UNIT 4

OPERATOR INTERFACE REQUIREMENTS

OPERATOR INTERFACE

- Well designed human interface required to permit error free interaction between human and automated system

- Two groups of plant personal interact with the control system

1. instrumentation and control system Engineer – initial setup and adjustments and maintenance

2.plant operators – monitoring and supervising

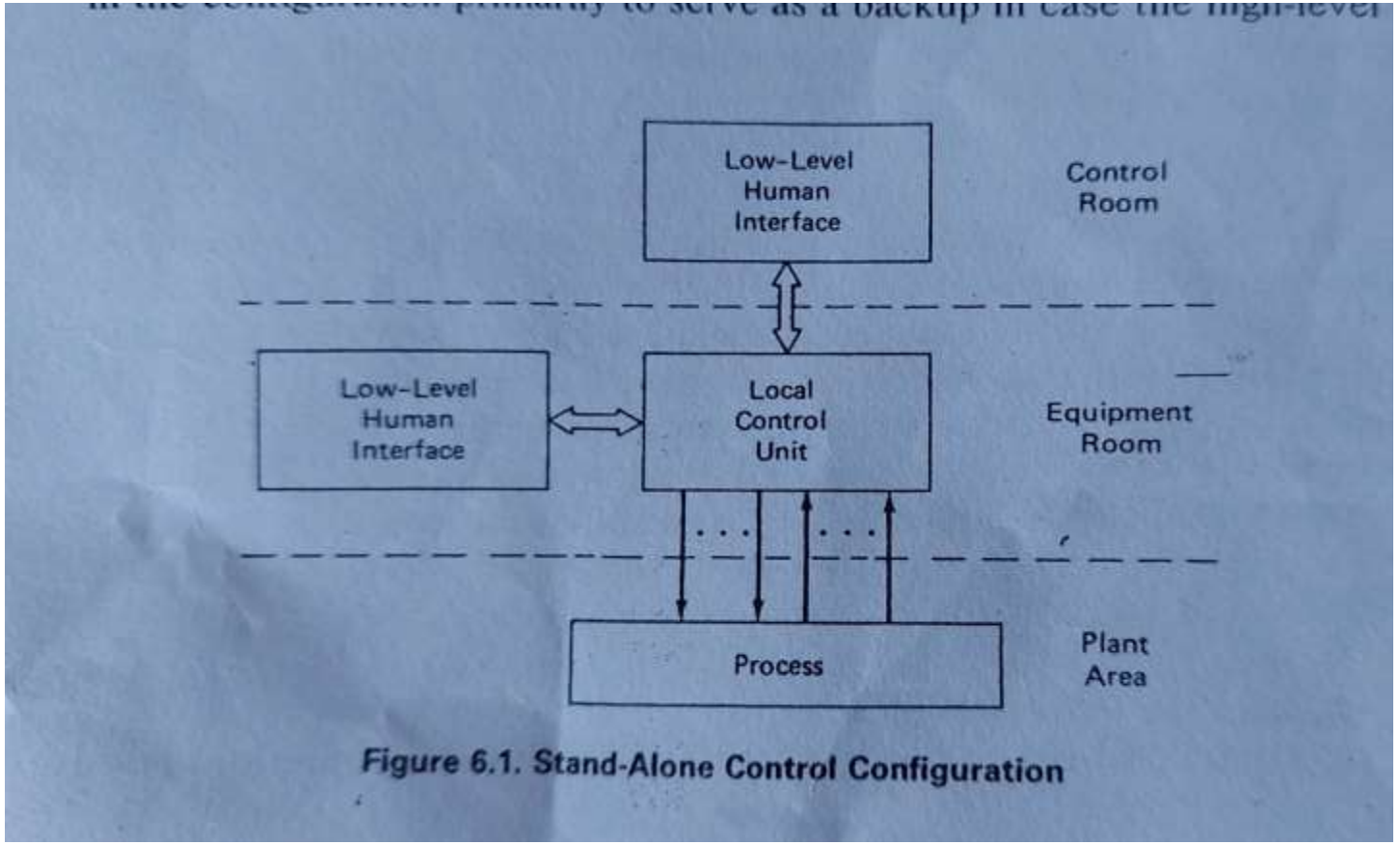


Figure 6.1. Stand-Alone Control Configuration

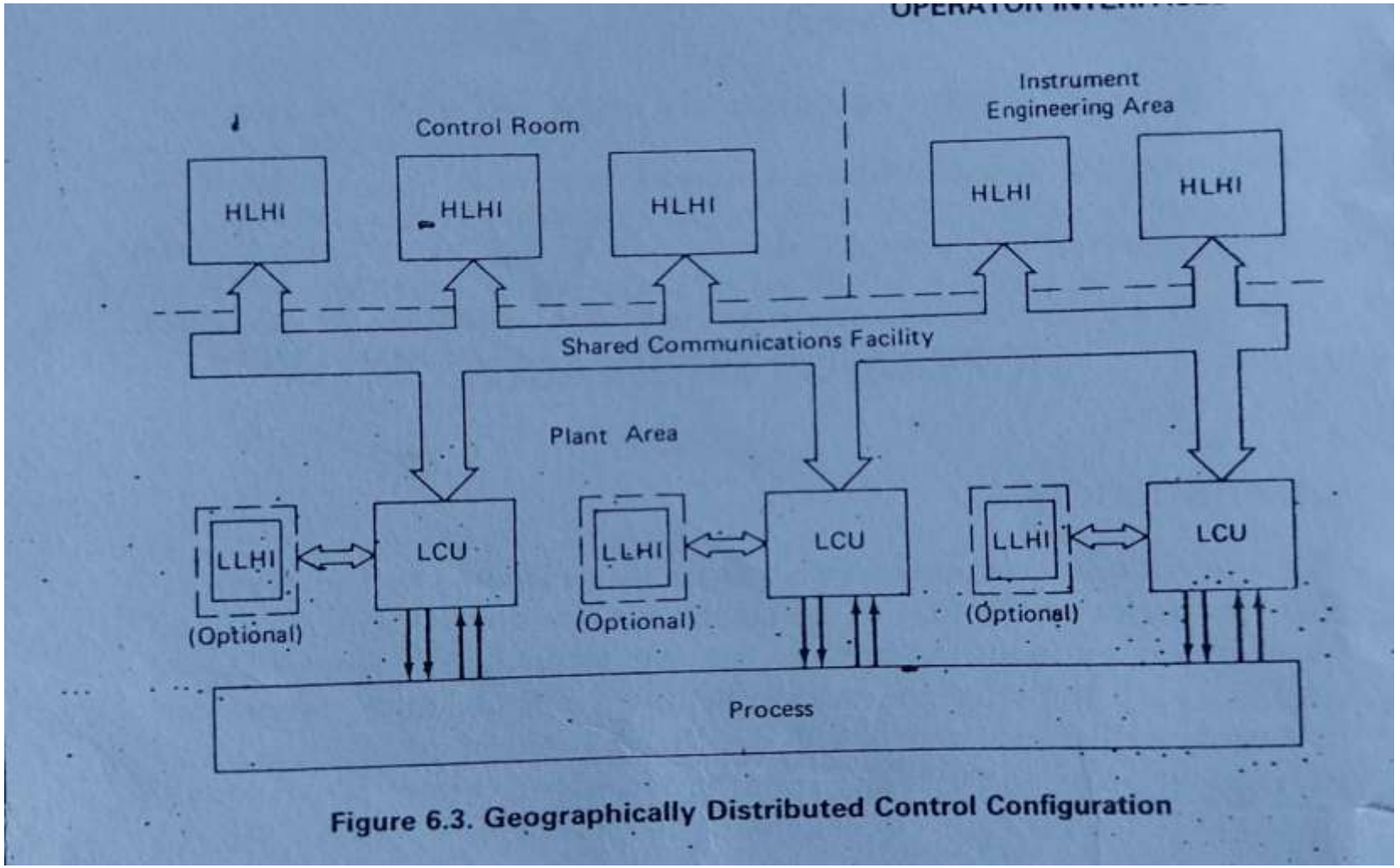


Figure 6.3. Geographically Distributed Control Configuration

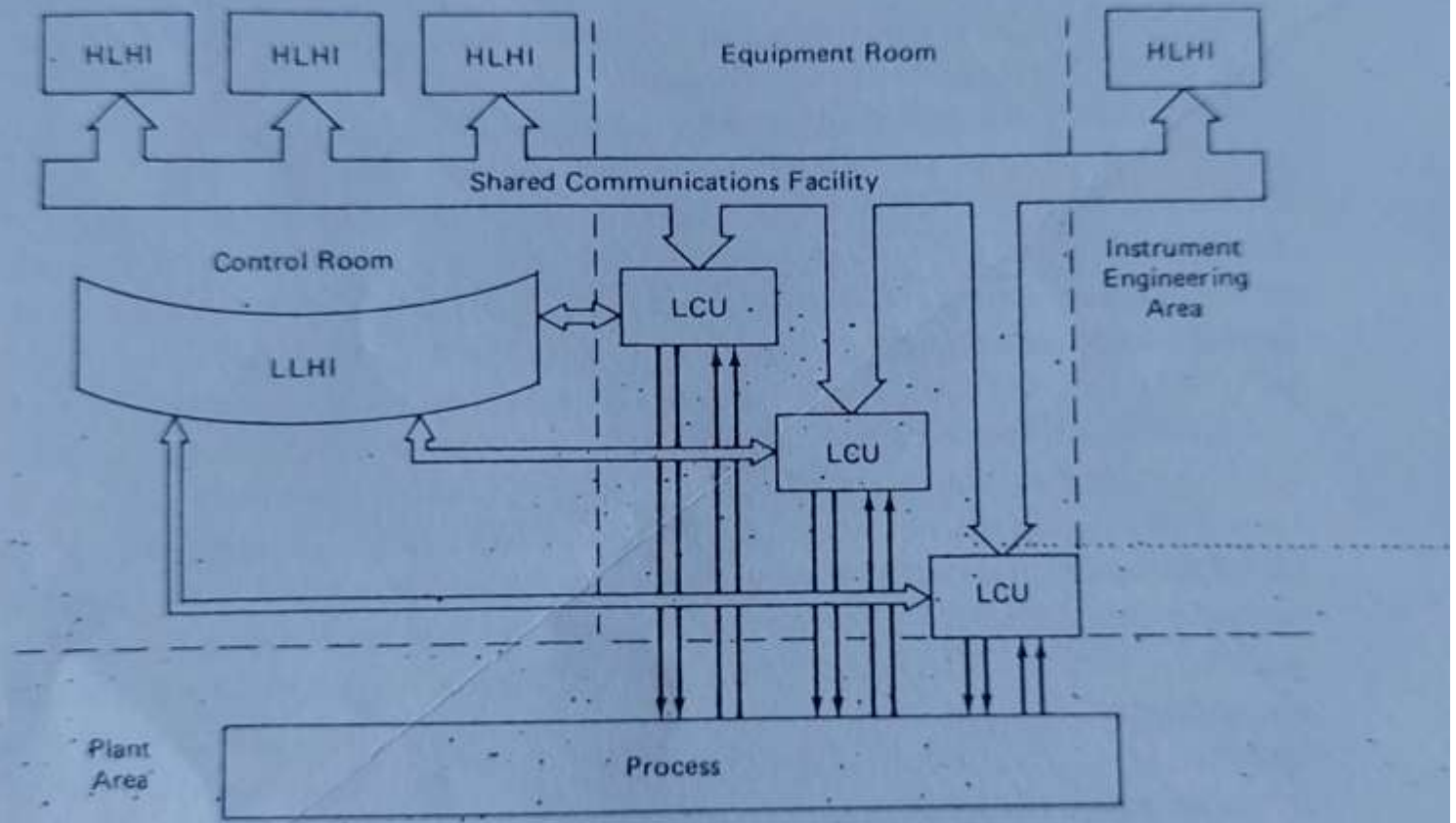


Figure 6.2. Geographically Centralized Control Configuration

OPERATORS RESPONSIBILITY

- Operator interface system should allow the operator to perform the following tasks:

- Process Monitoring
- Process control
- Process diagnostics
- Process record keeping

PROCESS MONITORING

- Operator interface system should allow the operator to observe and monitor the current state of the process
- The values of the process variable must be available for the operator at any time
- The values must be accurate
- If any malfunctions(sensors)should be readily visible to the operator
- Each process variable identifiable by the TAG assigned by instrumentation engineer
- Units of the variable should be visible along with the values

PROCESS MONITORING

- Some cases the computed variables should available for the operator
- Operator interface should alert the operator with various alarms(low – high)or indicators
- Operator interface should display the alarm limits with the process variables
- If the system detects multiple alarm condition ,operator interface should indicate the operator with priority of the various alarm conditions
- Operator requires trending of the process variable moving condition. Trending graphs should be provided

PROCESS CONTROL

- Operator interface should allow the operator to do the following functions to control the process:

1. To access the all control loops
2. To change the control modes from auto to manual
3. To perform logic control operations
4. To observe the current status and to initiate new steps or Halt
5. To access and be able to manipulate control variables despite any single point failure

PROCESS DIAGNOSTICS

- Operator interface should allow the operator to identify the equipment causing the problem, take measures to correct it,move the process to back normal operation
- Diagnostics features:

1. ongoing tests and reasonable checks on the sensors
2. ongoing self tests on the components and modules
3. should display all the process information with alarms for malfunctioning(first out alarms and priority alarming functions)

PROCESS RECORD KEEPING

- Record keeping was one of the first functions to be automated using conventional computer

1. Recording of short term trending information
2. manual input of process data
3. recording of alarms
4. periodic records of process variables information
5. long time storage and retrieval of information
6. Record of operator control actions

GUIDELINES FOR DESIGNING OPERATOR INTERFACE SYSTEMS

- Full Range of operator population
- Consider common minor disabilities in operators
- Rapid access for necessary controls and display
- Arrange equipment and display with operational point of view
- Minimize operator confusion by using colours, symbols and labels
- Information should be prioritized and organised
- Provide aids such as operator guides, menu’s, prompts or interactive sequences
- System can detect and filter our the operator inputs error
- Control room environment should be designed well

LOW LEVEL OPERATOR INTERFACE

- Directly connected to LCU for controlling and monitoring
- Motivations for using LLOI
    1. trained to use panel board instrumentation
    2. less expensive for small applications
    3. can provide manual backup

The devices are used in LLOI:

1. control stations
2. indicator stations
3. alarm annunciators
4. trend recorders

LOW LEVEL OPERATOR INTERFACE

- **CONTINUOUS CONTROL STATION**: one type of panel board instrumentation used in process control system is the manual/automatic station associated with a continuous control loop

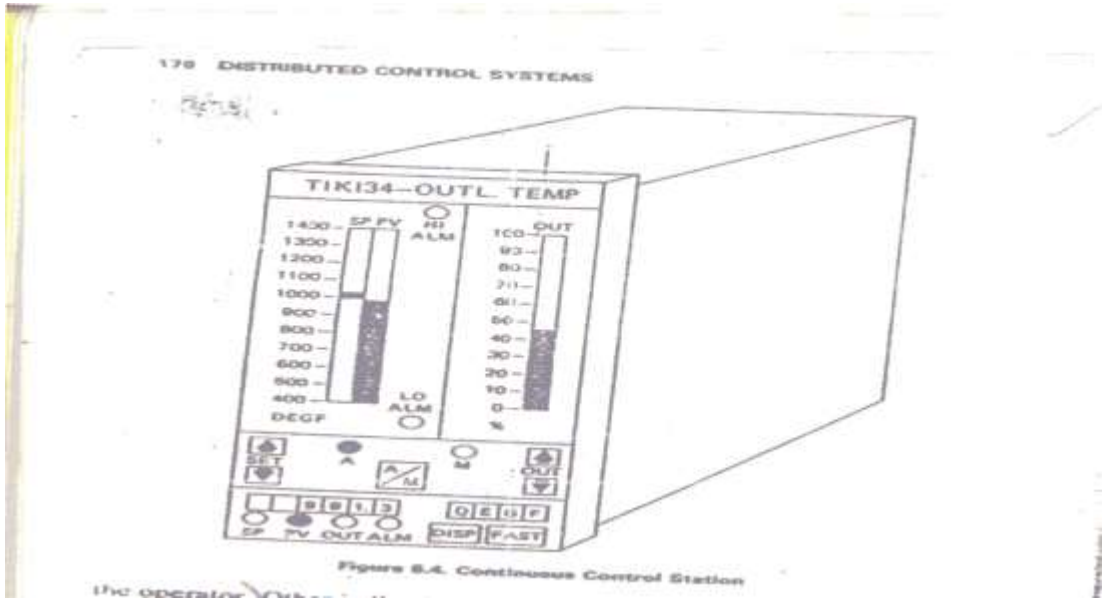
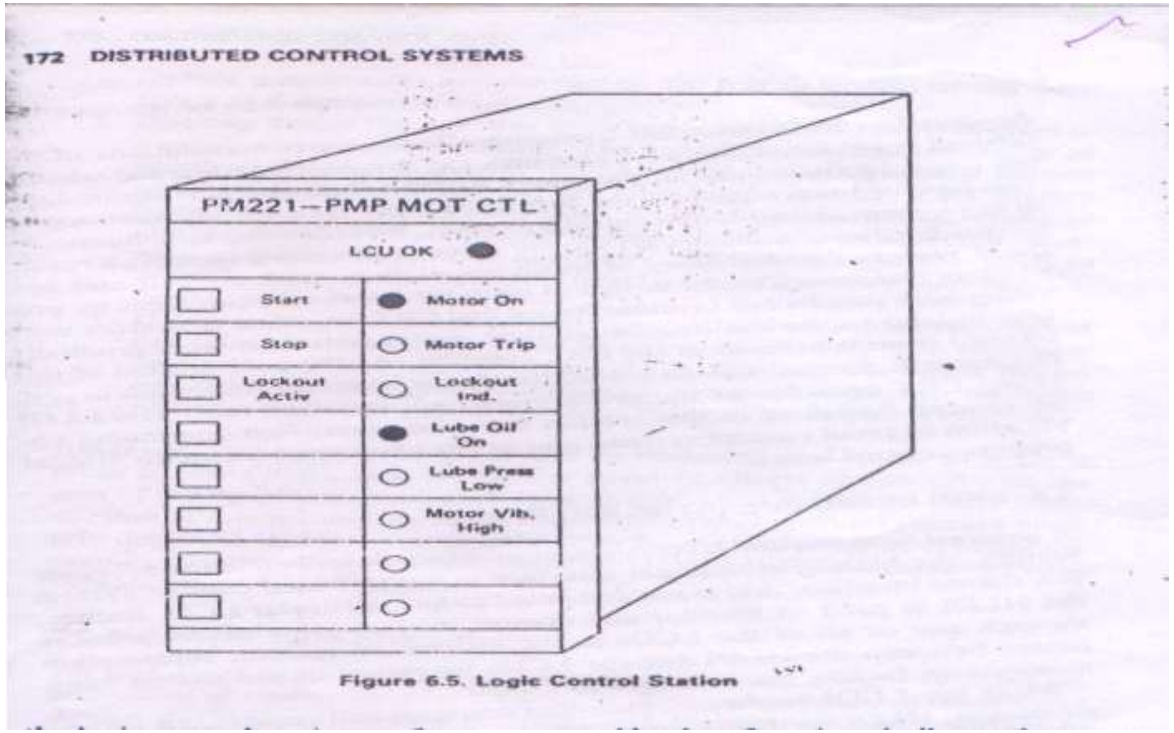


Figure 8.4. Continuous Control Station

LOW LEVEL OPERATOR INTERFACE

- **LOGIC STATION**: control station for a logic and sequential control system. consists of a set of pushbuttons indicating lights for logic operations.



LOW LEVEL OPERATOR INTERFACE…

SMART ANNUNCIATORS:

It can provide the following functions:

1. Alarm prioritization
2. Annunciation and acknowledgement mode options
3. First-out annunciation

LOW LEVEL OPERATOR INTERFACE…

Selection of Station Components:

The designer should meet the following requirements:

1. Displays and pushbuttons should be sealed against the atmosphere to avoid contamination.
2. Displays should be selected for high visibility in the expected ambient light environment.
3. Each pushbutton when depressed should provide tactile feedback to the operator to minimize potential errors.

The common types of push-button and switch inputs are

1. Spring-loaded plungers
2. Membrane or dimple switches

LOW LEVEL OPERATOR INTERFACE…

Application in Distributed System:

1. Small control systems
2. Backup mechanism for critical process control loops

HIGH LEVEL OPERATOR INTERFACE

- HLOI in a DCS is a shared interface that is not dedicated to any particular LCU.
- HLOI is used to monitor and control the operation of the process through any or all of the LCUs in the distributed system.
- HLOI hardware uses CRT or similar advanced display technology in console configurations often called video display units (VDUs).
- HLOI accepts operator inputs through keyboards instead of the switches, push-buttons, and potentiometers characteristic of conventional operator interface panels.

HIGH LEVEL OPERATOR INTERFACE…

Advantages:

* Control room space is reduced significantly
* More flexible
* Inexpensive

HIGH LEVEL OPERATOR INTERFACE

- Architectural Alternatives
    1. Centralized HLOI Configuration
    2. Fixed HLOI Configuration
    3. Modular HLOI configuration

HIGH LEVEL OPERATOR INTERFACE...

CENTRALIZED HLOI CONFIGURATION:

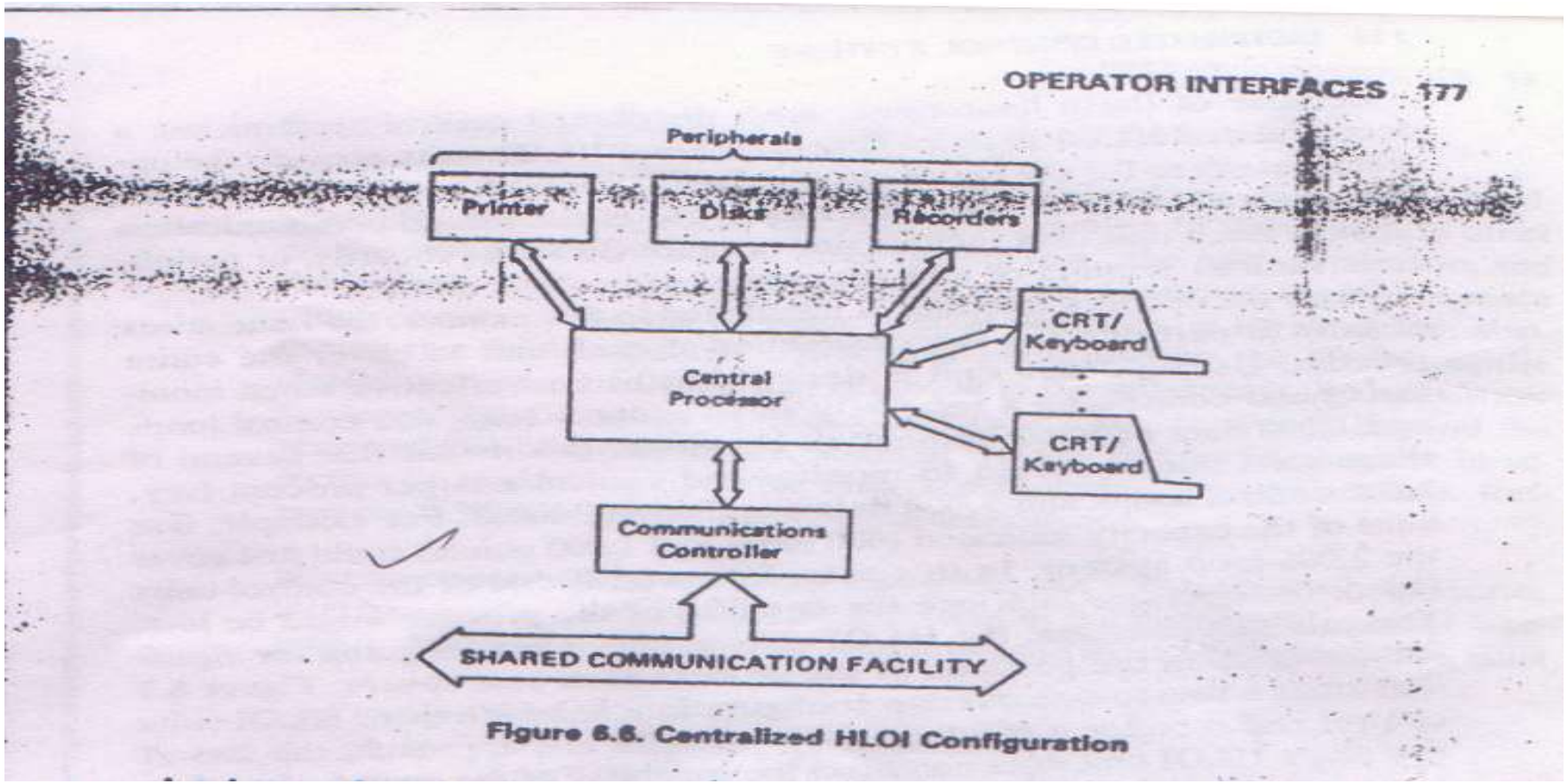


Figure 6.6. Centralized HLOI Configuration

HIGH LEVEL OPERATOR INTERFACE…

- A single CPU that performs all of the calculations, database management and transfer operations, and CRT-and-keyboard interfacing functions for the entire HLOI system.
- A separate communications controller interfaces the central processor with the shared communications facility.

Advantages:

1. The CRTs are all redundant and can be used to back each other up in case of a failure.
2. It reduces the no. of peripherals required for some situation.

HIGH LEVEL OPERATOR INTERFACE…

Advantages:

1. The CRTs are all redundant and can be used to back each other up in case of a failure.

2. Peripherals can be shared and need not be dedicated to any particular CRT/Keyboard combination. This can reduce the no. of peripherals required in some situation.

Disadvantages:

1. Complex peripheral-switching and memory-sharing implementations.

2. Display response times are long and the size of system that can be handled is severely limited.

3. Not scalable and too expensive for small ones.

HIGH LEVEL OPERATOR INTERFACE…

Overlap in HLOI scope and control:

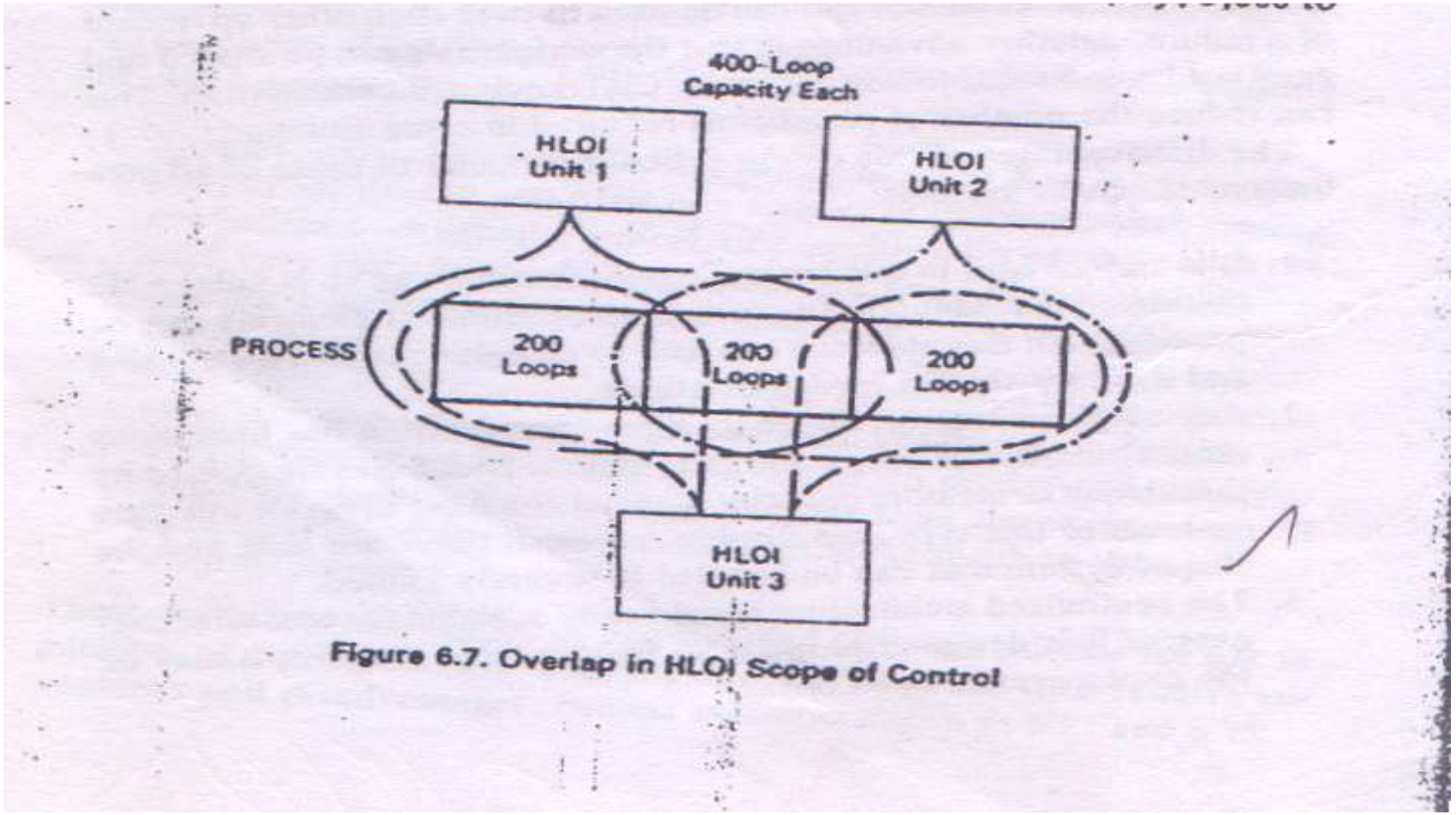


Figure 6.7. Overlap in HLOI Scope of Control

HIGH LEVEL OPERATOR INTERFACE…

- In this three HLOI units control and monitor a 600-loop process.
- The loss of any single HLOI unit does not affect the capability of the operator interface system to control the process.
- It is more expensive.
- Capable of backing up any other unit in the system.

HIGH LEVEL OPERATOR INTERFACE…

Fixed HLOI Configuration

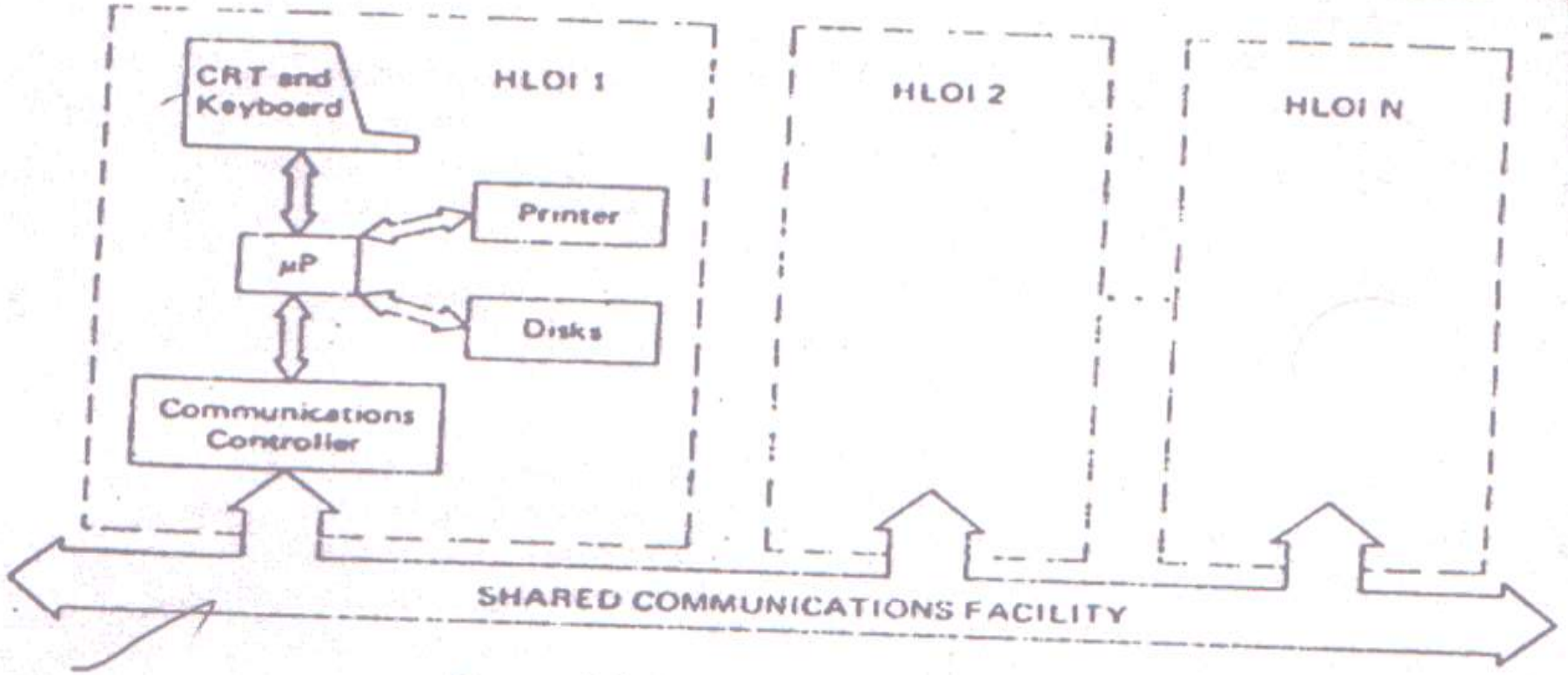


Figure 6.8. Fixed HLOI Configuration

HIGH LEVEL OPERATOR INTERFACE…

- A single HLOI unit consisted of a communications controller, main processor, CRT and keyboard, and associated mass storage.
- The only option for the user was whether to include a printer or other hard-copy device.
- Because of this fixed configuration of elements, the scope of control and data acquisition of the HLOI unit also was fixed.

HIGH LEVEL OPERATOR INTERFACE…

Modular HLOI Configuration:

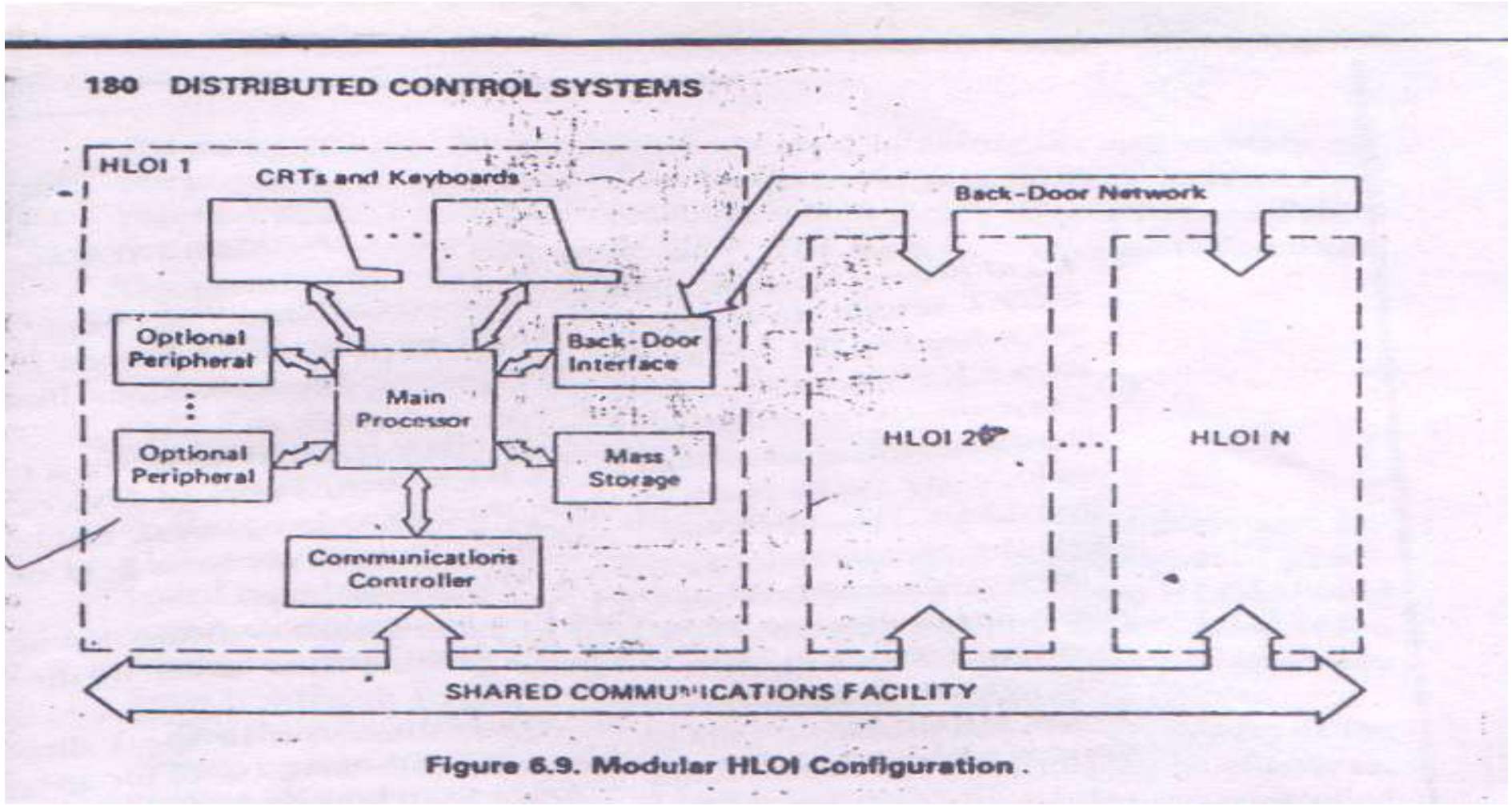


Figure 6.9. Modular HLOI Configuration.

HIGH LEVEL OPERATOR INTERFACE…

Modular HLOI Configuration in detail:

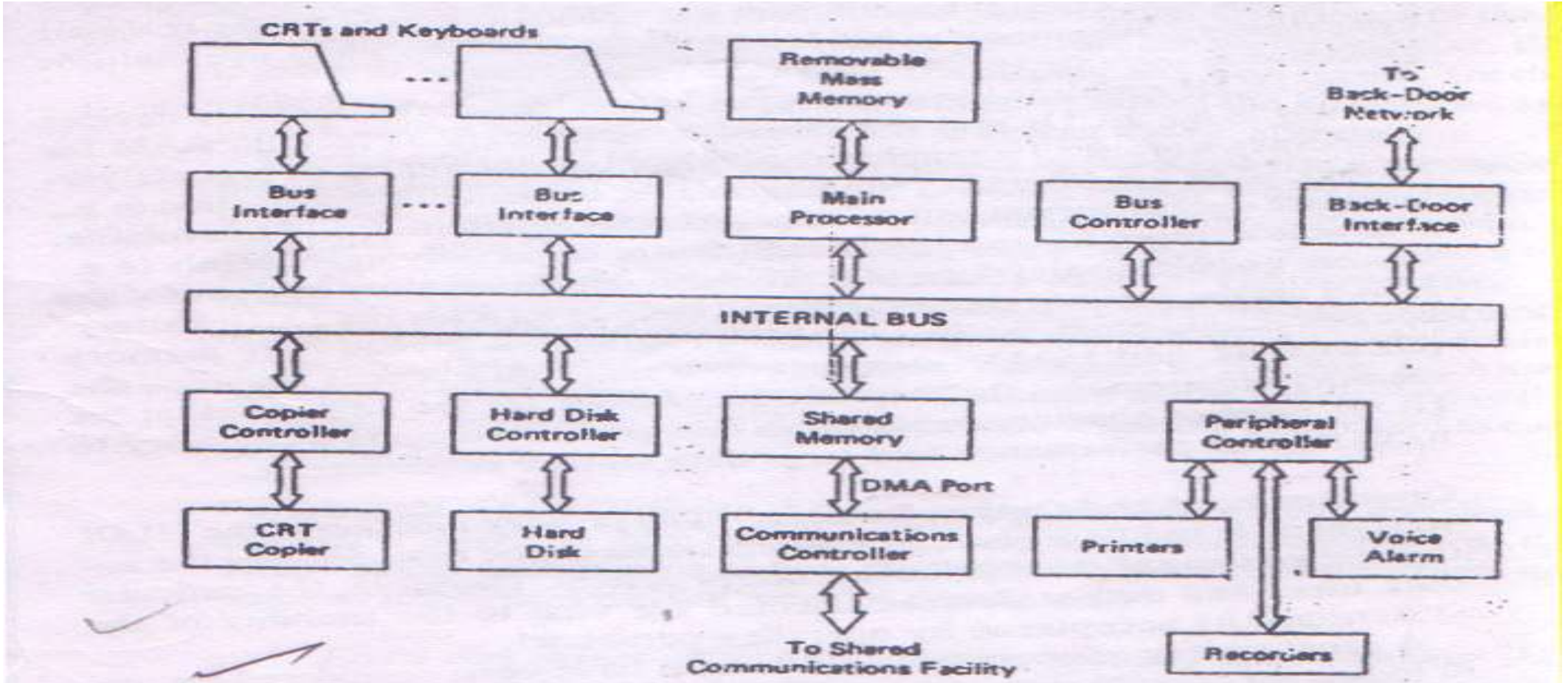


Figure 6.10. Modular HLOI Configuration in Detail

HIGH LEVEL OPERATOR INTERFACE…

- HLOI units have been designed to be modular; the user can buy the base configuration at minimum cost or expand it to handle a large no. of control loops and data points.

HIGH LEVEL OPERATOR INTERFACE…

Hardware Elements in the Operator Interface:

1. Microprocessor and Memory Components
2. Operator Input and Output Devices
3. Peripherals
4. Modular Packaging Approach

Characteristics of Modular Packaging:

* Good anthropometric design
* Elimination of glare
* Easy accessibility of peripherals
* Simple interconnection of modules

OPERATOR DISPLAYS

INTRODUCTION:

- The panel board in a control room uses many square feet of dedicated instruments to provide the operator with the information and mechanisms needed to control the plant.
- The VDU in an HLOI system provides a window to the process that allows the operator to see only a relatively small amount of information at any one time on one or more CRT displays.

OPERATOR DISPLAYS…

Typical Display Hierarchy:

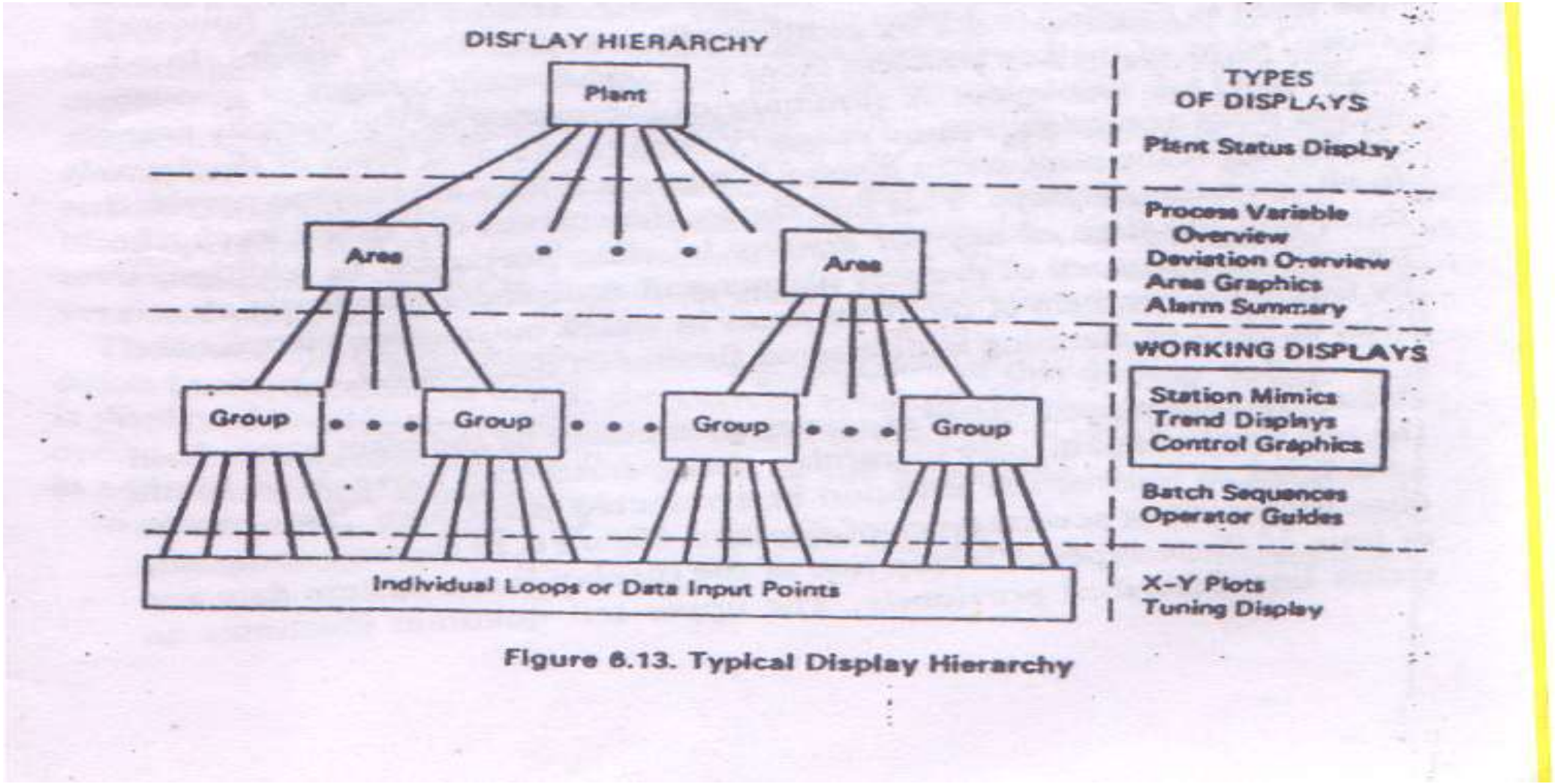


Figure 6.13. Typical Display Hierarchy

OPERATOR DISPLAYS…

1. PLANT LEVEL:

   - provides information about the entire plant.

   - If plant is large enough, then it can be broken up into several areas of interest.

2. AREA LEVEL:

   - provides information concerning the portion of the plant equipment that is related in some way.

OPERATOR DISPLAYS…

3. GROUP LEVEL:

- Displays at this level deal with the control loops and data points relating to a single process unit within a plant area.

4. LOOP LEVEL:

- Displays at this level deal with individual control loop, control sequences and data points.

OPERATOR DISPLAYS…

FEATURES OF GENERAL DISPLAY STRUCTURE:

- Covers the full range of detail of information required by the operator.
- Allows grouping of available information.
- Allows the operator to form a mental model of the relationships of various of various pieces of information in the plant.

OPERATOR DISPLAYS…

Design Considerations for Displays:

1. Display should not be cluttered. They must be as simple as possible.
2. Displays should not be overly “flashy” or have light colored backgrounds.
3. The top line or two of each display should contain common information of interest to the operator like current date, time, overview of the alarm status.
4. Color should be used in a consistent way throughout all displays to minimize operator confusion.
5. Color should not be the only means for communicating with the operator.

ENGINEERING INTERFACE

Levels of Engineering Interface Hardware:

1. Low level- Minimum function device that are inexpensive and justifiable for small systems.
2. High Level- Full function devices that are more powerful, that are needed for medium and large sized DCS.

ENGINEERING INTERFACE….

Functions of Engineering Interface Hardware:

1. System configuration
2. Operator interface configuration
3. System documentation
4. System failure diagnosis

ENGINEERING INTERFACE….

GENERAL REQUIREMENTS:

1. Access security
2. Ergonomic design
3. Data Reasonableness and Consistency
4. User convenience
5. Cost Effectiveness

LOW LEVEL ENGINEERING INTERFACE

- LLEI is designed to be a minimum function, inexpensive device whose cost is justifiable for small DCS.
- It can also be used as a local maintenance and diagnostic tool in large systems.

LOW LEVEL ENGINEERING INTERFACE…

General Description:

- LLEI is usually a microprocessor based device designed either as an electronic module or as a hand held portable device.
- To minimize the cost, the device is usually designed with a minimal keyboard or alphanumeric display.
- Some LLEIs use CRTs or Flat panel displays which are expensive.
- Some LLEIs are connected directly to one LCU and Data I/O unit at a time.
- It is not user friendly.

LOW LEVEL ENGINEERING INTERFACE…

System Configuration:

- The distributed systems provide a system engineering guide that helps the user, a step by step procedure for hardware configuration.
- The primary purpose of the LLEI is to provide a tool for configuring the algorithms in the system controllers.
- It is necessary to install a control configuration in a spare controller used to replace a failed controller.

LOW LEVEL ENGINEERING INTERFACE…

Operator Interface Configuration:

- LLEI is used only by DCS which are small that have only a limited no. of control loops.
- Operator interface is also simple usually consisting of a small no. of dedicated panel board devices.
- The connections of panel board instrumentation, between stations and controllers are through hard wiring or cabling. Changes are difficult to make.

LOW LEVEL ENGINEERING INTERFACE…

Documentation:

- The automation of documentation of the hardware and control configuration is less or nil.
- The documentation is a manual process, with the help of standard forms in the system engineering guide.

HIGH LEVEL ENGINEERING INTERFACE

- HLEI allows a user to use the full benefit of the flexibility and control capability of a DCS with minimal cost.
- The cost is minimum when used with medium to large scale systems.

HIGH LEVEL ENGINEERING INTERFACE…

General Descriptions:

- HLEI is implemented in the form of a CRT based console or VDU.
- The VDU architecture is modular with multiple microprocessors.
- This provides increased flexibility.
- It interacts with other elements in DCS through the shared communications facility.

HIGH LEVEL ENGINEERING INTERFACE…

Dual console functions:

- Engineering console is a device that is dedicated to engineering function and can also be used a s an operator’s console.
- A key lock is used to switch between the two console personalities.
- The first position permits only operator functions and the second position permits engineering functions.
- Implementing this is a single piece of hardware is cost effective.

HIGH LEVEL ENGINEERING INTERFACE…

Special Hardware Required:

- The operator’s console uses a flat panel, dedicated function keyboard for ruggedness and simplicity of operation.
- Some provide a digitizer tablet and stylus, a light pen with cursor keys, touch screens etc.,
- Some vendors provide special color graphic, printing or plotting devices.

HIGH LEVEL ENGINEERING INTERFACE…

Portable Engineering Interface:

- CRT based engineering interface device is provided generally.
- It is a portable unit that can be plugged into and interface with a single LCU or cabinet.

HIGH LEVEL ENGINEERING INTERFACE…

System Configuration:

- HLEI plays a major role in automating the process of configuring a DCS.
- The following information can be stored:
    * Definition of any hardware options.
    * Definition of each input point.
    * Number, type and location of each hardware module.
    * Logic state descriptions.
    * Control and high level language computational algorithms.
    * Communicational linkages.

HIGH LEVEL ENGINEERING INTERFACE…

Operator Interface Configuration:

- Configure or change its display structure and parameters in a convenient manner.
- Should be able to download displays and display hierarchies configured on one engineer's console to any other operators console.

Steps in Configuring:

- To structure a hierarchy of displays.
- Define the individual displays.

HIGH LEVEL ENGINEERING INTERFACE…

Documentation:

- It can reduce the amount of time required to configure a control system and its associated operator interface.
- After the configuration process, all the information defining hardware, control logic, computational algorithms and displays is stored in mass memory.
- This make it possible to completely automize the process of documenting.

HIGH LEVEL ENGINEERING INTERFACE…

Design Consideration for documentation:

- List of hardware module in DCS.
- Documentation of control configuration and associated tuning parameters.
- Listing of tags in DCS, special operator functions that are associated with tag.
- Definition of operator displays.

HIGH LEVEL ENGINEERING INTERFACE…

Diagnosis of System Problems:

- HLEI helps in diagnosing failures and other problems in DCS.
- Most of this hardware is microprocessor based and has the intelligence to perform on-line self diagnostics.
- Overall diagnostic status is indicated in top line of each display in the HLOI system.
- If any problem occurs, then a status alarms goes off and the operator or engineer can call up a hierarchy of diagnostic displays to pinpoint the problem.

HIGH LEVEL ENGINEERING INTERFACE…

TYPICAL DIAGNOSTIC HIERARCHY:

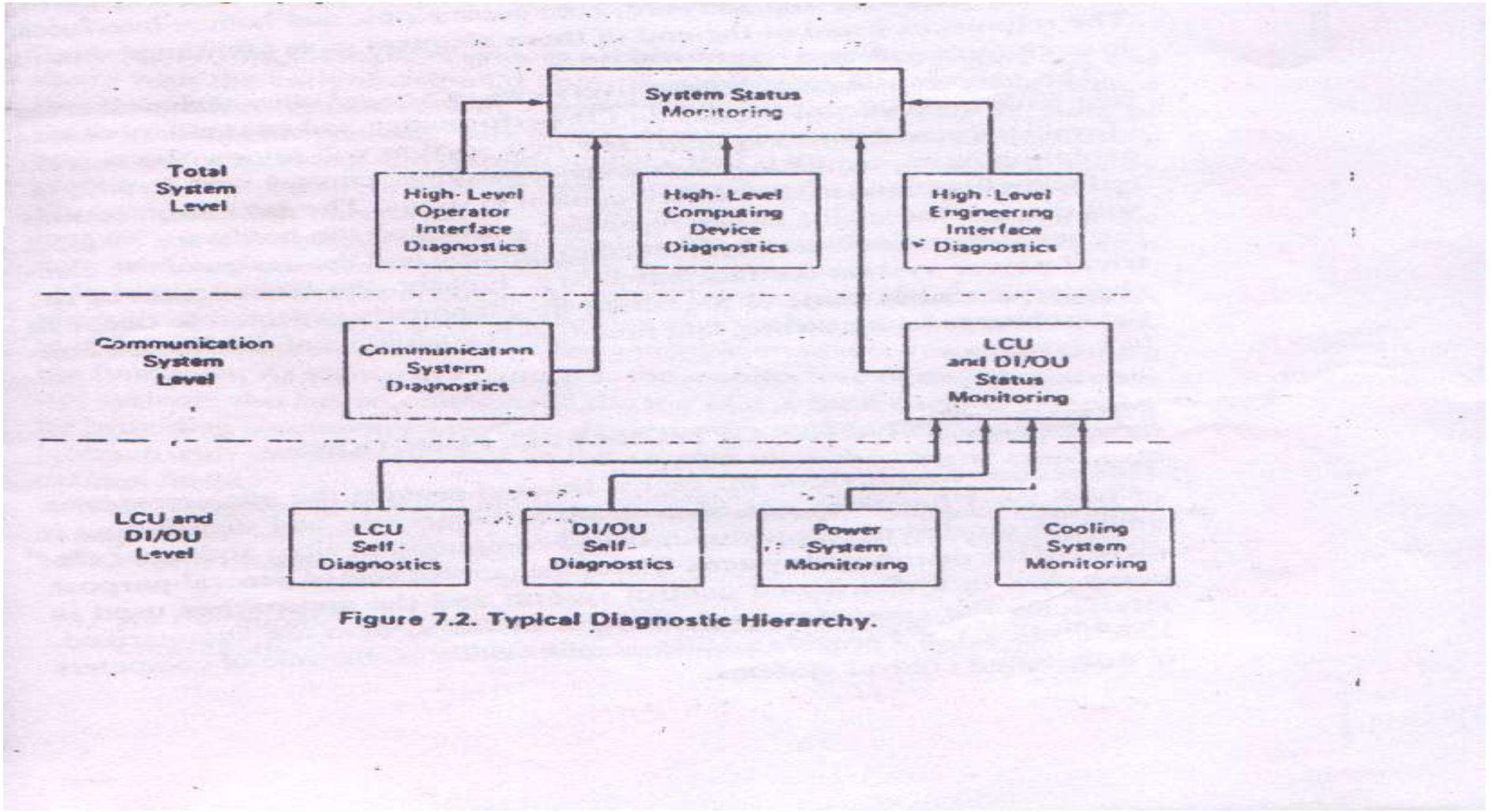


Figure 7.2. Typical Diagnostic Hierarchy.

GENERAL PURPOSE COMPUTERS IN DCS

- The general-purpose computer may well have a role to play in a distributed control system depending on the background of the user and the needs of the particular application.
- Some of the issues that would motivate a user to include a general- purpose computed in a distributed control system are:
    1. Software investment
    2. Specialized language requirements
    3. Extensive computational requirements
    4. Personal computer for small systems