BEST PRACTICES FOR MANAGING CONTROL SYSTEM MIGRATION

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PROBLEMS

- FREQUENT SHUTDOWNS RESULTED IN INABILITY TO MEET CAPACITY DEMAND AND LOST REVENUES.
- CONTROL SYSTEM FAILURES CREATED UNSAFE EQUIPMENT AND PERSONNEL OPERATING CONDITIONS.
- INABILITY TO KEEP AUTOMATIC CONTROLS WORKING REQUIRED ADDITIONAL PERSONNEL TO MANUALLY OPERATE THE FACILITY.
- FREQUENT UNAVAILABILITY OF DATA LOCALLY AND REMOTELY UNDERMINES OPTIMAL UTILIZATION OF THE PIPELINE.
- VARIOUS TYPES OF HARDWARE REQUIRED GREATER STOCK OF SPARE PARTS.
- VARIOUS TYPES OF OPERATING SYSTEMS REQUIRED ADDITIONAL TRAINING FOR THE ONSITE OPERATING PERSONNEL AND CREATED GREATER DEPENDENCY ON OUTSIDE SUPPORT FOR DAY TO DAY OPERATION.

BENEFITS

- REDUCE REVENUE LOSS
- ENSURE SAFE PERSONNEL AND OPERATING CONDITIONS
- MINIMIZE TRAINING AND DOCUMENTATION COSTS
- RETAIN KNOWLEDGE
- IMPROVE OPERATING PROCEDURES
- POSITION FOR FUTURE

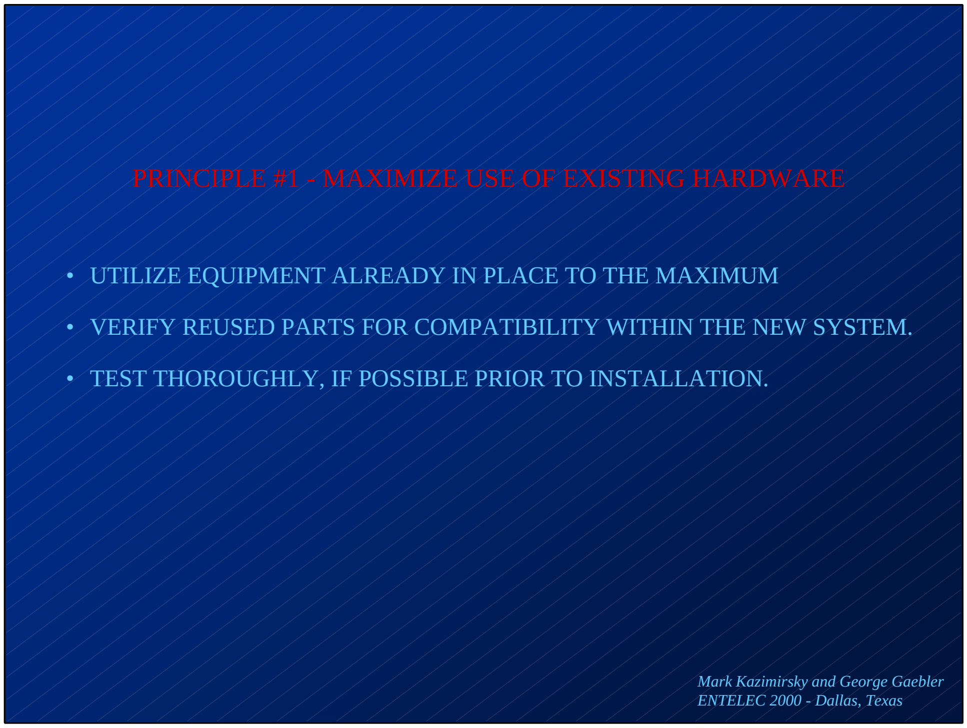
SUMMARY OF EQUIPMENT

PARTIAL LIST OF EQUIPMENT CONTROLLED BY PLC SYSTEM AT HINKLEY COMPRESSOR STATION:

4	Electric Generators, 500 KW each
1	Electric Generator, 200 KW
8	Cooling Tower Pumps
8	Gas Cooling Fans
4	Lube Oil Cooler Pumps
10	Lube Oil Cooling Fans
8	Jacket Water Pumps
20	Jacket Water Cooling Fans
4	Unit Fin Fans
4	Raw Water Pumps
10	Air Compressors and Dryers
32	Other Miscellaneous Loads (Fans, Pumps, Etc.)

MIGRATION PRINCIPLES

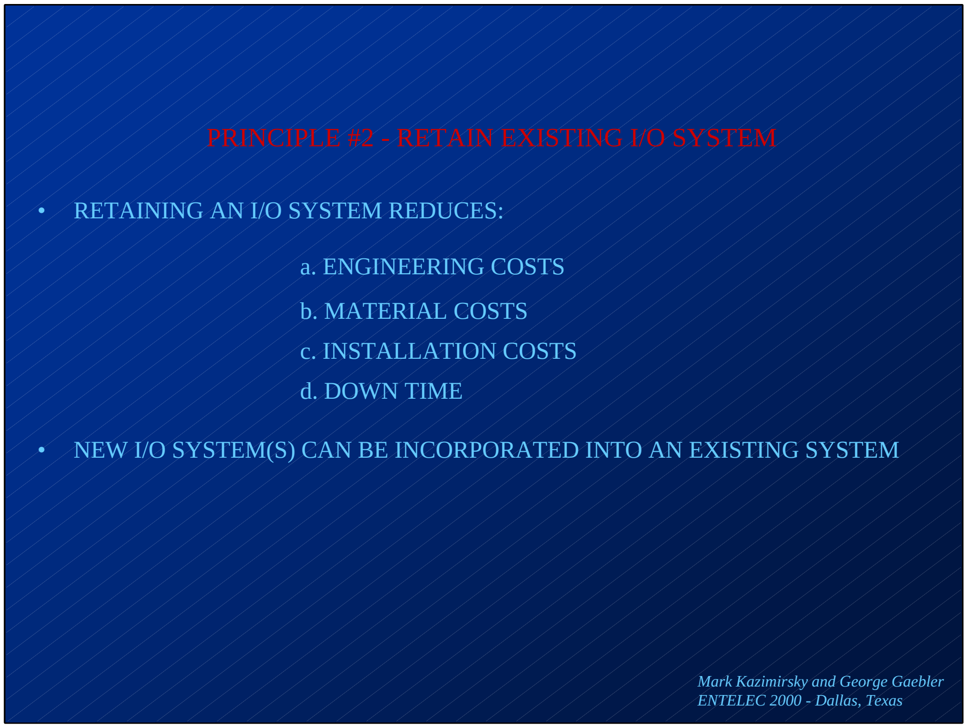
- MAXIMIZE USE OF EXISTING HARDWARE
- RETAIN EXISTING I/O
- RETAIN LOCAL SUB-SYSTEM INTERFACES
- MINIMIZE IMPACT ON REMOTE SYSTEM
- USE OPEN ARCHITECTURE
- SEPARATE SOFTWARE MODULES
- EMPLOY REDUNDANCY JUDICIOUSLY
- SMART OUT-SOURCING



Whenever possible, use equipment already in place. Often a control system includes hardware of different ages, quality, and reliability. Identify the primary elements of your system and determine if any of the equipment can be reused or recycled. Any parts which are no longer supported by the manufacturer or which are being phased out should be eliminated from the new design. But elements of a control system which may be recent acquisitions may be reused in a more effective way, thereby reducing the initial capital outlay in a control system migration. Many manufacturers have instituted standard form factors for their products, enabling a user to upgrade components without replacing entire systems.

When reusing equipment however, ensure that the reused parts have been thoroughly verified for compatibility within the new system. While a new processor board may fit into an old rack, it may not be backward compatible and thus not work with other elements in the same system. The smallest discrepancy in matching different firmware versions which is not caught up front can create costly delays during start-up and testing.

Firmware which is not backward compatible is not always easy to identify. In two separate projects at PG&E, manufacturers assured us that their new products were fully backward compatible with the old. But in each case, not only was the new equipment incompatible with the old, the manufacturers themselves were unaware of the problem! The lesson: verify specifications, but test thoroughly prior to installation.



The I/O system, consisting of field devices (e.g. PTs, TTs), wire, terminal blocks, and finally the system I/O boards, represent a huge installed cost. Not only in terms of hardware but especially in labor to install, test and calibrate each I/O point. Retaining an intact I/O system can therefore result in significant reduction of cost of a control system upgrade and may subsequently be a major factor in the decision making justifying the project.

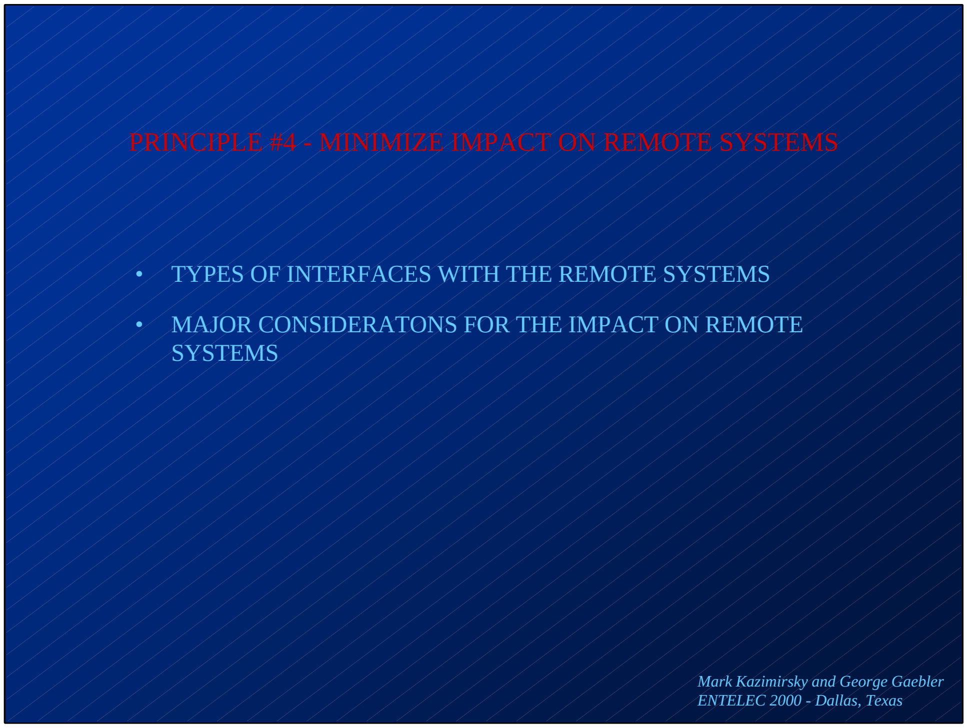
Some might view retaining the I/O system as virtually “locking in” a single type or manufacturer of control system, but this is not necessarily true. In one PG&E project, operations personnel insisted on installing monitoring equipment which used only one type of communication protocol for data acquisition. Presented with huge costs to change out existing I/O and control equipment to accommodate the new system, engineers proposed a data translator which not only retained the existing I/O system for the short term, but for the long run made the operating data more accessible to future control system modifications.

New or disparate I/O systems can be incorporated into an existing control system by strategic translation of different protocols or by combining different signal types into common ones. These translations should take place at the lowest possible level in the system architecture so as to simplify the data collection and processing functions which take place at higher levels in the control system structure.

Whenever possible and practical, retain the methods by which operators and technicians interface with local sub-systems. During a control system migration project, there is often a temptation to combine multiple small control processes into fewer, larger systems. While less equipment to maintain is often touted as a reason for consolidating control functions, efficient operation and technical support of these same systems may be sacrificed in the processes.

At any facility, there are specific points where data entry and monitoring are crucial and operators need to be immediately effective with the new system as they were with the old. For example, many smaller sub-systems such as flow computers, gas chromatographs and odorizers include a separate dedicated keypad and display as an operator interface. At PG&E, operators and technicians throughout the organization recognize and know how to use the equipment unique to these functions at any facility they may enter. If an old system uses graphic displays for data monitoring and set point entry, then the new system should provide similar graphic displays and methods for display navigation and data entry regardless of changes in hardware, operating system or increases in system capability.

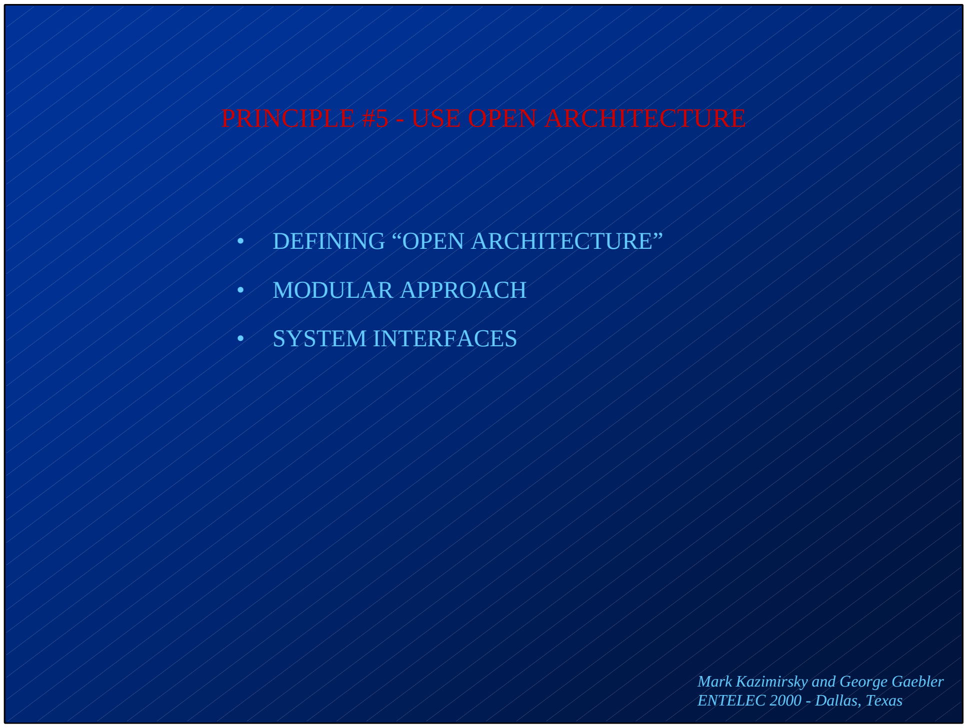
Tried and true operating methods should only be abandoned in favor of significant increases in productivity, performance or safety.



When changing out the primary control apparatus at a site, careful consideration should be given to how all remote devices may be connected to the system via phone line, radio, Internet or intranet. Questions to explore include:

- What are the physical connections to the system?
- How many circuits exist?
- Are all the circuits now used actually needed?
- What data communication protocols are used?
- How much is the data base of the remote system affected by the change?
- What changes to the remote system displays and alarms are needed?
- What additional training is required for operators at remote sites?

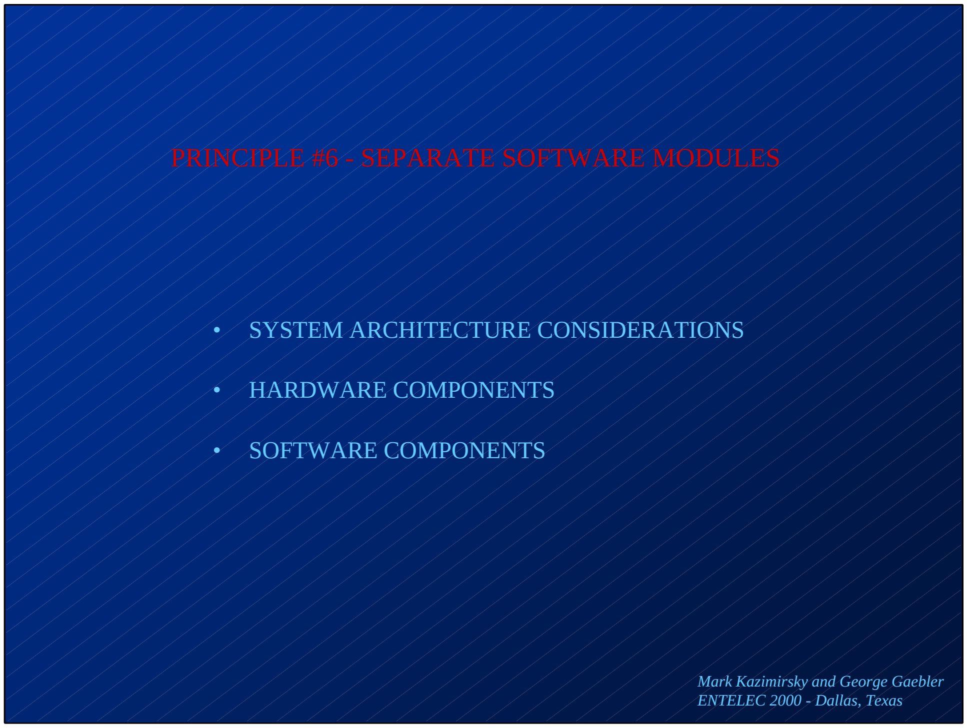
The answers to these questions can severely impact a control system migration project if not addressed early. Addressing these issues in the early stages of design can minimize the impact one facility's control system migration may have on other remote systems and therefore minimize the ultimate cost of the upgrade.



"Open Architecture" means different things to different people. Ultimately the term should mean that a control system owner has unlimited choices of which equipment to use and when to use it. Any new or upgraded control system must provide means for devices from any manufacturer to be used with a minimum of interface complications.

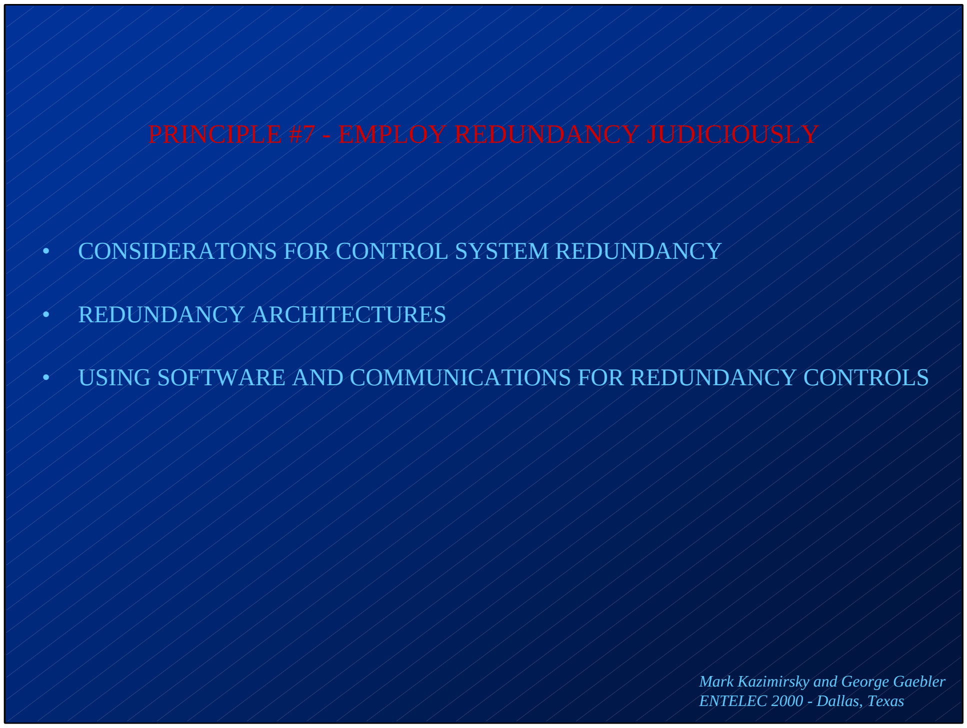
An open system is easily achieved by adopting a modular approach for both hardware and software in the overall control system architecture. By designating separate processors for different tasks, a control system can allow for interface with virtually any manufacturer's device provided with a means of data transfer (be it a discrete switch, a current loop, a communications port, or a web site) and minimize risk by distributing the control tasks among different components.

While benefits may certainly be gained in standardizing on a specific manufacturer, the owner so standardized not only runs the risk of being at the mercy of or affected by changes imposed by that entity, but may also become unable to take advantage of innovations made by other manufacturers.



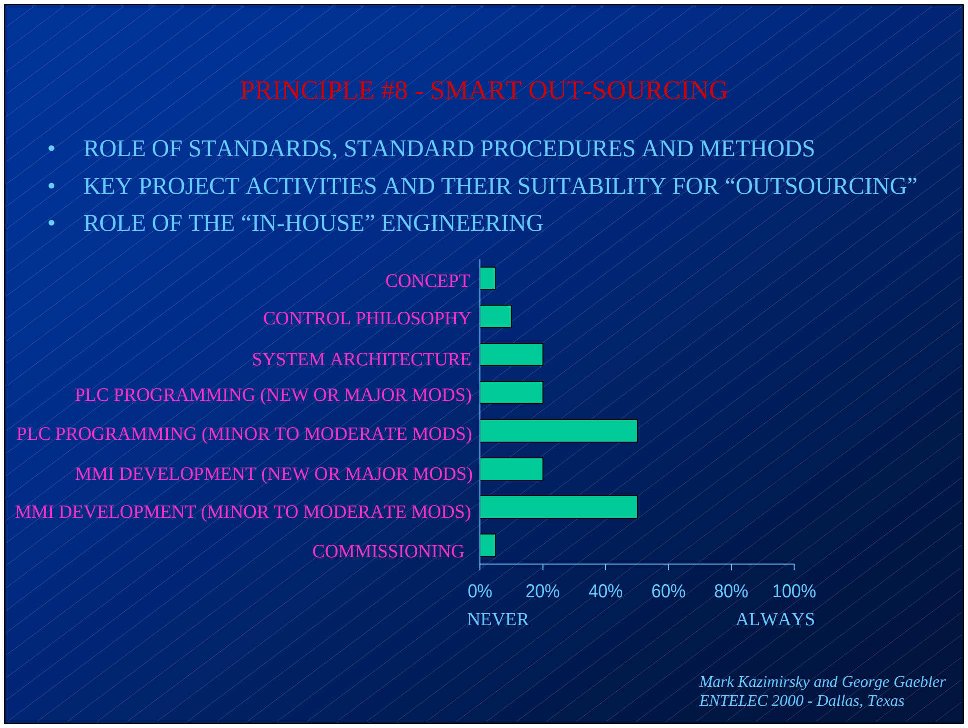
With the availability of cheap processing power at end devices (e.g. smart transmitters with embedded PID loops), control systems are becoming ever more distributed. However, in pushing processing functions down to lower and lower levels in the control system architecture, a point of diminishing returns can be reached with regard to the number of processors involved. As the number of processing devices increase, interconnectivity between these devices becomes proportionately more crucial, not only for sending and retrieving process data and set points, but also for monitoring diagnostic information and implementing coordinated system-wide control actions like controlled or emergency shutdowns. Establishing and maintaining a network of smart devices can add to the overall complexity of a system and actually reduce overall system reliability. Another often forgotten reason for distributed control systems in the past was the limitations within the processor. Sometimes a single processor simply would not be able to solve all control tasks.

At PG&E's Hinkley compressor station, individual PLC's were installed for each of four 500 KW power generators. Each PLC received set points from a single station controller. Unfortunately, any reliability gained by the distributed control architecture was quickly lost due to the harsh environments at the unit PLC's locations and consequently unreliable communication link between the unit and the station PLC's. The result was a system fraught with operational difficulties. When the control system was upgraded last year, the individual unit controllers were eliminated. Instead, remote I/O modules at each unit coupled with data processing at the station controller provides a system which is more reliable and easier to maintain.



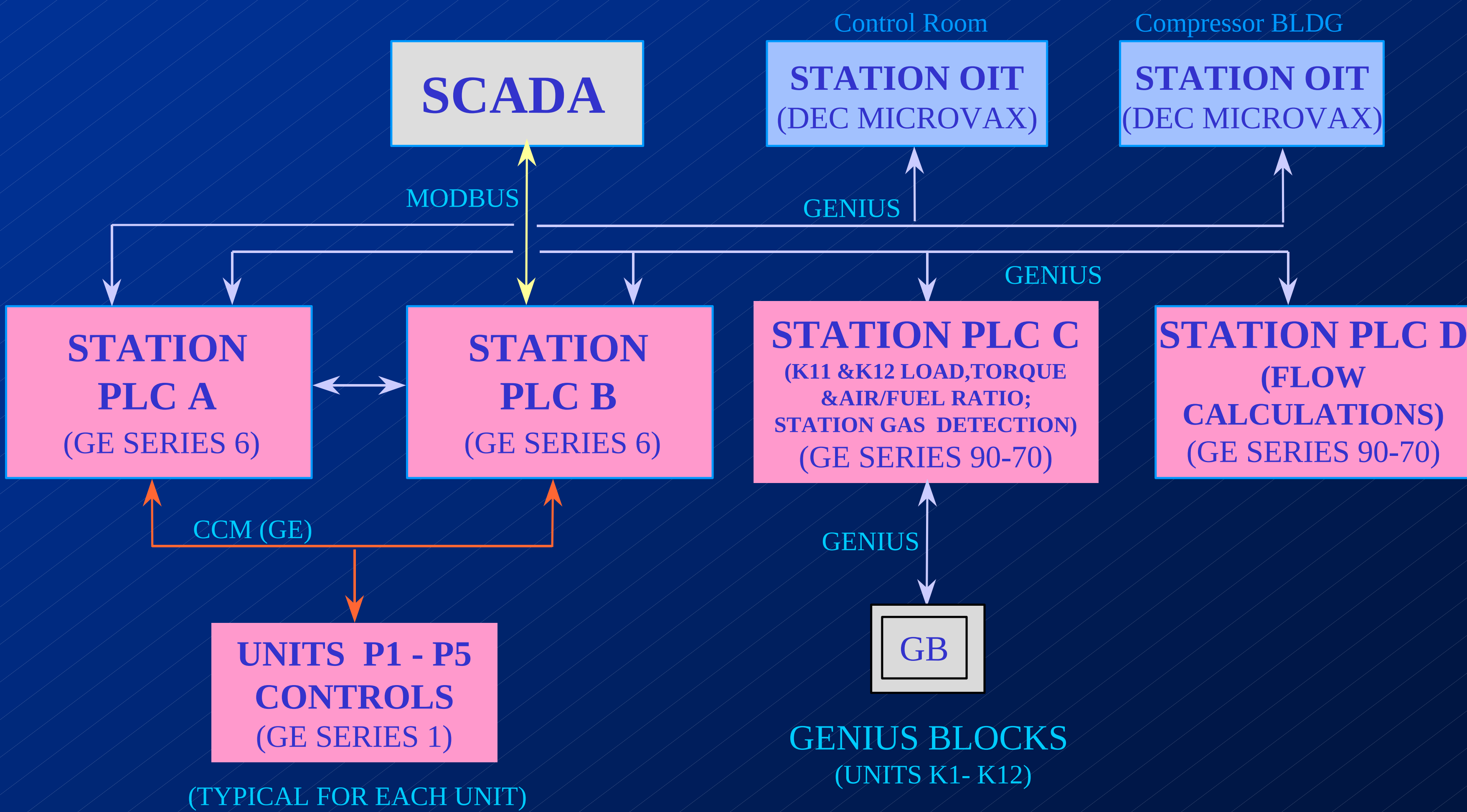
Redundancy in a control system should increase reliability and reduce down time. Too often though, implementing redundancy increases the complexity of a system significantly by introducing additional components required for monitoring the on-line equipment and controlling the transfer when a failure occurs. In these types of systems the transfer equipment itself must then be monitored for failures to assure that it is functioning properly. In older systems, the cost of maintaining the redundant equipment is by itself enough to justify migrating to an entirely new system.

In a new or updated control system architecture, minimize and simplify redundant applications. By using a open architecture approach, isolate the most critical processes in the system and specify redundancy for only those processes. Use control equipment which can be configured to monitor and transfer automatically from the primary to the secondary processor through software and common communication methods without using additional hardware.



Operating companies rely on contractors' adherence to standards such as ISA symbology in design drawings in order to minimize maintenance and training costs. The same economic reasoning supports developing standard control methodologies for use in any large production environment. Design contracts must now include a specific control system philosophy for the organization or facility to assure consistency across division boundaries. Qualified in-house expertise is therefore essential to develop and maintain the control system philosophy and to review the contractor's work. The chart above shows how much of each type of control systems work an operation could plan to contract out and still retain sufficient in-house resources to maintain design consistency and provide on-going technical support.

HINKLEY COMPRESSOR STATION
CONTROL SYSTEM ARCHITECTURE (OLD)



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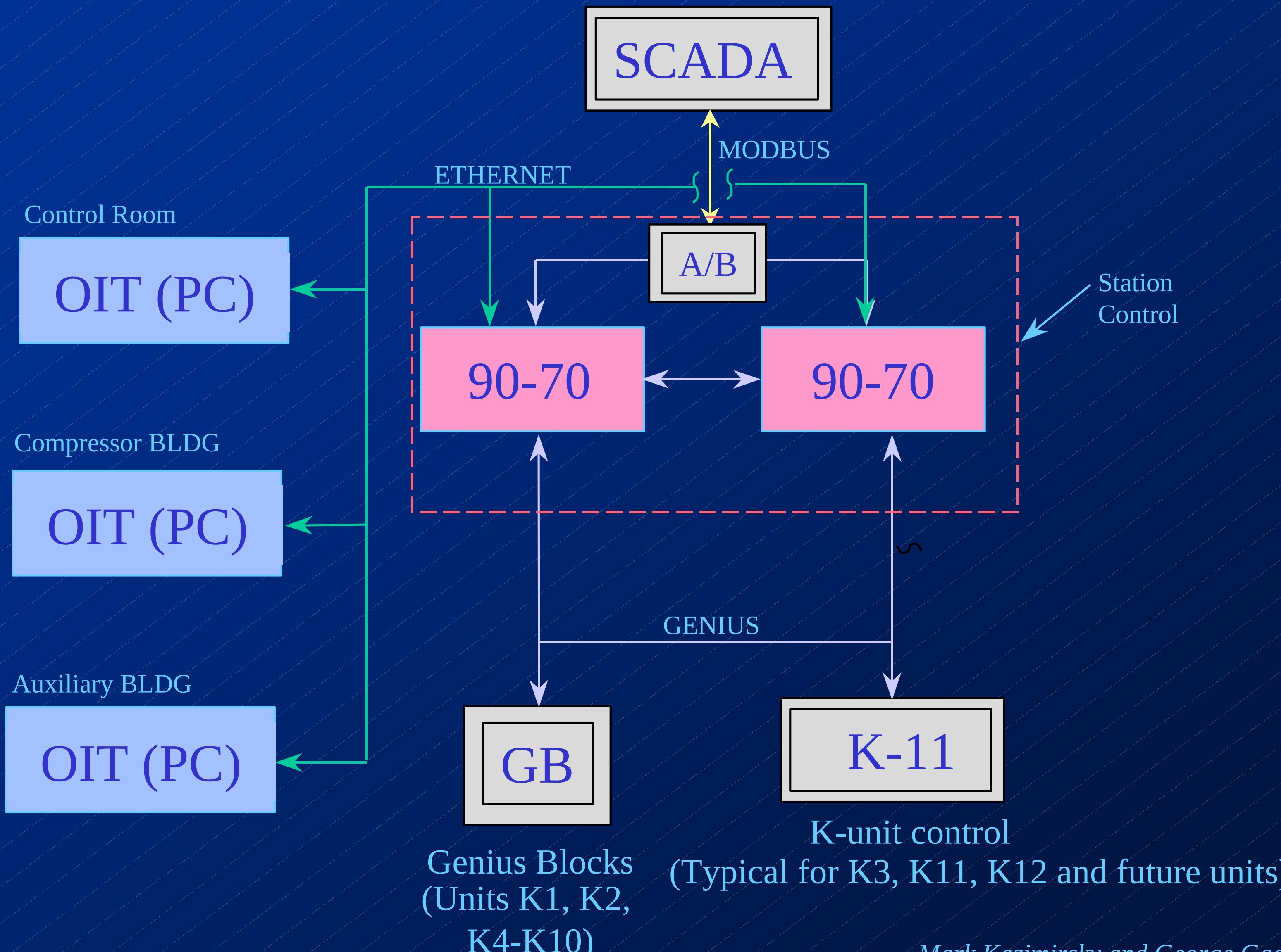
HINKLEY COMPRESSOR STATION CONTROL SYSTEM ARCHITECTURE (NEW)



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