSP SUP DDC
Computer
Alarms A. Summ Ack Ack Horn
26-Jun-1996
03:40:53
OARs O. Summ
LL-LIC-4 LL-FIC-4 1FIC-410 ID-TT
Display Stack Lock
LL-OWP
ID-VALVE
ID-MAIN

DCS Operator Interface



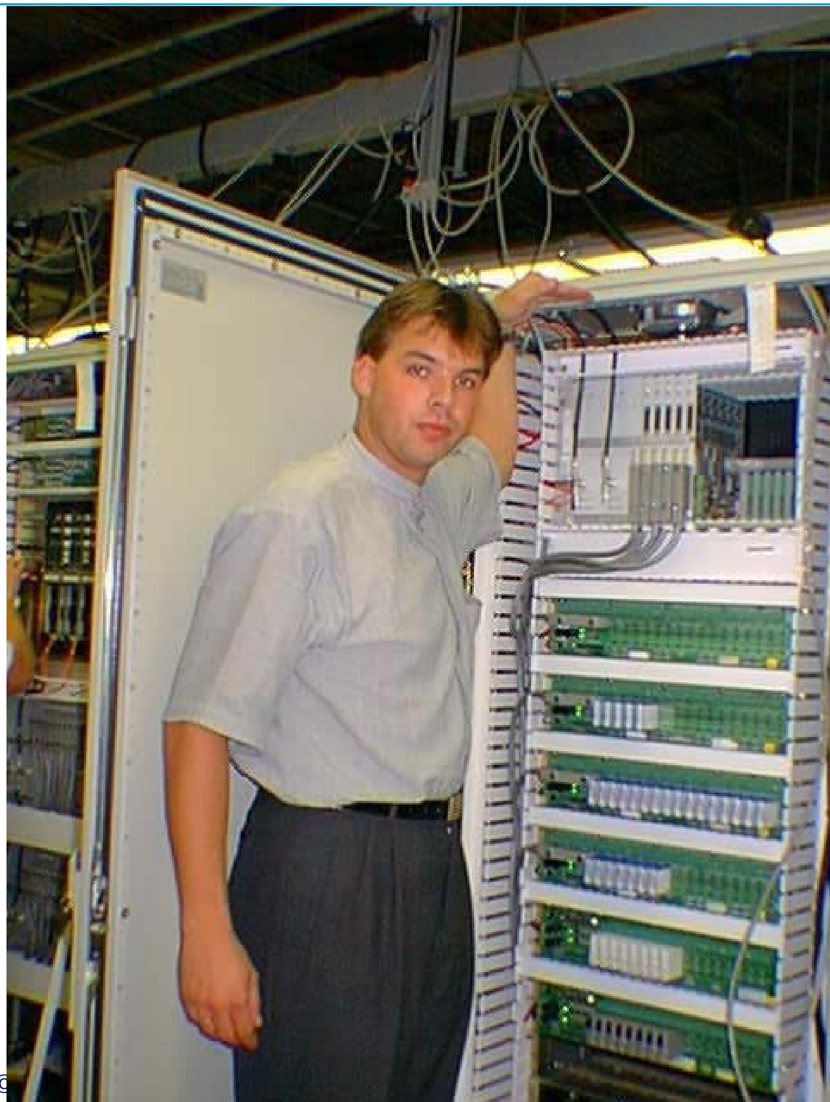
- Early DCS operator interfaces were expensive to install and maintain since the physical components were often custom design and construction.

Distribution of Control



- Control Equipment was Distributed Throughout the Plant to Motor Control Centers or Rack Rooms
- Heating, cooling and air scrubbers are commonly used to maintain correct operating conditions

DCS Controller Cabinet



- Typical DCS controller cabinet e.g. Provox controller, I/O cards, and termination panels.
- Physical layout and size was limited by available device and manufacturing technology
- Redundant communications, controllers and I/O were support

DCS – Typical I/O supported

Analog Input Modules
- High-Level Single-Ended
  - 1-5 Vdc
  - 4-20 mA
- High-Level Isolated
  - 0-10 Vdc
  - 4-20 mA
- High-Level Isolated
  - -10 to 70 mV
- Various RTD types
- Various Thermocouple types

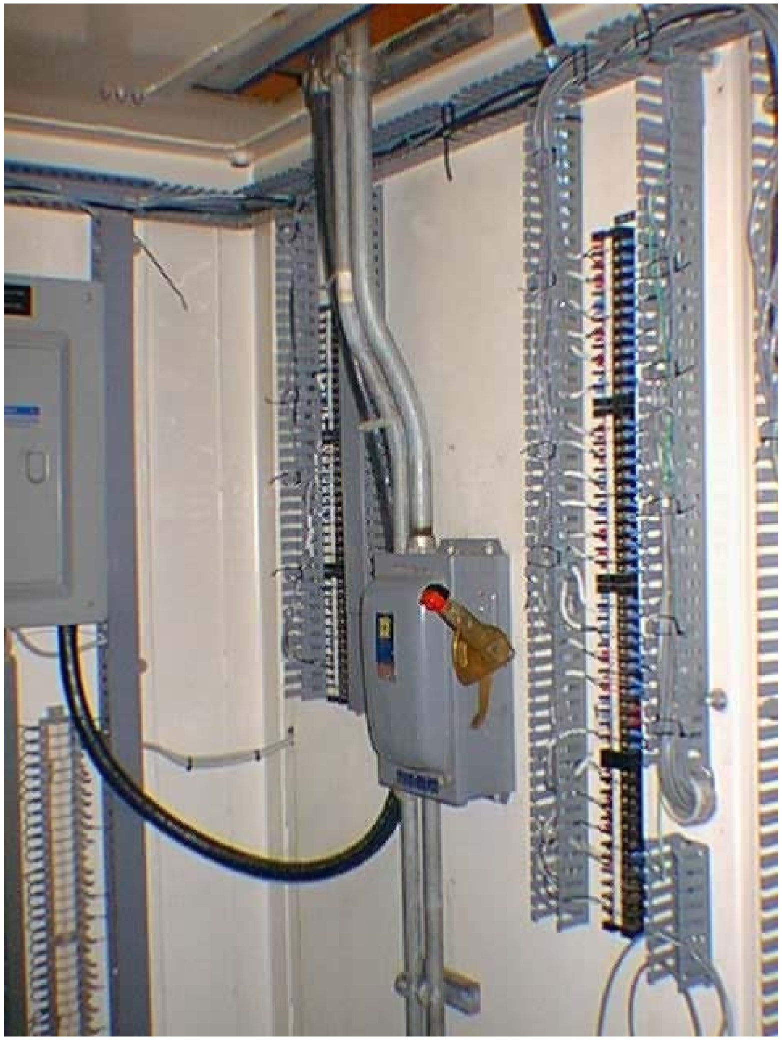
Analog Output Modules
- 4 - 20 mA dc

Smart Modules
- HART Input
- HART Output

Discrete Input Modules
- 3 - 32 Vdc w/ debounce
- 3 - 32 Vdc w/o debounce (fast switching)
- 3 - 32 Vdc for Vortex flowmeters
- 90 - 140 Vac/Vdc
- 180 - 280 Vac/Vdc
- Dry Contact input (low side switching)

Discrete Output Modules
- 24 Vdc
- 3-60 Vdc
- 24-140 Vac
- 24-140 Vac w/ MOV-protection
- 24-280 Vac
- 24-280 Vac w/ MOV-protection
- Relay Output

Junction Boxes



- Field wiring may be terminated at junction boxes or panels and from there wired to the controller termination

Interfacing to Intelligent Devices

- There is often a requirement to integrate intelligent devices e.g. PLC into the control system.
- Often integration is done using a communication interface e.g. serial interface card for MODBUS.

Interfacing to Intelligent Devices (Cont)

- Specialized devices such as for vibration monitor may provide information needed by the operator

Local Panels

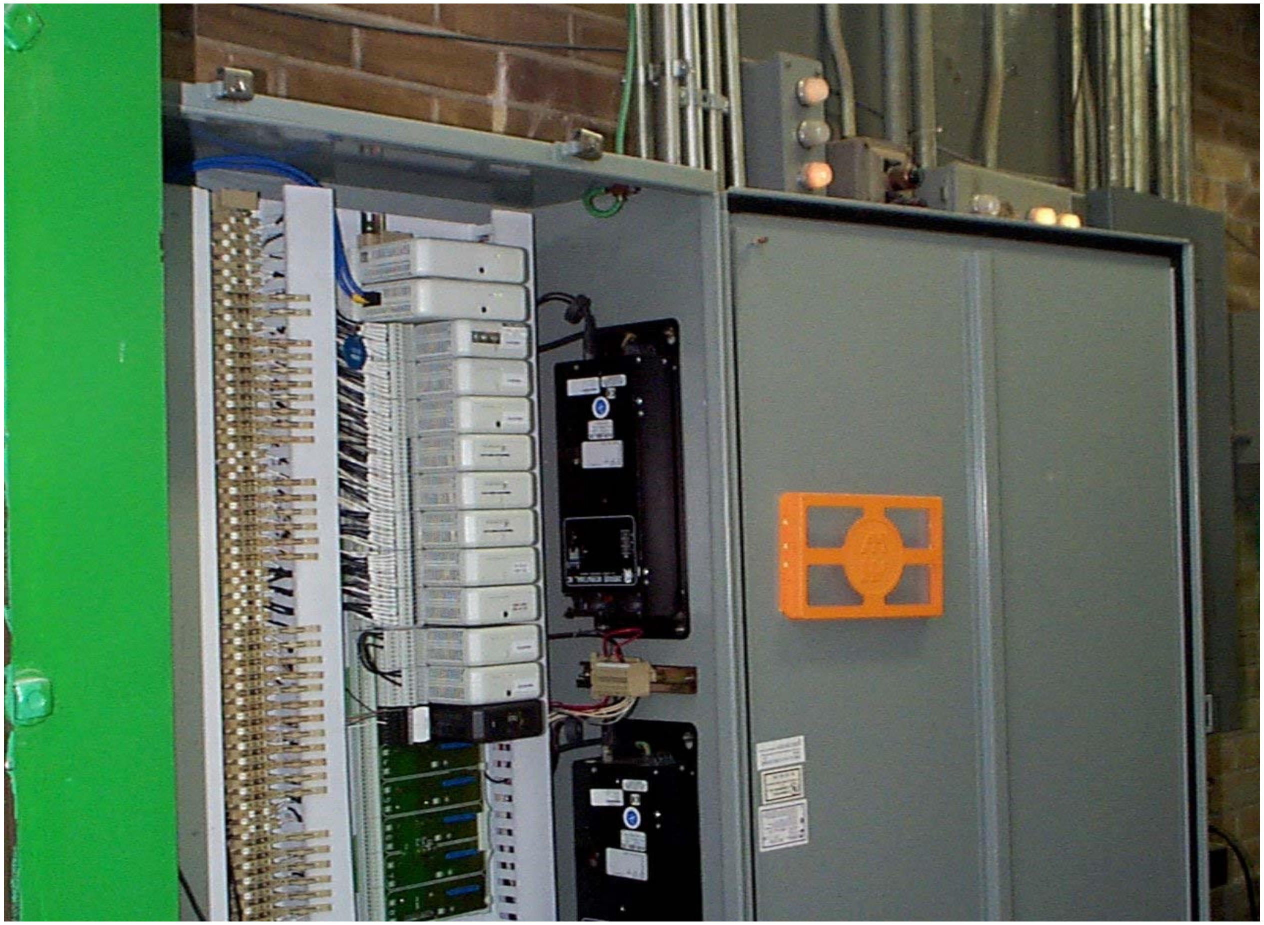
- In some cases, local control is still required to allow adjustments in the field.
- Typical of some batch processes in which manual adjustments are required.

DeltaV Controller Hardware - Changed the game!

Traditional Controller

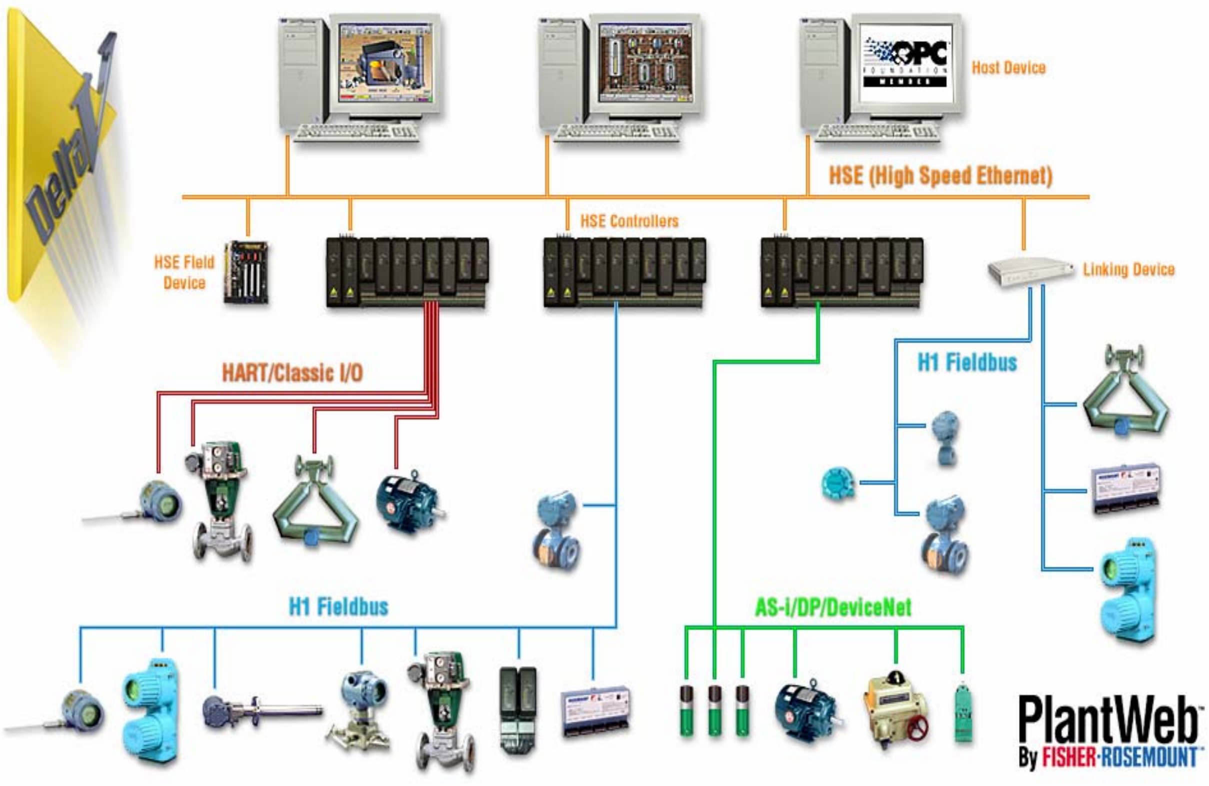
DeltaV Controller

DeltaV Terminations



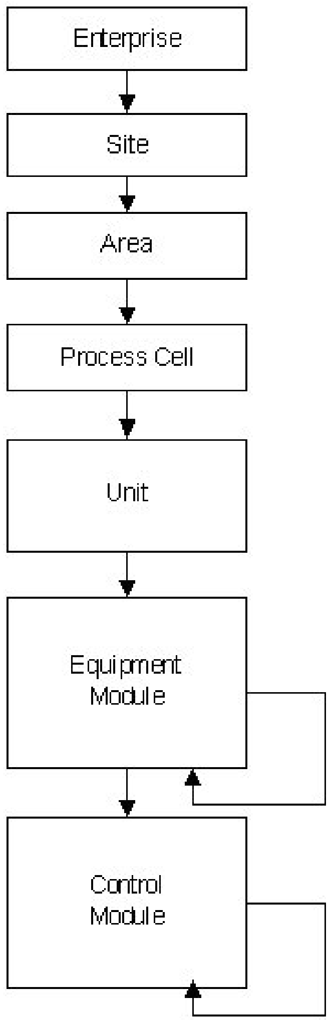
- High density terminations of DeltaV controllers allow cabinet space to be reduced compared to a traditional DCS installation.

DeltaV - Impact of Bus Technology



- Information from a wide variety of fieldbus devices are available for use in control.
- Since the DeltaV basic function block set is based on Foundation Fieldbus blocks, control may be defined independent of where it executes.

ISA S88 defines basic structure for control systems



An organization that coordinates the operation of one or more sites.

A component of a batch manufacturing enterprise, or logical segmentation within the enterprise.

A process site is divided into 1 or more physical, geographical, or logical segmentations called plant areas.

A logical grouping of equipment that includes the equipment required for production of one or more batches.

A collection of associated control modules and equipment modules in which one or more of the processing activities can be conducted.

A plant area can contain 0 or more equipment modules. An equipment module can contain other equipment modules, control modules, and function blocks. The control for a EM is described in terms of SFCs and Function Blocks.

A control module may be contained by a plant area, a equipment module, or by another control module. A control module may contain other control modules or function blocks.

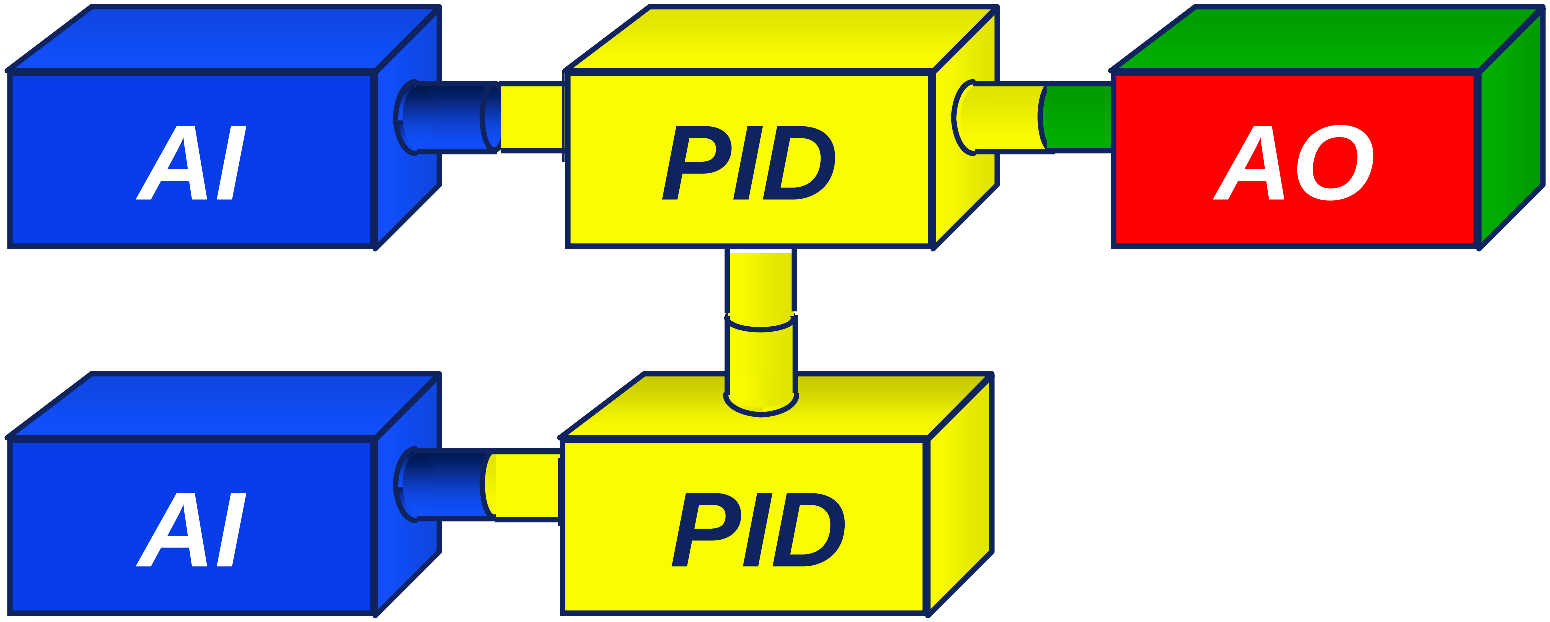
IEC 61131-3 defines Sequential Function Chart (SFC)

- Originally defined as a program organization unit for a PLC.
- Many process control systems, including DeltaV have adopted this graphical language as the primary means of sequential logic specification.

IEC61804 Standard Defines Function Block Architecture for the Process Industry

- The Foundation Fieldbus profile is used by many manufacturers of fieldbus devices
- Many control systems have adopted the Foundation Fieldbus function block architecture and specific function blocks

FUNCTION BLOCKS



BASIC FF FUNCTION BLOCKS

- Discrete Input
- Discrete Output
- Analog input
- Analog Output
- PID, PI, I Controller
- P, PD Controller
- Control Selector
- Manual Loader
- Bias/Gain Station
- Ratio Station

ADVANCED FF FUNCTION BLOCKS

- Pulse Input
- Complex Analog Output
- Complex Discrete Output
- Step Output PID
- Device Control
- Setpoint Ramp Generator
- Splitter
- Input Selector
- Signal Characterizer
- Lead Lag
- Deadtime
- Arithmetic
- Calculate
- Integrator(Totalizer)
- Timer
- Analog Alarm
- Discrete Alarm
- Analog Human Interface
- Discrete Human Interface