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ABSTRACT

"Intelligent building" is a term that has been coined in recent years to describe buildings in which computer technology is intensely applied in two areas of building operations: control systems and shared tenant services. This two-part study provides an overview of the intelligent building industry and reports on issues related to the training of technicians who operate and maintain the systems in these buildings. Part 1, the industry overview, discusses the types of systems that are found in intelligent buildings; identifies industry trends, concerns, and conflicts; and provides information about the organizational structure and job functions of personnel who hold responsibilities for intelligent building systems. Part 2 describes a study that assessed the need for and the employability of technicians who have been specially trained to operate and maintain intelligent buildings. This study included an information search, a task analysis, and a Texas industry-wide survey of 138 building owners/managers, 94 plant and building engineers, and 97 controls vendors (averaging a 25 percent response). The study concluded that there is a need for intelligent building systems technicians who have been trained to operate and maintain automated building control systems. The final chapters of part 2 list tasks and competencies for such technicians and describe a proposed curriculum for training them. Appendixes include survey instruments, lists of organizations, and an annotated bibliography. (KC)

FINAL REPORT

TECHNICIANS FOR INTELLIGENT BUILDINGS

Submitted by

Austin Community College

to

The Coordinating Board
Texas College and University System

Produced by

The Center for Occupational Research and Development

July 30, 1987

PREFACE

Intelligent buildings are hotels, office buildings, shopping malls, hospitals, schools and other public-assembly areas that incorporate new technology and computer controls for air-conditioning, communications, security, safety and lighting. These facilities represent enormous strides in design for better creature comfort, convenience and efficiency.

But sophisticated designs and instrumentation are not enough to ensure maximum benefits from advances in technologies. These facilities and equipment must be properly maintained, calibrated, adjusted and repaired. The performance of these services requires a new type of worker—the Intelligent Building Technician.

This report summarizes the results of a ten-month study conducted by CORD for the Austin Community College and the Texas Higher Education Coordinating Board to determine the need for and appropriate education/training required to prepare these new technical workers.

The principal investigators and authors of this study are Ms. Carolyn Prescott and Mr. Ron Thomson , in CORD's Austin office. Special assistance to the project staff was provided by Mr. Jim Wilson and Ms. Marcie Serratt.

We are particularly indebted for the cooperation of Mr. Bert Marcom, Dean of Vocational and Technical Programs at Austin Community College and the expert guidance and unfailing cooperation of the Project Advisory Committee, whose membership is listed on the following page.

Daniel M. Hull, President
Center for Occupational Research
and Development

August 1987

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Assisted in the collection of critical data for the study.

American Institute of Plant Engineers (AIPE)
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
Association of Physical Plant Administrators (APPA)
Building Owners and Managers Association (BOMA)
International Facilities Management Association (IFMA)
Texas Hospital Association (THA)

Managers of Intelligent Buildings

Shared information, time and staff for job task analysis.

Don Dowell, Building Manager, LTV Center, Dallas
Ed Hanks, VP of Operations, Infomart, Dallas
Bill Hunnsucker, Chief of Operations, Lincoln Center, Dallas
Gene Sumter, Manager of Operations, Interfirst Plaza, Dallas

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EXECUTIVE SUMMARY

"Intelligent building" is a term that has been coined in recent years to describe buildings in which computer technology is intensely applied in two areas of building operations: control systems and shared tenant services. Control systems include heating, ventilation, air conditioning, lighting, security and fire protection systems. Shared tenant services include various types of telecommunication and office automation services. This two-part study provides an overview of the intelligent building industry and reports on issues related to the training of technicians who operate and maintain the systems in these buildings.

Part 1, the industry overview, discusses the types of systems that are found in intelligent buildings, identifies industry trends, concerns and conflicts, and provides information about the organizational structure and job functions of personnel who hold responsibilities for intelligent building systems.

Part 2 is a study that assesses the need for and the employability of technicians who have been specially trained to operate and maintain intelligent buildings. It also proposes a specific curriculum for training such technicians. This study included an information search, a task analysis, and a Texas industry-wide survey.

Automated control systems have been more widely accepted and integrated into buildings of varying sizes and types than have shared tenant services. The degree to which shared tenant services will become a common feature of buildings in the future remains uncertain at this time. The marketability of these services to tenants has been challenged in some quarters of the industry, and the exact form and organization of these services are still in the process of evolving.

Automated building control systems, on the other hand, are already well-established in buildings of all sizes and types. This sector of the intelligent buildings industry is currently healthy and growing. Even so, many buildings use only a small portion of the capability that these systems offer because building operations personnel are inadequately trained. Consequently, much of the efficiency and economic benefit that these systems promise frequently is not realized.

This study concludes that there is a need for intelligent building systems technicians who have been trained to operate and maintain automated building control systems. Shared tenant services do not fall within the purview of this type of technician since these services are almost invariably provided by business and management entities that are entirely separate from the ownership and management of the buildings themselves.

The conclusion that there is a need for intelligent building systems technicians is based upon data gathered in numerous telephone and in-person interviews and from an extensive industry-wide written survey. Extrapolations from the data collected in the written survey indicate that more than 10,000 such technicians could be hired in the state of Texas between 1987 and the year 2000. Intelligent building systems technicians may be hired in one of several sectors: commercial building management; physical plant management of industries, schools, colleges and hospitals; and companies that manufacture, sell and service building control systems.

The curriculum proposed to meet the training needs of intelligent building systems technicians is one that provides a broad interdisciplinary base of knowledge and equips the student with a strong orientation to systems. It is based upon the concept of the common core curriculum, which includes a core of basic courses, a technical core and, then, a sequence of specialty courses.

The first technicians to graduate from a program such as the one proposed here will be the first of their kind. Any school that chooses to implement the curriculum should be prepared to provide special assistance in introducing them to industry and in placing them in appropriate jobs.

PART 1

OVERVIEW OF THE INTELLIGENT BUILDING INDUSTRY

CHAPTER 1

INTELLIGENT BUILDINGS AND BUILDING SYSTEMS

This chapter provides a working definition of "intelligent building" and discusses the major characteristics of the technologies that make a building intelligent. Two categories of technology are involved: building controls and shared tenant services (telecommunications and office automation services).

DEFINING "INTELLIGENT BUILDING"

The term "intelligent building" applies to those buildings in which computer technology is intensely applied in the areas of building control systems and shared tenant services. "Smart buildings" and "technology-enhanced real estate" are terms that have also been used to describe the same buildings.

Building control systems that may be "intelligent" include heating, ventilation, air conditioning, lighting, security, and fire protection. Shared tenant services include telecommunications and office automation services such as private branch exchange (PBX) systems, local area networks, video conferencing, high-speed data networks, and voice and electronic mail.

Providing a precise and universally accepted definition of "intelligent building" turns out to be a difficult and inconclusive task. Several factors make constructing a definition difficult.

- The two aspects of technology related to building intelligence (building control systems and shared tenant services) may be present to very different degrees in the same building. For example, a building with a highly sophisticated telecommunications system may have no more than simple time-clock controls. How much computerization and automation of building functions is required for it to qualify as an intelligent building? There are no standards.

- Many different business entities contribute to the incorporation of technology into a building: owners, developers, architects, telecommunications service providers, controls systems vendors, and property management companies, as well as various combinations of all of these, such as subsidiaries or joint ventures. Each of these entities has a particular perspective on what is required for a building to be considered "intelligent."

- The market for buildings described as "intelligent" is uncertain, and the validity and value of the term "intelligent building" is being questioned within the industry.

- Broadly considered, building intelligence may include more than the intense application of technology. It may include considerations such as the design of space and how the use of space is matched to job functions. According to some sources, the availability of amenities such as rest and recreational facilities is a factor in building intelligence. Some maintain that a heavily automated large office building that does not have facilities for child care is not a very intelligent building.

In spite of the somewhat confusing nature of building intelligence, the following working definition was formulated by the advisory committee that provided guidance to this study.

> An intelligent building is one in which architecture, information and communication needs, and building management and control are systematically addressed in building design and construction in order to—
>
> - meet the needs of occupants,
> - maximize productivity,
> - operate the building with energy efficiency,
> - automate building management and control to minimize labor,
> - accommodate present and future uses of the building, and
> - accommodate changes in available technology.

Intelligent buildings are most typically found among office buildings, plants, factories, hotels, hospitals, regional malls and on college campuses.

SHARED TENANT SERVICES (TELECOMMUNICATIONS AND INFORMATION SYSTEMS)

The advances in telecommunications technology and information technology of the last two decades have led to the new market commonly known as shared tenant services. Shared tenant services include telecommunications and information services such as private branch exchange communication and information telephone lines, local area networks, electronic mail, video conferencing and videotext. These and other shared tenant services are described in the following pages.

Telecommunications Services—PBX or CENTREX

Two parallel developments have spawned the new telecommunications industry in the last decade: deregulation and computer technology.

Deregulation has introduced competition in several areas: in the manufacturing and marketing of customer premise equipment, in the terminal equipment and transmission service market and, finally, in the long-distance service market.

During the same period as deregulation has taken place, the introduction of microprocessor chips and integrated circuits into telephone switching equipment has allowed for partitioning of large switches through specialized software. This partitioning capability means that, in effect, a building can set up its own local exchange service. Partitioning means that the building's main switch is divided into discrete partitions that separate the telephone transactions of individual tenants [Schwanke]. The building's switching arrangement may be a private branch exchange (PBX), or it may be on-premise switching provided by the local Bell operating company (or other local exchange service company).

Because of the network configuration of on-premise switching, services can be provided at a lower cost, with simplified billing and improved transmission. The greatest rate reduction that can be offered to tenants is usually for long-distance service, and that service has proven to be the most popular and profitable for service providers. In addition to basic and long-distance telephone service, shared tenant service companies often offer a host of other voice and data transmission capabilities—from electronic mail to shared modem use—to which tenants may or may not subscribe.

Local Area Networks (LANs)

A local area network (LAN) links personnel and equipment within a building. A LAN is capable of a faster transmission rate than a switch or externally based network. A LAN usually consists of a mainframe computer or large minicomputer that is connected via twisted-pair, coaxial or fiber-optic cable to tenants' terminals and workstations [Schwanke]. LANs are used for data and text transmission, graphics handling and transmission, external database access, video teleconferencing, electronic mail, shared word processing and printer use, and many other communication and information services. LANs can afford sophisticated office automation technology on a cost-sharing basis to smaller tenants who would otherwise be unable to afford it. In addition to commercial office applications, LANs are extremely useful in some manufacturing and processing plants in which various equipment and management functions need to be linked.

Teleports, Microwave, Infrared, and Other Extra-building Networks

In a few very large buildings and complexes, highly sophisticated networks are used for voice, data and image transmission to locations outside the building. Short-haul networks link buildings within 10 miles of each other such as adjacent buildings within an industrial park. Long-haul networks link buildings located over long distances such as many buildings spread throughout the country that are occupied by various divisions of a single corporation.

Microwave radio is a popular means of point-to-point, line-of-sight transmission. Microwave may be linked, in turn, to the buildings' PBX or LAN. Because microwave transmission is line-of-sight, repeater antennae are used where mountains or other buildings block the microwave link. Another short-haul, line-of-sight link is infrared light wave communication.

Satellites provide an important method of long-distance transmission. They are capable of high-speed data, voice and video transmission and become cost-effective for distances greater than 500 miles. Teleports provide earth station receivers (antenna farms) for orbiting communications satellites, thereby providing links to other earth stations. Regional users of a teleport may be connected to it by means of other technologies such as fiber-optic cable.

Other Information Ser..ces

In addition to basic telecommunications services, many buildings offer related information and office automation services. These services, some of which have already been mentioned, are listed and briefly explained below.

- Modem pooling—Shared use of modems by more than one tenant
- Videotex—Use of a TV display for information services such as a community calendar or shopping guide
- Word and text processing—Sharing of word processing services, printing, or desktop publishing capabilities that are more sophisticated and expensive than individual tenants could justify based on their own usage
- Teleconferencing centers—Sharing of teleconferencing rooms available to tenants by reservation on a per-use basis
- Facsimile—Shared use of facsimile equipment for high-speed image transmission
- Archival storage—Vault storage for hard copy and other forms of data storage such as optical disk storage or microfilm

BUILDING CONTROLS

Building control systems include heating, ventilation and air conditioning (HVAC), lighting, electrical power, wiring, security and fire protection/life safety. HVAC systems are among the most critical; they also account for a large percentage of the building's operating budget.

Heating, Ventilation and Air Conditioning (HVAC)

During the last decade, HVAC systems have changed appreciably. The 1973 oil embargo encouraged energy-savings features throughout the country. In commercial office buildings, however, where the tenant's comfort may be the owner's leasing edge, simply turning back the thermostat proved inadequate, and more sophisticated energy management controls were instituted. In addition to the need to save energy, the increased use of computers and other office equipment has had an effect on HVAC design. Automated equipment has created three types of changes that must be accommodated by the HVAC system:

1. Different levels of heating and cooling are required within a given office building because of different levels of automation with the building.

2. Greater cooling is required to offset the heat from office machinery.

3. More stringent humidity and temperature control is necessary because of the environmental sensitivity of office equipment.

Finally, HVAC systems have been radically changed by the application of microprocessors and centralized computer control. The introduction of direct digital control to HVAC makes it possible to monitor and control temperature more closely within more zones of a given building and to accommodate a greater number of variables such as office equipment, lights, and office traffic. Some types of computer controls not only can control temperature; they can simultaneously change the operating parameters of certain HVAC equipment to increase its efficiency. The most sophisticated control systems generally include a complex energy management function, which, depending on the capabilities of the building staff to research and program, can be exploited for significant savings.

Lighting

Lighting systems for commercial buildings have also undergone changes recently. The trend has been toward lower levels of ambient lighting supplemented by task lighting. Ambient lighting is likely to be placed at the perimeter of the building interior, and may be cycled on and off according to the intensity of available light during successive periods of the day. Lighting is often controlled, along with temperature, by a central computer.

Electrical Wiring and Cabling

Building wiring is a critical issue in today's office buildings. As the number of employees who work at a computer terminal increases, the demand for electrical wiring, and especially for flexible wiring, becomes greater. Although it is typically not the primary responsibility of the building operations staff, the cabling requirements for telecommunications systems also must be considered. In some cases, responsibility for the communications cable installed in the vertical riser space *does* fall to the building owner/manager. If well managed, the building management will be able to cooperate more quickly with telecommunications companies in meeting tenant's needs and will be able to avoid problems resulting from incorrectly installed communications cabling. For example, if electrical and communications cable is intertwined, interference and static can occur in data and voice lines.

Perhaps the most important aspect of cabling and wiring takes place when the building is designed. A building designed for intelligent systems will afford adequate space for and easy access to cabling. Some buildings are prewired with telecommunications cable based on the anticipated needs of tenants.

Security Systems

Security systems are an essential part of nearly all new and retrofitted office buildings. Tenants are concerned about the protection of personnel, office equipment and business information.

In most buildings, security is ensured by more than one approach. For example, a building might have a central alarm system to monitor key critical areas, a visual monitoring system (camera eye) for key access points, a key-card system for limited floor access by elevator, a voice-activated system in the parking garage, and a security patrol that makes routine rounds. Security systems may be integrated with other building control systems, or they may exist alongside those systems.

Fire Protection

Fire protection and life safety systems are part of every commercial property and are regulated by city, state and federal codes. Some of the newer fire protection systems generally consist of alarm-initiating devices (sensors), fire signaling systems (alarms), and various automatic control devices to react to fires such as on/off switches for sprinklers. Other capabilities of many newer systems include emergency audio and occupant paging systems; smoke control by connection to building HVAC; fire department and command station provisions; and control and monitoring equipment for elevators, door locks, lighting and emergency power.

Multiplex wiring schemes have allowed for an increase in the number of sensors and alarms. Buildings are divided into many zones of protection, and fire protection control panels generally indicate the precise location of the smoke or fire by zone. Many of the features listed above are relatively recent in the development of fire protection systems; most notably, digital control was not accepted by many regulatory agencies until the last few years. Now that digital control and the accompanying features are more common, however, fire protection systems have many of the same characteristics of building environmental controls. Therefore, integration of fire protection systems with other building controls is beginning to occur.

Power Supply

The building's power supply is another critical factor in its operations. As businesses rely increasingly on information technology to accomplish daily tasks and to keep all records, loss of electrical power becomes a primary concern. In many commercial buildings, the reponsibility for a backup, or emergency power supply for operation of office computers, is assumed by each tenant.

At the building level, uninterruptible power systems (UPS) with battery backup are required to ensure that critical systems such as lighting and fire protection continue to function during an emergency. Another aspect of the power supply is its quality; spikes and sags can greatly affect computer performance and communications equipment. Power conditioners or voltage regulators are installed to accommodate such power "glitches."

INTELLIGENT BUILDING SERVICES NOT TECHNOLOGY-BASED

Some of the available tenant services are not technology-based, but may be an important part of the total services available in an intelligent building. These services include—

- Secretarial support services—On-site temporary and full- time secretarial support for tenants
- Daycare—On-site daycare centers for building tenants
- Health rooms—On-site workout rooms, raquetball courts, etc.
- Office supply stores—On-site for the convenience of tenants
- Cultural activities—Exhibits, concerts, and other activities during lunchtime and after-hours.

CHAPTER 2

INDUSTRY TRENDS, CONCERNS, CONFLICTS

In this chapter, the interests of businesses and individuals who participate in the intelligent building industry are described. These interests are difficult to assess because many different types of businesses, regulatory agencies, and individuals are involved in various aspects of building intelligence.

A typical intelligent building may be created through the joint efforts of a developer, a property management company, a telecommunications service provider, a building automation company, and various other subcontracting businesses. All of these businesses are affected to some extent by the regulatory agencies that oversee telecommunications services, fire prevention and protection, and building and electrical standards. After an intelligent building has been constructed, its operation becomes subject to the needs and interests of individuals such as building managers, chief engineers, and building owners.

TELECOMMUNICATIONS / SHARED TENANT SERVICES INDUSTRY

The companies that provide telecommunications service can be divided into three main categories: large telecommunications or building systems corporations with tenant service arms or subsidiaries; small entrepreneurial ventures dedicated to the tenant service business; and developer-created telecommunications subsidiaries [Schwanke article, Miami Center]. Table 1 on the next page lists companies in each category.

Relationship between Building Developer and Service Provider

The relationship of the developer with the service provider varies greatly among the three categories listed in Table 1, depending upon the type of company providing service and the nature of the deal struck, which may be a lease agreement, a contract, a joint venture, a partnership, or a wholly owned subsidiary [Schwanke]. Depending on the arrangement between the developer and the service provider, the developer will be involved to a greater or lesser degree in marketing, establishing guidelines for and operating the shared tenant services. In the Texas buildings visited by this study, two of the telecommunications services were subsidiaries of the building management company. However, there was virtually no contact between the building management company and the telecommunications company; of particular significance, there was no sharing of staff.

Table 1: Telecommunications Shared Tenant Service (STS) Providers.

STS subsidiaries of telecommunications or building systems corporations	*Entrepreneurial ventures dedicated to STS*	*STS subsidiaries created by real estate developers or building management companies*
Realcom (IBM)	Tritel	Brantel
Contel		AmeriSystems (Lincoln Properties)
TelCom Plus		Martnet (Trammell Crow)

Regulatory Environment for Shared Tenant Services

The regulatory environment for shared tenant services in Texas is presently favorable, but has the potential for reversal, since current regulations are being appealed in court for all areas served by Southwestern Bell. The Public Utility Commission has ruled that STS providers may offer unpartitioned service; that is, tenants may share lines rather than each having individual lines to the local operating company. Therefore, STS providers in Texas now pay a flat PBX tariff or a slightly modified joint user tariff.

Overall Health of Shared Tenant Services Market

The overall health of the shared tenant service market is difficult to assess. STS providers do not generally want to disclose the degree of tenant participation in their services. At the national level, discussion over the economic potential of the STS market has ranged from "blue sky" predictions to pessimistic caution. Telecommunications services have been posited as the "leasing edge" in an overbuilt commercial office development market. Others have claimed that buildings offering shared services do not lease faster or command higher rents than ordinary buildings [Engineering News Record].

An investment research group of Jones Lang Wootton released a report of a study of 37 buildings identified as intelligent by the Urban Land Institute and located in the five cities in which Jones Lang Wootton operates: Boston, New York, Los Angeles, San Francisco and Washington, DC. The research group concluded that shared tenant services were not having a significant effect on occupancy rates or rental rates [Jones Lang Wootton].

Those who have disagreed with the Jones Lang Wootton report have noted the small size of its sample (11 of the 37 buildings originally identified were dropped from the sample because they were still in early stages of planning or construction) and the nonrepresentative sampling of the five cities (19 of the 26 buildings studied were in the Washington, DC area). In addition, the Jones Lang Wootton report did not attempt to measure the effect on leasing of telecommunications services as they contribute to the total image of a building. The Jones Lang Wootton report has received wide publicity and has been quoted often, creating a somewhat negative impression concerning the STS market.

More detailed analyses of specific building projects, such as those contained in the Urban Land Institute's report on technology-enhanced real estate, indicate that STS ventures can be successful with the right kind of planning, marketing and service. The STS subscription rate of 50% is not countered by the subscription rates reported in projects studied by the Urban Land Institute, which range from 20% to 97%. Rather, the Urban Land Institute's report underscores the many differences among tenants and tenant needs of buildings grouped together under the label of "intelligent." Such differences have a significant effect on the need for and success of shared tenant services.

The Shared Tenant Services Market in Texas

In Texas, as elsewhere, the shared tenant service market is tied to commercial real estate development, which is now in a period of slow growth. According to one industry representative, virtually every new office building over 250,000 square feet has shared tenant services. However, with new commercial development activity at a low point, current growth in the shared tenant service market may be expected to be low as well. Nevertheless, industry representatives report success among companies that have been able to adapt to the changing market. These representatives cite companies that are service-oriented as being the most successful and developer-owned companies as the area of greatest growth.

AUTOMATED BUILDING CONTROLS

Building automation systems are designed to control temperature and airflow, lighting, fire protection, building security and energy management in today's intelligent buildings. Such systems, which may or may not be integrated, together form a significant part of what is commonly considered building intelligence.

The building automation systems industry is comprised of a relatively small number of manufacturers and vendors. In Texas, the controls companies include—

- American Energy Controls
- Andover Controls
- Barber Coleman
- Control Systems International
- Honeywell
- Johnson Controls
- MCC Powers
- RobertShaw
- Simplex

Like all parts of the controls industry, the building controls industry has been technology-driven. The technology has changed radically in the last two decades, and it keeps changing. Pneumatic controls were replaced by circuit boards that are now being replaced by chips. When asked to predict when the technology might "settle down," one intelligent building systems expert replied, "Never."

Health of Building Automation and Controls Industry

According to informal reports and industry predictions, the building automation and controls industry is experiencing healthy business activity at this time and is expected to continue to do so well into the future. However, like the shared tenant service industry, the building controls industry is tied to some extent to the commercial building market, which is now at a low point in Texas. The market for retrofitting is low as well, presumably because the Texas economy as a whole is very lean, and businesses are not willing or able to spend money even if it would mean subsequent savings. However, a potentially significant factor in the trend toward automated building systems is the new tax laws, which are requiring that build-ings operate at a profit. Building owners/developers are under greater pressure to operate buildings efficiently, and they may be willing to spend some money to do so.

Energy management systems were extremely popular after the 1973 increase in oil prices; the recent reduction in oil prices (now reversing itself) may have induced some complacency among small business energy users. As one industry representative expressed it, "People are just used to paying more." On the other hand, the availability of small-point controllers makes energy-efficient systems an option for buildings as small as 10,000 square feet. In large buildings, owners are more likely to invest in energy management systems because they will realize greater savings; even a 1% savings may mean thousands of dollars. Some industry representatives cite tenant demands for lower utility costs as a factor favoring retrofitting of energy management and building automation systems; in the presently overbuilt market in Texas, tenants have numerous options and can get good deals in buildings that have efficient control systems. This situation may encourage older buildings to retrofit in order to stay competitive.

The proliferation of intelligent building systems is not restricted to the commercial real estate market. Government buildings, schools, colleges, hospitals, and retail chains comprise a large segment of the market for intelligent systems. Multisite automated controls are being installed in grocery stores, department store chains, and fast food chains.

Problems Associated with Control Systems

There are aspects of the controls industry to consider, in relation to intelligent buildings, other than its economic growth. The communication between controls companies and developers and building management personnel appears to be problematic in some ways. Building managers complain that control systems designers and salespersons are not knowledgeable of building operations. "They can sell you a system, but they don't know how the HVAC system actually works, so they don't really know its [the control system's] effect," said one building manager.

The same manager complained of the lack of standardization of parts, even within the same company. Controls engineers and energy management engineers are part of separate divisions. They may have very little contact with each other, resulting in headaches for their customers. One consulting engineer echoed some of the building manager's complaints in a recent article [Kutas]. He cited problems associated with space temperature control, energy management functions, and initial building startup. According to the engineer, "The experience may prove so frustrating that managers eventually abandon the more exciting promises of the system, along with many of the economic benefits, in favor of fewer intelligent features and greater reliability [Kutas]." This view of the way that control systems are actually used was repeated by many people interviewed during the course of this study.

The reasons posited for the low level of system use and the high level of user frustration vary according to the position of the speaker. Control systems engineers as well as most building managers indicate that there are problems at both ends of the automated system—the supply end (controls vendors) and the demand end (building operations). Some of the problems attributed to building operations personnel in intelligent buildings are covered in the next section.

CONCERNS OF BUILDING OWNERS, DEVELOPERS, AND MANAGERS

Building developers, owners, and managers sometimes have conflicting concerns in regard to intelligent building features. The wiring and cabling that go into a building illustrate this point. Buildings with intelligent systems have more extensive requirements for wiring and cabling than conventional buildings do. Not all the wiring may need to be be pre-installed, but at the least, the design team must consider the space required for wiring and incorporate such features as access floor systems with large cable capacity. In order to incorporate such a feature, which will undoubtedly simplify the life of the building manager and the tenants for years to come, the owner/developers must be willing to pay for an increase in floor-to-floor dimensions. If the owner/developers are planning for the long term, they may see the advantage to paying for the extra space up front.

The Trammell Crow Company's LTV Center in Dallas is one example of a building in which the decision was made to invest in access floor systems with large cable capacity. Owner/developers who require a faster turnaround on investment, however, may not be concerned with long-term building management efficiencies, so they may forego extra space for wiring as a savings in construction costs. This is a simplified example, but it should convey the nature of the choices that are made in the development of an intelligent building.

Justifying the Need for a Building Systems Technician

After a building is in operation and thousands of dollars have been spent on sophisticated control systems that were sold partly on their ability to cut operational labor costs, building managers may have difficulty convincing managers of the need for a trained building systems technician to program the system and operate it at high levels of efficiency. Any expenditures beyond the most basic level must be sold in the boardroom, and in a slow real estate market, the cost/benefit will be closely examined indeed.

Fear of Losing Control and Mistrust of Computers

Building managers sometimes resist the technology that makes buildings intelligent. For example, building controls, especially multisite automated controls, take some of the *direct* control for the building environment and other operations out of the hands of managers and operating engineers. Some managers may feel that their territory has been encroached; others may feel that the system is too vulnerable to anyone who can program the computer. The issue of computer mistrust is one that affects everyone involved in intelligent building systems, from owners/developers to tenants.

In many cases, mistrust of the computer does not stem from issues of system control so much as reliability and understanding. Many building operations personnel are trained in mechanical or pneumatic systems. When such a system fails, they are accustomed to being able to identify the problem and solve it through manual means. With digital controls, and especially with a centralized computer control system, such direct intervention is not the way that problems are solved.

Training Problems

In many cases, building engineers do not speak the same technical language as the vendors who train them on the system. One chief engineer described vendor training as a potentially frustrating experience for many building operations personnel. Such training is usually of short duration (one to five days), and classes are large, with little or no opportunity for hands-on training or asking detailed questions. In light of the difference in orientation of the building engineer and the control systems designer and the lack of communication that often occurs between them, it shouldn't be too surprising that many sophisticated building control and energy management systems are underused, partially disabled, and eventually even partially replaced with manual controls.

Contracting Building Management Services

Building management for large commercial buildings is frequently handled by a separate building management company, often a subsidiary or joint venture of the development company. The largest development companies maintain their own property management departments, but smaller companies are tending to contract out the building management services. The new tax law changes may increase the trend toward outside contracting for smaller companies with relatively few buildings. Further discussion of building management is included in Chapter 3, "Current Building Systems Personnel."

CHAPTER 3

CURRENT BUILDING SYSTEMS PERSONNEL

This section of the report includes information about the organizational structure and job functions of intelligent buildings personnel. The information was collected in interviews with personnel who manage or operate the four buildings that were visited to accomplish the task analysis. The main positions encountered were Building Manager, Chief Engineer, and Operating/Maintenance Engineer. Table 2 summarizes the salary levels, background and training, and years of experience

Table 2: Personnel and Organization Chart

Item	Building			
	1	2	3	4
1. Job descriptions on file	No	Yes	No	No
2. Salary range for engineering supervisors	$30,000 to $40,000	$30,000 to $42,000	$20,000 to $30,000	$20,000 to $30,000
3. Salary range for building operations and maintenance engineers	$15,000 to $20,000	$15,000 to $25,000	$12,000 to $19,000	$13,000 to $22,000
4. Training of engineering supervisors	Total of 4: 4-HS Diploma 1-BOMA Certified 1-Master Elec	Total of 4: 4-HS Diploma 1-Jrnyman Elec 1-Military Trained	Total of 3: 3-HS Diploma 2-BOMA Certified 1-Some College	Total of 3: 3-HS Diploma 1-BOMA Certified 1-Trade Sch.Cert
5. Training of operations and maintenance engineers	• Most have HS Diploma • Some have trade school training • Mostly OJT	• Most have HS Diploma • Some have BOMA courses • Mostly OJT	• Some have HS Diploma • Some have BOMA courses • Mostly OJT	• Some have HS Diploma • Some have BOMA courses • Mostly OJT
6. Years of experience for engineering supervisors	10-30 years	10-18 years	10-17 years	10-15 years
7. Years of experience for operations and maintenance engineers	3-5 years	3-15 years	2-12 years	2-10 years

associated with these positions in the buildings visited. A new position related specifically to automated building systems had been created in one of the buildings visited: Building Maintenance Systems Engineer. This position is also described in the following section.

BUILDING MANAGER

The organizational structure for the operation of large commercial office buildings is generally headed by a Building Manager, known in some buildings by titles such as the Manager of Operations or Chief of Operations. The Building Manager is responsible for all the aspects of the physical plant, including environmental control, energy efficiency, people-moving, fire-protection/life safety and security. Some of these responsibilities may be contracted out to other companies; in most buildings, elevators and escalators are maintained and serviced by outside contractors. In addition, some portions of the fire protection and security systems may be maintained by outside companies. Other automated systems, including HVAC and lighting controls, may be covered under a partial service contract with the vendor, especially within the first year of installation.

The degree to which the building manager relies on outside contractors or, conversely, on the building maintenance staff, depends on several factors:

- possible liability for maintenance negligence,
- requirement for contractor services as a term of warranty or insurance of system/equipment, and
- building management philosophy toward operations and maintenance.

Specific repairs and maintenance functions may be performed by contractors, based on the following factors:

- the urgency of the problem encountered and the response time of the contractor,
- the volume of work to be completed, and
- the technical expertise of the building maintenance operations staff.

The building manager's responsibilities may extend well beyond the building's automated systems technology, encompassing everything from cleanliness and sanitation to cultural amenities. Therefore, the responsibility for automated systems is shared with the chief engineer or engineering supervisor.

CHIEF ENGINEER OR ENGINEERING SUPERVISOR

The Chief Engineer or Engineering Supervisor is in charge of the day-to-day operation of the physical plant. He supervises the work of all the operators/engineers in the building. The Chief Engineer schedules preventive maintenance, is in charge of equipment logs and may verify the work performed by contracting maintenance personnel.

OPERATING / MAINTENANCE ENGINEER

Operating/maintenance engineers perform a variety of maintenance and repair tasks, from light bulb changing to monitoring and operating the centralized computer control system. These engineers perform preventive maintenance on HVAC equipment, check all equipment on a regular basis, and monitor the conditions of the building and its systems. They also run periodic tests of equipment, take readings and calibrate equipment, and record readings. They interact with tenants as required in the performance of duties.

BUILDING MAINTENANCE SYSTEMS ENGINEER

In one of the buildings visited during the task analysis, a new position had been created for a Building Maintenance Systems (BMS) Engineer. The primary duties of the BMS Engineer are—

- to ensure that the building owners are getting the promised specifications from the building maintenance system delivered by the vendor,
- to work with the vendor to determine the full range of applications of the building maintenance control system,
- to program and modify the system for maximum productivity, energy efficiency and cost savings,
- to work with the operating/maintenance engineers in using the system, interpreting the data provided by the system and taking appropriate corrective actions.

The BMS engineer, who had a strong technical background from his military service on a Naval submarine, had been on the job for over two years and had made many changes in the use of the building maintenance system. As a result of his efforts, the savings realized through the use of the system had significantly exceeded the original expectations of the building management.

The position of BMS Engineer is similar to the position of Intelligent Building Systems Technician that is proposed in this report. At the present time, individuals who hold, and who are qualified to hold, such positions are rare.

PART 2

NEEDS AND FEASIBILITY STUDY

CHAPTER 4

DEFINITIONS, GOALS AND METHODOLOGY OF NEEDS AND FEASIBILITY STUDY

This chapter describes the type of technician qualified to operate and maintain intelligent buildings, specifies the goals of the study, and describes the research methodology that was used.

DEFINITION OF "INTELLIGENT BUILDING SYSTEMS TECHNICIAN"

The type of technician who is the subject of this study is one who can operate and maintain state-of-the-art building systems. Since it was discovered in the course of the study that the term "intelligent building" is difficult to define and may be passing from usage, the job title "intelligent building systems technician" may not be the most appropriate one. Assigning a job title was a functional necessity at the outset of the study, however, and "intelligent building systems technician" was the one selected. A title such as "building systems technician" may be more widely accepted and less likely to become dated.

Whatever job title is ultimately assigned, the role of this technician was described as follows:

> Intelligent building systems technicians install, repair, troubleshoot, program, and operate automated building control systems, and they understand how various automated systems interact and interface with each other and with mechanical equipment. They have broad-based electronic and mechanical skills relating to building electrical and mechanical operations, automated building control systems, and building communication and information technologies. They have a background in computers that includes PC operation, simple communication protocols, methods, and interface requirements. They have a knowledge of HVAC systems, including the basic refrigeration cycle, temperature monitoring, and other HVAC instrumentation and controls. Intelligent building systems technicians may work independently, under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

As with any emerging technology, the parameters of the technician's role in this area are by no means fixed; further discussion is included in Chapter 6, "Interpretation of Findings."

GOALS OF STUDY AND RESEARCH METHODOLOGY

The specific goals of the study were three-fold:

1. To determine the need for specially trained technicians to operate and maintain intelligent buildings.

2. To determine the feasibility of developing a curriculum for training such technicians.

3. To develop a preliminary curriculum model for training intelligent building technicians, if such a curriculum is warranted.

To address the goals of the study, these three primary activities were undertaken:

1. An information search, consisting of a review of literature on intelligent buildings and telephone interviews with industry personnel, revealed current trends and provided an overview of the industry.

2. A task analysis identified what technicians who operate and maintain intelligent buildings do and what they must know.

3. A survey of building owners and managers, building engineers, and control systems vendors provided raw data on how individuals associated with intelligent buildings assess current and projected training needs and technician employment trends.

FOCUS OF STUDY: BUILDING CONTROLS

The preliminary curriculum model proposed in this study focuses upon the control systems of intelligent buildings, not shared tenant services. This is so because shared tenant services, particularly telecommunications, are typically provided by business entities that are separate from the business entities that own and manage the building themselves. Consequently, the technicians and engineers who operate within the management structure of the building's ownership perform far fewer tasks related to shared tenant services than they do to building control systems. Furthermore, the market for computerized building controls is currently healthy, and evidence suggests that the trend toward incorporating them into both new and older buildings will continue. The market for shared tenant services, by contrast, is still in the formative stages and many questions about this area of intelligent building systems remain unanswered.

Even though the proposed curriculum model does not address in-depth the training needs of technicians who operate and maintain the technologies of shared tenant services, this report includes information on shared tenant services so that the picture of intelligent buildings presented is a complete one.

PROJECT ADVISORY COMMITTEE

All project activities were conducted with the guidance of an Intelligent Building Advisory Committee composed of representatives from development companies, providers of telecommunications service, control systems vendors, building managers, chief engineers, and community college and vocational educators. Members of the advisory committee are listed at the front of this report under "Contributing Groups."

The Advisory Committee met three times: March 16, May 13, and July 22. The purpose of each meeting is described below.

March 16 Meeting. The purpose of the first meeting was to define the term "intelligent building," to develop a preliminary definition of "intelligent building systems technician," and to exchange ideas about the roles and training of such technicians. The committee also discussed the methodology proposed for the project, including the survey of needs and the task analysis.

May 13 Meeting. The purpose of the second meeting was to review the preliminary findings from the information search and task analysis, with the task analysis being the central focus. The committee discussed and revised the list of competencies that had been developed as a result of the task analysis interviews.

July 21 Meeting. The purpose of the third and final meeting of the advisory committee was to review and comment on the preliminary project report. Committee members validated the findings and interpretations of the study and assessed the appropriateness of the proposed curriculum.

In addition to the guidance provided by the advisory committee during meetings, the members gave active support to research staff throughout the project. Committee members supported the project by identifying intelligent buildings that could be visited for task analysis, by suggesting individuals for telephone and on-site interviews, by reviewing the survey instruments to ensure their appropriateness for the targeted audience, and by raising and clarifying relevant issues with research staff outside of the formal meetings.

PRIMARY ACTIVITIES OF THE STUDY

As already stated in this chapter, this study involved three primary activities: an information search, a task analysis, and an industry survey. Each of these activities is explained here.

Information Search

The information search consisted of a review of the literature on intelligent buildings and telephone interviews with individuals who represent various facets of the intelligent building industry. The purpose of the information search was to obtain a qualitative overview of the intelligent buildings industry and associated needs of the workforce. The information search also helped in the identification of intelligent buildings for the task analysis and in the development of the survey instruments used in the study.

The review of literature was conducted in the libraries of the University of Texas at Austin. These indices and catalogs were used:

Public Catalog
On-line Index
InfoTrac
Applied Science and Technology Index
Computer and Controls Abstracts
Architecture Index

In the literature search, 35 articles, five major reports and one book were found that were relevant to the study. An annotated bibliography is included as Appendix F of this report.

In addition to the literature survey, more than 75 individuals in the industry or related fields were contacted by phone. They represented key facets and organizations of the intelligent building industry: professional associations, developers, building managers and engineers, vendors, and trainers and educators. These individuals were generous in providing their perspectives on training needs related to intelligent buildings, and their various opinions are incorporated into the body of this report. Intelligent building organizations, listed in Appendix E, were also contacted.

Task Analysis

The purpose of the task analysis was to produce a list of tasks that intelligent building systems technicians perform on the job and to determine what they need to know in order to do those jobs. Along with data gathered through the industry survey, the task list provided the basis for designing the preliminary curriculum for training intelligent building systems technicians.

The task analysis was carried out in four buildings in Dallas, Texas:

LTV Tower
InterFirst Plaza
Infomart
One Lincoln Center

These buildings were identified as being "intelligent" by the Intelligent Building Advisory Committee as well as being listed in the Urban Land Institute report, *Smart Buildings and Technology-Enhanced Real Estate.* (A list of intelligent buildings in Texas is included as Appendix D.)

The task analysis was conducted by a team consisting of staff members from the Center for Occupational Research and Development and consultants from the Francis Tuttle High Technology Center, Oklahoma City.

The team spent a half day at each building. Team members collected data about current intelligent buildings' operations and maintenance staffs and analyzed the systems currently used in the buildings. They interviewed building managers (or persons of equivalent title and responsibilities), chief engineers, and members of the engineering/operations staff. Data collected in this fashion was used to produce the task listing.

Industry Survey

The purpose of the industry survey was to assess the potential job market for technicians to operate intelligent building systems and to ascertain the areas where training is needed. The survey also solicited opinions on the appropriateness of the proposed job description for intelligent building systems technicians.

Survey Instruments. The survey instruments were developed by the research staff. The development process included validating each instrument through in-person interviews with members of the Intelligent Building Advisory Committee who represented the various target audiences of the survey. After these interviews, revisions were made, as necessary, to ensure that the questions were unambiguous and that the data collected would be valid.

Target Audience. On the recommendations of the Intelligent Building Advisory Committee, the Texas members of six professional associations were selected as the target audience for the survey. Each of the associations has members who are involved with the issues that are the focus of this study. The professional associations included in the survey are—

- Building Owners and Managers Association (BOMA)
- International Facilities Management Association (IFMA)
- American Institute of Plant Engineers (AIPE)
- Association of Physical Plant Administrators (APPA)
- Texas Hospital Association (THA)
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Intensely protective of the interests of their members, these associations agreed to cooperate with the project only after they were satisfied that the study's goals were worthy of their support.

These organizations were identified as representing three major groups of participants in the intelligent building systems industry:

- Owners and managers (BOMA and IFMA) primarily of commercial office buildings and retail complexes
- Plant and building chief engineers (AIPE, APPA, and THA) for industrial plants, colleges and hospitals
- Vendors and contractors of building control systems (ASHRAE).

Separate survey instruments were developed for each of the groups identified above. Each of these instruments is included in Appendix A.

For building owners and managers, two survey instruments were developed: one for owners or managers who could answer questions for one building or complex only, and another for owners or managers who could answer for more than one building or complex.

Table 3 on the next page shows the group each association belongs to, the membership of each association, sample size (number of members who received questionnaires), and the identification of the survey instruments sent to that group.

The survey instrument was not sent to 100% of the membership of two of the associations included in the survey. The Texas Hospital Association has a total membership of 1000, but only those members were surveyed who are affiliated with hospitals that have over 250 beds, since it is improbable that smaller hospitals would have the types of building systems that are the concern of this study. There were 89 such hospitals. Any interpretation of the data that includes hospitals refers only to those 89.

Table 3. Itelligent Bbuilding Ssystems Survey

GROUP	ASSOCIATION	MEMBERSHIP	SAMPLE	INSTRUMENT
Building Owners & Managers	BOMA	677	677	A & B
	IFMA	170	170	A & B
Total owners & managers surveyed:		847		
Plant & Building Chief Engineers	AIPE	240	240	2
	APPA	38	38	2
	THA	89 (Hospitals with over 250 beds)	89	2
Total engineers surveyed			367	
Controls Vendors	ASHRAE	1400	480	3

The ASHRAE survey was restricted to the membership in Dallas, Fort Worth, Austin, San Antonio, El Paso, and Houston. The ASHRAE data affects the survey results and extrapolations only for these five cities. Since the ASHRAE membership was so large in those cities (over 1,400), the survey was further limited by sending a survey instrument only to every third name on the membership list.

Mailings and Response Rate. The survey instruments were sent to the target audience in two mailings. Those who did not respond to the initial mailing within three weeks received a follow-up letter and second survey instrument. The letters that accompanied each mailing are included as Appendix B.

By the end of the survey period, the overall response rate was 25%. Table 4 indicates the number and response rate for each group surveyed.

Table 4. Response Rate for Intelligent Building Survey

GROUP SURVEYED	SAMPLE SIZE	NO. RESPONSES	RESP. RATE
Building Owners and Managers	847	138	21%
Plant and Building Engineers	367	94	28.6%
Controls Vendors	480	97	29.5%

Analysis of Survey Data. Computer analysis of the data was accomplished by using the SPSS statistical package. Dr. Kris Moore, Chairman of Information Systems, Baylor University, supervised this stage of the data analysis. As the project staff evaluated and interpreted the data, Dr. Moore provided additional counsel and assistance.

CHAPTER 5

SURVEY RESULTS

This chapter reports the findings of the industry survey. The survey results provide information on two main aspects of the intelligent building industry: the current state of building systems and the current state of the workforce in building control systems.

CLARIFICATION OF TERMINOLOGY

Technicians who work with intelligent building systems are found in two different types of environments and work situations. In one case, they work for the management of a building and perform tasks related to the building's operation and maintenance. In the other case, they work for a company that installs or services building systems. Those technicians who work with building systems as part of the building's staff are referred to in many buildings as "building operators" or "engineers." Persons who work with building systems as a product for companies that install or service building controls are often referred to as technicians. For the sake of clarity, both groups—those who work in buildings and those who work for outside companies—are referred to here as "building systems personnel." The term "intelligent building systems technician" is used to refer to the specific type of technician proposed in this study.

Respondents to survey questionnaires A, B, and 2 include building owners, managers, and chief engineers; they are referred to here by their titles or as "building management." Respondents to survey 3 include representatives from companies that manufacture, distribute, sell, install, service and repair building control systems; they are referred to here as "controls vendors."

CURRENT STATE OF BUILDING SYSTEMS

Survey respondents identified the types of control systems found in their buildings, the features of those control systems, and the percent of building systems personnel who work with those systems.

A total of 332 responses were received from groups surveyed: 138 from building owners and managers, 94 from chief engineers of colleges, hospitals and industrial physical plants, and 97 from controls vendors.

Building owners, managers and chief engineers reported on a total of 464 buildings.

Types of Buildings

Table 5 shows the percent of buildings surveyed that have the types of building systems listed. The percents were obtained by adding together the number of buildings identified with each feature from each of questionnaires A, B, and 2 and dividing this number by 464 (the total number of buildings identified).

Table 5: Frequency of Systems (By Percent) in Buildings Surveyed

SYSTEM	PERCENT OF BUILDINGS
Automated, computer-controlled HVAC	56%
Automated, computer-controlled lighting	21%
Automated, computer-controlled security	39%
Automated, computer-controlled fire protection	39%
Shared tenant telecommunications systems	48%
Shared tenant office automation system	27%

(Data based on survey questionnaires A, B, and 2)

Features of Building Systems

Table 6 shows the percent of buildings surveyed that have control systems with the features listed. The percents were obtained by adding together the number of buildings identified with each feature from each of questionnaires A, B, and 2 and dividing this number by 464 (the total number of buildings identified).

Table 7 shows the percent of each type of building system and of each identifying feature, according to the building use. Building use is divided into four main categories: primarily commercial buildings (single-occupant and multiuse),

Table 6: Frequency of Specific Control Features (by Percent) in Buildings Surveyed

SPECIFIC CONTROL FEATURES	PERCENT OF BUILDINGS
Time-initiated (start-stop) energy controls	61%
Temperature sensing/monitoring	60%
Load-initiated building controls	36%
Programming capability	51%
Centralized building/complex control center	42%
Control of building/complex from remote location	24%

(Data based on survey questionnaires A, B, and 2)

Table 7: Types of Building Control Systems and Identifying Features—Breakdown by Building Use

	PRIMARILY COMMERCIAL	INDUSTRIAL PLANTS	COLLEGES	HOSPITALS
HVAC	50%	72%	78%	77%
Lighting	19%	32%	35%	12%
Security	39%	47%	39%	19%
Fire	34%	47%	48%	65%
Time-initiated controls	56%	75%	96%	69%
Temperature sensing/ monitoring	52%	87%	91%	73%
Load-initiated controls	34%	36%	61%	42%
Programming capability	46%	64%	74%	65%
Centralized building/ complex control center	36%	51%	78%	61%
Control of building/ complex from remote location	19%	32%	65%	27%

(Data based on survey questionnaires A, B, and 2) industrial plants, colleges, and hospitals. The percents indicate the number of buildings with a given type of feature as compared with the total number of buildings in that building use category.

Size Categories of Buildings

Table 8 shows the percentage of buildings and complexes surveyed that fit into each of the size categories listed. Table 8 includes commercial office buildings, multi-use complexes, hospitals, colleges and industrial plants surveyed.

Table 8: Size Categories of Buildings Surveyed (by Percent)

SIZE OF BUILDINGS	PERCENT OF BUILDINGS
Zero – 100,000 square feet	13%
100,000 – 250,000 square feet	29%
250,000 – 500,000 square feet	19%
500,000 – 1,000,000 square feet	18%
Over 1,000,000 square feet	21%

(Data based on survey questionnaires A, B, and 2)

Personnel Who Work on Building Systems

Table 9 indicates the median percent of building systems personnel who work with each type of system listed. For example, 50% of the respondents stated that 75% or more of the building systems personnel work with automated, computer-controlled building control systems.

Maintenance Contracted with Outside Companies

Table 10 indicates the median percent of maintenance that is performed on contracts with companies outside the building management. The percents from which the median was drawn are based on the percents identified by respondents to survey questionnaires A, B, and 2.

Table 9: Median Percent of Building Systems Personnel Who Work in Three Areas of Building Intelligence

AREAS OF BUILDING INTELLIGENCE	MEDIAN PERCENT OF PERSONNEL
Automated, computer-controlled building systems	75%
Telecommunications systems	17.5%
Office automation systems	22.5%

(Data based on survey questionnaires A, B, and 2)

Table 10: Median Percent of Building Systems Maintenance Performed by Outside Contractors

AREA OF BUILDING INTELLIGENCE	MEDIAN PERCENT OF MAINTENANCE PERFORMED BY OUTSIDE COMPANIES
Automated, computer-controlled building systems	73.5%
Telecommunications systems	75%
Office automation systems	95%

(Data based on survey questionnaires A, B, and 2)

BUILDING CONTROL SYSTEMS WORKFORCE

Respondents in the survey provided data on the current state of the workforce in the field of building systems by answering questions related to—

- the proposed definition of "intelligent building systems technicians" (Chapter 4)
- training needs and duties performed by existing personnel
- projected hiring of intelligent building systems technicians.

Availability of Intelligent Building Technicians

Table 11 shows the current availability of building systems personnel who fit the proposed description of an intelligent building technician, as assessed by survey respondents. Owners, managers, chief engineers and building controls company representatives checked one of four categories of availability to answer the question, "Are technicians that fit the description available now?" Results are reported as the percent of respondents who checked each category of availability.

Table 11: Availability of Intelligent Building Systems Technicians

Commonly available	3.6%
Available, but not commonly	38.6%
Rarely available	38.3%
Not available	9.3%

(Data based on survey questionnaires A, B, 2 and 3)

Percent of Technicians Who Fit Proposed Definition

Each survey questionnaire asked respondents to indicate the percent of personnel in their organization who currently fit the proposed definition of an intelligent building systems technician. Table 12 shows the number of respondents who selected each percent category.

Table 12: Distribution of Current Building Systems Personnel Who Fit the Description of "Intelligent Building Systems Tech"

PERCENT OF TECHNICIANS	NUMBER OF RESPONDENTS SELECTING PERCENT CATEGORY
0 – 20%	79
21 – 40%	25
41 – 60%	19
61 – 80%	9
81 – 100%	25

(Data based on survey questionnaires A, B, 2 and 3)

Note: Only 169 respondents out of a total of 332 answered this question. The apparent explanation is that the placement of the question on the page made it seem to be part of the previous question; therefore, it was overlooked by many respondents.

Appropriateness of Proposed Definition

Table 13 shows how building owners, managers, chief engineers and controls vendors rated the appropriateness of the job description given for an intelligent building technician. The question was, "How well qualified would the technician described be to maintain buildings that have computer-controlled, automated systems/to perform the duties of a technician employed by your company?"

Table 13: Qualifications of "Intelligent Building Systems Tech"

Very well qualified	52.4%
Moderately qualified	29.5%
Moderately poorly qualified	3.6%
Very poorly qualified	2.7%

(Data based on survey questionnaires A, B, 2 and 3)

Employability of Intelligent Building Systems Technicians

Respondents (building management and controls vendors) indicated their interest in hiring intelligent building systems technicians by answering the question, "Does your company presently hire—or would it hire if they were available—intelligent building systems technicians [such as those described in the proposed definition]?" Their answers are indicated in Table 14.

Table 14: Percent of Respondents Who Would Hire "Intelligent Building Systems Techs"

Yes	42%
No	19%
Maybe	31%

(Data based on survey questionnaires A, B, 2 and 3)

Projected Need for Intelligent Building Systems Technician

The number of positions for intelligent building systems technicians that will be needed by 1988, 1990, 1995, and 2000, based on projections by building owners, managers, chief engineers and building controls company representatives is indicated in Table 15. The projections were obtained by taking the total number of technicians estimated as needed during each time period and dividing it by the number of respondents in the sample (332) to obtain an average number of technicians per response. The average number was then multiplied by N, the number that represents the total sample surveyed. N is the best estimate of the total population of building owners, managers, chief engineers, and controls vendors who may be affected by changes in building systems technology.

$$\frac{\text{\# technicians in each category}}{\text{\# of repondents}} \times \text{N (total population)} = \text{projected need}$$

Table 15 lists both the projections made by survey respondents and the need based on extrapolation of respondents' projections.

Table 15: Need for "Intelligent Building Systems Technicians" in Texas

YEAR	NUMBER OF TECHNICIANS NEEDED AS PROJECTED BY SURVEY RESPONDENTS	NUMBER OF TECHNICIANS NEEDED EXTRAPOLATED FOR ENTIRE POPULATION N
By 1988	676	5,308
By 1990	1,007	7,962
By 1995	1,134	9,023
By 2000	1,311	10,350

(Data based on survey questionnaires A, B, 2 and 3)

Table 16 shows the percent of need for intelligent building systems technicians in each of three hiring sectors: commercial buildings; hospitals, colleges and industrial plant facilities; and controls vendors.

Table 16: Need for "Intelligent Building Systems Technicians" in Texas—Breakdown by Hiring Sector

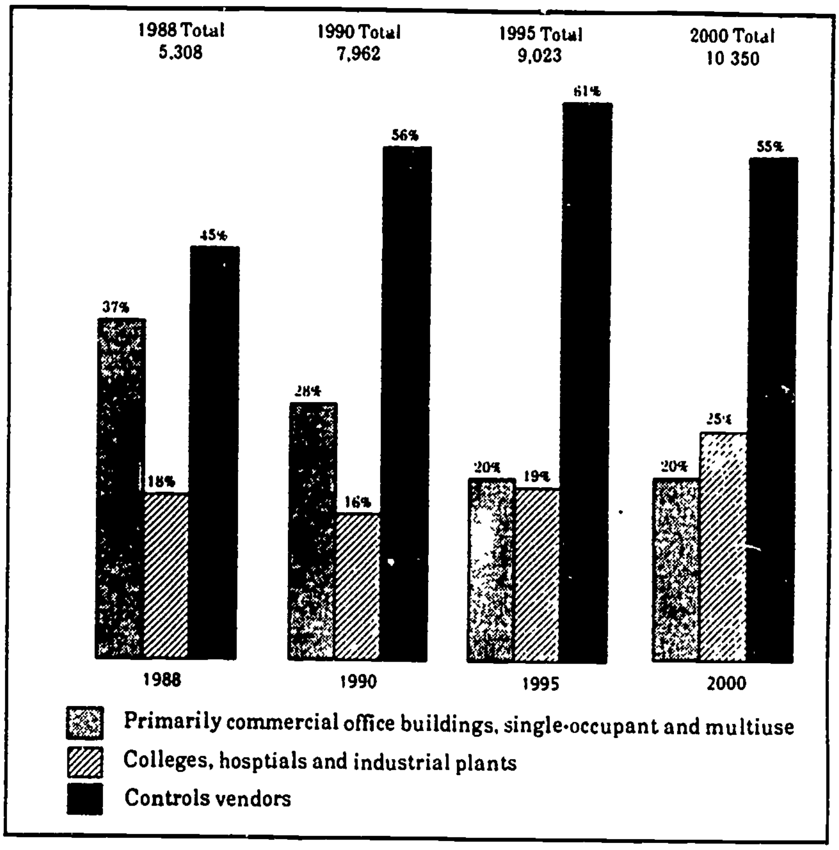
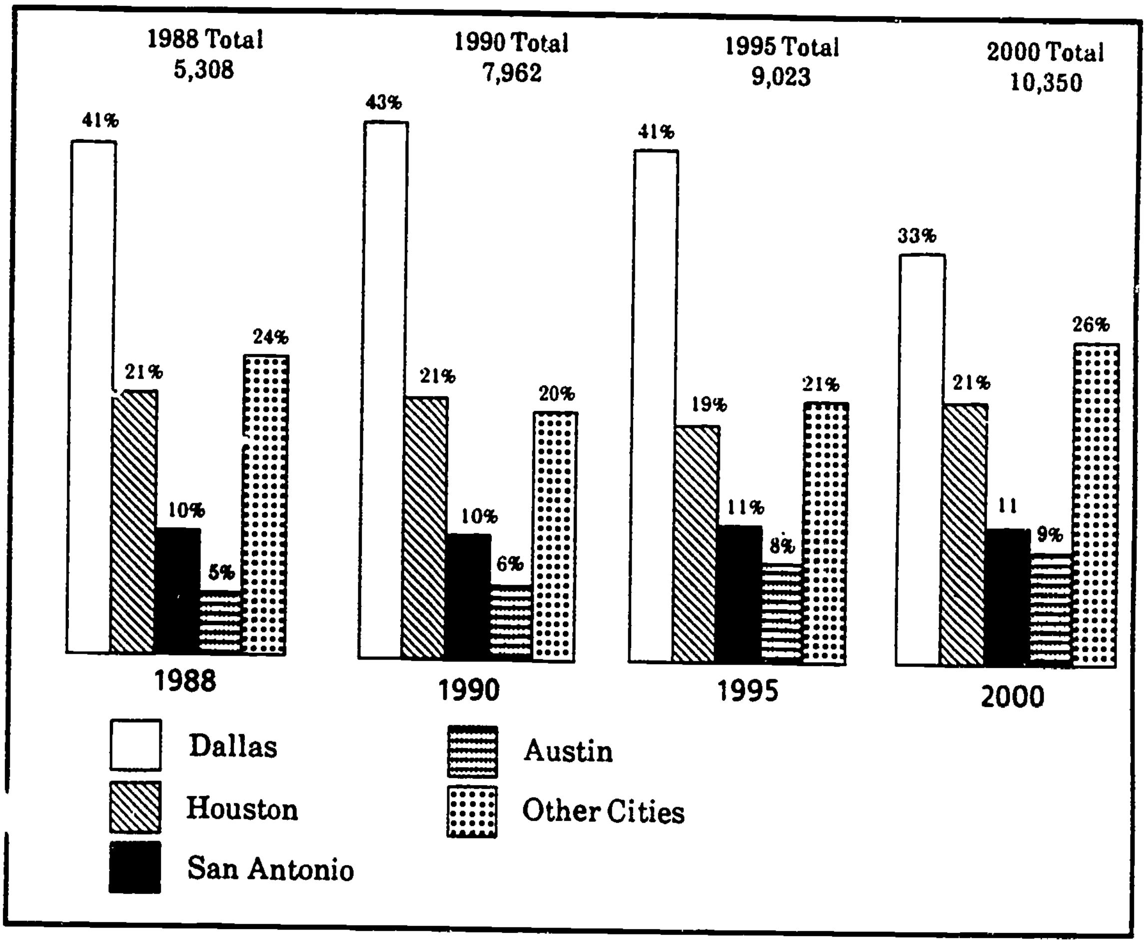


Table 17 indicates the projected needs for intelligent building systems technicians, broken down by major cities in Texas.

Table 17: Need for "Intelligent Building Sysytems Technicians" in Texas—by Major Cities



Areas Where Training Is Needed

Table 18 shows how building owners, managers, chief engineers and control vendors ranked potential training areas for building systems personnel. Number 1 represents the area of greatest training need; number 14 is the area in which the need is least critical.

Table 18: Ranking of Training Needs for Building Systems Personnel

TRAINING AREA	RANK
Heating, Ventilating and Air Conditioning (HVAC)	1
Electronic Controls	2
Electric Power/Wiring	3
Fire Protection/Life Safety Systems	4
Lighting	5
Computer Literacy	6
Security Systems	7
Computer Programming	8
Control Software	9
Communication	9
Organization/Planning	9
Interpersonal Relations	10
Telecommunications Hardware	11
Telecommunications Software	12
Signal Transmission	13
Office Automation	14

(Data based on survey questionnaires A, B, 2 and 3)

Duties Performed By Technicians Who Work With Building Systems

Table 19 shows how building owners, managers, and chief engineers rank the importance of duties performed by building systems personnel. Number 1 represents the most important and 6 the least important.

Table 19: Ranking by Building Management of Duties Performed by Building Systems Personnel

DUTY	RANK OF IMPORTANCE
Troubleshooting	1
Inspection of system devices and instrumentation	2
Service, preventive maintenance	2
Repair	3
Monitoring of computerized controls and instrumentation	4
Programming of automated systems	5
Training	6

(Data based on survey questionnaires A, B, and 2)

Table 20 shows how controls vendors rank the importance of duties performed by building systems personnel employed in their companies.

Table 20: Ranking by Controls Vendors of Duties Performed by Their Company's Building Systems Personnel

DUTY	RANK OF IMPORTANCE
Troubleshooting	1
Service, preventive maintenance	2
Repair	3
Installation	4
Programming	5
Training	6
Sales	7

(Data based on survey questionnaire 3)

Sources of Training for Building Systems Personnel

Table 21 shows how building owners, managers, chief engineers, and controls vendors rank the importance of current sources of training for building systems personnel. Number 1 represents the most important and 7 the least important.

Table 21: Sources of Training for Building Systems Personnel

SOURCE OF TRAINING	RANK OF IMPORTANCE
In-house	1
2-year colleges/technical schools	2
Short-term vendor training	3
Training by professional associations (such as BOMI)	4
Armed forces	5
High school vocational education	6
4-year colleges	7

(Data based on survey questionnaires A, B, 2 and 3)

Education Level of Building Systems Personnel

Table 22 shows the median percent of building systems personnel who have attained each educational level listed. For example, 50% or more of the respondents stated that 19% of their building systems personnel had less than a high school diploma.

Table 22: Educational Level of Building Systems Personnel— by Median Percent

EDUCATIONAL LEVEL	MEDIAN PERCENT OF PERSONNEL
Less than high school diploma	19%
High school diploma	92.5%
Associate's degree from two-year school	30%
Bachelor's degree	18%

(Data based on survey questionnaires A, B, 2 and 3)

CHAPTER 6

INTERPRETATION OF FINDINGS

This chapter looks at all the information collected during the course of this study through the information search (telephone interviews and literature survey), task analysis and industry survey. This information is interpreted collectively to answer fundamental questions about the need for and employability of intelligent building systems technicians.

THE NEED FOR INTELLIGENT BUILDING SYSTEMS TECHNICIANS

The need for intelligent building systems technicians is suggested by the widespread use of computerized building control systems, as revealed by the industry survey and by the information search.

Widespread Use of Computer-controlled Building Systems

The growing need for technicians who can operate and maintain state-of-the-art (i.e., intelligent) building systems is suggested by the fact that computer-controlled building systems are becoming quite common. The industry survey included buildings that varied in size from under 100,000 square feet to over 1,000,000 square feet (Table 8). Types of buildings included commercial buildings, industrial plants, colleges, elementary and secondary schools, and hospitals.

Over half of the buildings in the survey are equipped with automated computer-controlled heating, ventilating and air-conditioning systems; over one-third have computer-controlled security and fire protection systems; and over one-fourth have computer-controlled lighting (Table 5). Of these systems, more than half were reported to be fairly sophisticated: more than half have programming capability; 42% have a centralized control center for the building or complex; and almost one-fourth may be controlled remotely (Table 6).

The survey data suggests that intelligent building systems are widely used and are not restricted to the largest commercial high-rise buildings (Table 7). The need for intelligent building systems technicians, then, extends beyond the need for technicians who work only in that select number of buildings that may be "officially" designated as "intelligent."

Need for Technicians Revealed by Information Search

The information search further substantiated the need for intelligent building systems technicians. In telephone interviews with individuals associated with the intelligent building system industry, there was virtually unanimous endorsement of the idea for such technicians. It was frequently suggested that building managers and engineers become frustrated in their attempts to use state-of-the-art building control systems because of their lack of experience with them. As a last resort, they stop trying to use some of the desirable features of their systems and implement less sophisticated methods of building operations. Consequently, the promises and economic benefits of intelligent systems are not realized.

The literature on intelligent building systems confirms that this pattern of frustration and rejection of sophisticated building control systems is not uncommon. The message is quite clear: building managers, engineers and technicians could all benefit from greater expertise related to computer-controlled building systems.

New Tax Laws

The project advisory committee suggested that the new tax laws may also stimulate the need for intelligent building systems technicians. Before the new tax laws, developers and owners could use investments in buildings as tax shelters without being concerned about the buildings' profitability. This means that, in some cases, it was acceptable for the occupancy rate of buildings to remain low, and low tenant occupancy requires smaller building maintenance and operations staffs.

With the new tax laws, however, unprofitable real estate will be less viable as tax shelters. Consequently, there will be a greater interest in operating properties at the highest level of energy efficiency. Also, there will be increased urgency about finding occupants for empty office space so the property can operate at a profit. As occupancy rates increase, so will the building maintenance and operations staffs. In addition, as building owners and managers begin to compete more aggressively to recruit tenants, it is probable that they will have to increase the level of technical support to keep their tenants happy. All these changes translate into a potential increase in demand for technicians who can operate and maintain intelligent building control systems.

EMPLOYABILITY OF INTELLIGENT BUILDING SYSTEMS TECHNICIANS

The practical evidence that intelligent building systems technicians are needed resides in the answer to the question, "Will they be hired?" Survey respondents estimated that a significant number of building systems technicians could be hired during the next 12 years. Figure 1 shows the extrapolated projections, 1988 to 2000, based on Table 15, which includes data from all questionnaires.

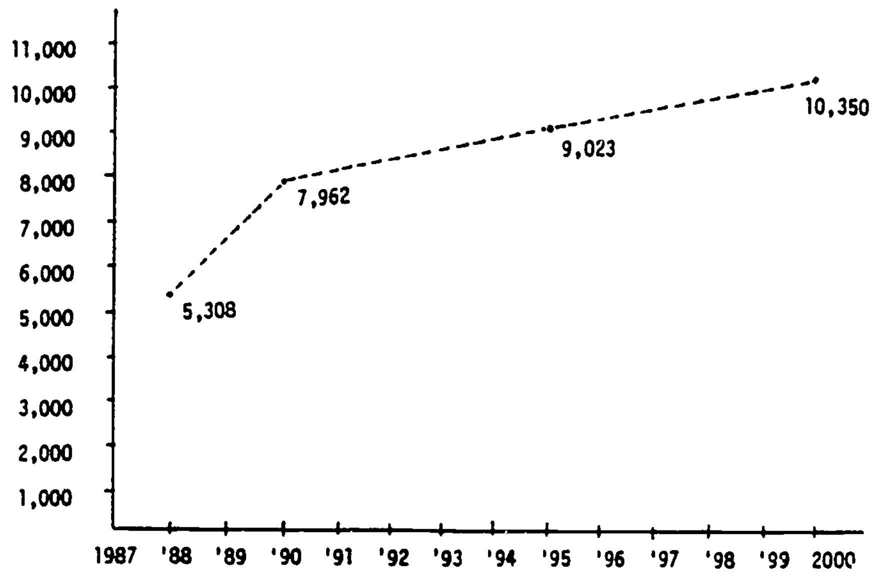


Figure 1

While respondents projected a very positive hiring trend for intelligent building systems technicians, they expressed caution when asked outright if they would hire such technicians. Only 42% of the respondents checked "yes," and 31% checked "maybe" (Table 14). Also, when asked to evaluate the qualifications of the technician described in the definition given for an intelligent building systems technician, only 52% of the respondents checked "very well qualified," and another 29% checked "moderately qualified" (Table 13). Possible explanations for the reservations reflected in these responses were suggested in the written comments of survey respondents. The relevant comments are summarized below.

- Many building managers indicated that they would not hire one person whose sole responsibility is building systems control. The technician would have to be willing to perform other, less technical, duties in the general daily operations of the building. A few indicated that they would have only one position in the building for such a technician.

- Some building managers said that they could not afford to pay a technician with the range of skills indicated. The salary for entry-level building operations personnel is lower (around $12,000 per year) than a technical school graduate of an intelligent building systems curriculum may expect.

- Some building managers indicated that they would want the intelligent building systems technician to hold a certification or license; specifically mentioned were "certified building systems technician" (BOMI) and "stationary engineer's license" (city of Houston).

- Some building managers believe that the demands of building operations are so unique that only on-the-job training or apprenticeship can provide the necessary background. Respondents ranked in-house training as the most important source of training (Table 21). They seem more inclined to hire an experienced person with a proven attitude than a person trained in specific skills.

- The proposed definition did not include interpersonal communication skills. which are considered essential by many building managers.

Appendix C contains a complete listing of the comments made by survey respondents concerning the appropriateness and employability of intelligent building systems technicians. These factors were also mentioned by managers and engineers in the the task analysis interviews, in telephone interviews, and in discussions with the advisory committee.

The advisory committee suggested that more survey respondents would have indicted a more definite willingness to hire intelligent building systems technicians if the question had specified that the technicians were being hired for entry-level positions. This is the question that was asked: "Do you presently hire—or would you hire if they were available—'intelligent building systems technicians'?"

TECHNICIAN TRAINING AND EDUCATION

Levels of education and sources of training vary considerably among those who currently operate building systems.

Education Levels of Current Building Systems Personnel

The highest level of education attained by most building systems personnel is that of high school graduate; only 30% have an associate's degree and 18% have a bachelor's degree (Table 22). However, 2-year colleges and technical schools were viewed by respondents as the second most important source of training for building systems personnel. In interviews, the implementation of a curriculum in building systems technology was greeted enthusiastically. However, during interviews and advisory committee discussions, some reservations were expressed regarding the employment of associate degree holders. Managers pointed out that such graduates often have unrealistic expectations for entry-level employment, in terms of responsibility and salary. Also, many potential employers stressed personal qualities such as motivation to learn, common sense and attitude as more important than education; they indicated that it was somewhat difficult to find these qualities in the younger graduates of associate degree programs than in more experienced people who had learned their jobs in the field.

Sources of Training on Intelligent Systems

The depth of training that is needed to operate sophisticated building control systems to maximum advantage is not readily available. Vendors offer training on the products they sell, of course, but there are some inherent problems in this situation. As would be expected, vendor training is product-specific. Trainees who are not already grounded in the principles of the technology, however, are not well positioned to benefit from it as much as they would like or need. Since vendors can be expected to deliver only product-specific training, the need for preparatory background training may remain unaddressed. Until that need is satisfied, however, it is improbable that the systems will be optimally operated.

The Building Owners' and Managers' Institute (BOMI) offers a wide range of courses relating to building operations, but the focus of that training is not the more advanced building systems technologies. The same limitation applies to programs that have been implemented in two-year postsecondary technical institutions.

Knowledge and Skills Needed

Based on respondents' rankings of areas of training need (Table 18), the IBS technician should be the most strongly grounded in *heating, ventilating and air conditioning (HVAC) systems.* Rankings were also high for the areas of *electrical wiring, electronic controls, fire protection systems, lighting, security* and *computer literacy. Computer programming* appeared just above the halfway mark in a ranking of 16 items. *Communication* and *interpersonal relations* were ranked lower (9 and 10, respectively); however, they were among the most mentioned skills in the written comments of respondents. It's probable that repondents ranked communication and interpersonal skills fairly low only because they felt they could not rank those skills above required technical skills.

Information gathered during advisory committee meetings, informal interviews and task analysis verified the high rankings by survey respondents of HVAC systems and electronic controls. However, computer literacy was stressed somewhat more during interviews than by the survey respondents. Interviewees also stressed communication, interpersonal relations and organization/planning skills.

The skill of *troubleshooting* was ranked highest on the list of duties performed by intelligent building systems technicians by both building management and building controls vendors. *Service and preventive maintenance* ranked high on both lists (which included some unlike items), and *repair* ranked slightly higher on the vendor's list than on the building management list (Tables 19 and 20).

The question of how much repair would be required of intelligent building systems technicians arose frequently during advisory committee meetings and informal interviews. Many people in the field felt that repair was a secondary function for the on-site intelligent building systems technician. The intelligent building systems technician would troubleshoot and change parts when the operation was fairly simple, but would leave repair and maintenance to contract personnel or other building systems personnel trained more specifically to perform repairs. It was also pointed out by some that the nature of the building systems is such that changing of parts is a more frequent occurrence than on-the-job repair.

Survey respondents ranked *monitoring* of computerized controls and instrumentation higher than *programming*. However, in interviews, both building management and building controls company representatives lamented the fact that sophisticated control systems are vastly underused. Most building control systems personnel did not have the knowledge required to program (i.e., "personalize" or modify) the system to a higher level of use. Some personnel had the capability to learn the system, but this was considered a lengthy process that the building management could not afford and/or that would not be tolerated by ownership. In short, most managers would like to have someone who can program the system, but question whether hiring such a person would be feasible.

INVALID DATA

The validity of survey data on the percent of buildings that have shared tenant telecommunications systems was questioned by the project advisory committee. The survey indicated that 48% of the buildings surveyed have shared tenant telecommunications systems. Advisory committee members concurred that 48% is too high, although they could not predict how much lower the percent should be. Data on the frequency of shared tenant telecommunications services was collected from responses to this question: "Does your building or building complex provide telecommunication services to tenants—for example, basic telephone service, long-distance service, data lines?" The advisory committee members suggested that data reported on telecommunications services is erroneous because the respondents themselves are confused about who provides telecommunications services and what constitutes shared tenant services. Consequently, respondents did not possess enough information to provide accurate data.

CONCLUSIONS

The findings of this study suggest that—

- there is a need for the type of intelligent building systems technician that has been proposed here, and
- this technician would be employable.

This technician may be characterized in general terms as one who has—

- a broad base of technical knowledge,
- a strong systems orientation,
- a strong foundation in HVAC,
- skill in using computers, and
- well-developed people skills.

The intelligent building systems technician proposed here could be employed by different business entities:

- Building management—to operate and maintain building systems
- Control systems companies—to install and service computer-controlled systems

Any decision to establish a two-year postsecondary curriculum to train intelligent building systems technicians should be made with an awareness of the following concerns that building owners, managers, and engineers emphasized in numerous ways throughout this study.

- Building operations personnel who are especially trained in intelligent building systems would represent a new type of worker to building owners, managers, and engineers, so there is no ready-made slot for them to fit into. This is a common phenomenon as the workforce evolves to fit any emerging technology.

- Building owners, managers, and engineers have stated that they could not hire, at this time, a person whose job focused exclusively upon computer-controlled building systems. Almost all building operations personnel perform a wide range of duties and hold numerous responsibilities. An individual trained to be an intelligent building systems technician should be prepared to accept this fact. Flexibility in the performance of duties would be imperative, since menial tasks must be accomplished as well as the challenging ones.

- An Intelligent Building Systems curriculum cannot provide all the training a technician requires to maintain and operate automated building systems. A significant portion of the training must still be acquired on-the-job because only in buildings will the technician encounter the exact types of equipment that he or she must master. A two-year curriculum can provide the foundation so that learning on-the-job—and at vendors' courses—can occur quickly and efficiently.

- Building owners, managers, and engineers expressed concern that even if intelligent building systems technicians were currently available, they would not be able to hire them because they could not meet their salary expectations. To find jobs in buildings, then, prospective technicians would have to be prepared to work at entry-level pay scales. Since pay scales reflect the economy, the pay for entry-level positions is currently very modest. Controls vendors may hire such technicians at somewhat higher salaries.

- School placement services should be prepared to promote the new type of technician that would be produced by the new type of program. Without the active support of the school in job-seeking, program graduates would be left unfairly to their own resourcefulness and ability to sell a new idea in the job market.

The concerns reviewed here are not meant to discourage the establishment of two-year postsecondary curricula for intelligent building systems technicians. They are identified only so they can be dealt with deliberately and intelligently.

CHAPTER 7

TASKS AND COMPETENCIES

The skills and knowledge required by technicians who operate and maintain state-of-the-art building systems are listed in this chapter under the headings shown below.

1. Sources, Interpretation and Uses of Data and Record Keeping
2. Computer Use/Literacy
3. Communication, Supervisory and Interpersonal Skills
4. Electrical Systems
5. Mechanical Systems
6. Pneumatic and Electrical Control Systems
7. Emergency Power and Life Support Systems
8. HVAC Systems
9. Security and Surveillance Systems
10. Information/Communication Systems
11. Codes and Licenses
12. Contingency Plans

1. **Sources, Interpretation and Uses of Data and Record Keeping**

The technician must be able to:

a. Read, understand and follow explicit technical data on electrical, electromechanical, pneumatic, HVAC, emergency power, security and life support systems.

b. Evaluate all systems for proper operation and make any adjustments or calibrations, or perform preventive maintenance as per job description and preventive maintenance schedule requirements.

c. Develop and maintain a log (history) on operating performance of specified equipment and calibration, adjustments, and repairs performed according to job requirements.

d. Interpret the preventive maintenance record-keeping system, perform necessary preventive maintenance according to schedule, and properly and accurately record all data necessary to maintain all systems.

e. Evaluate productivity, assist in purchasing, and assist in performance evaluations as needed.

2. **Computer Use/Literacy**

The technician must be able to:

a. Explain basic operating principles of a computer.

b. Operate computer hardware and utilize software capabilities to enter and retrieve data.

c. Explain how each system of the building that is monitored by the computer works, what information is available, how to use it, and how to save that information if it is needed for documentation.

d. Use the computer to monitor systems and to search and record system information as required by job duties.

e. Report systems information to proper personnel for immediate action and record such data in a log in the correct manner at the appropriate time.

3. Communication and Interpersonal Skills

The technician must be able to:

a. Use verbal communication skills to:

- Communicate with peers/next-shift engineers about problems with systems or equipment to ensure ongoing maintenance of normal operational situations and emergency maintenance for crisis situations.
- Report to supervisors and building managers about current status of all systems and possible future system problems based on observations, log records and experience.
- Consult with tenants on the phone and in person about service and maintenance requests/problems.
- Provide information to building security and fire department personnel in emergency situations.
- Provide assistance to contract service vendors as they perform contract maintenance and repair on building systems and equipment.

b. Use written communication skills to:

- Write understandable and legible documentation of system events in all logs as required.
- Document completion of maintenance tasks on preventive maintenance logs.
- Write messages and reminders to next-shift engineers to ensure ongoing maintenance.
- Document completion of tenant maintenance requests on proper forms.

c. Use interpersonal relations skills to:

- Maintain positive customer relations with building tenants.
- Establish and maintain good working relationships with peers.

- Maintain positive relationships with supervisors and building managers.

- Maintain cooperative working relationships with service contract vendors.

4. **Electrical Systems**

The technician, in accordance with code and licensing requirements, must work safely in the performance of job duties and must be able to:

a. Perform basic tasks such as reading and interpreting blueprints and schematics, identifying common electrical components found in a circuit, making necessary calculations, and safely using basic electrical skills.

b. Identify the location of electrical distribution centers, controls, panels and transformer locations, and explain secondary power and distribution in the building.

c. Troubleshoot, remove and/or replace light switches, bulbs, controls, fixtures and components.

d. Identify, test and make minor repairs on three-phase circuits.

e. Test, remove and replace power interrupting devices (fuses and circuit breakers) and properly identify characteristics of and selection criteria for these devices.

f. Identify equipment and component specifications from a ledger or a print.

g. Confirm that circuits are properly sized and wired in accordance with the print.

h. Read a volt ohmmeter, a voltage tester, and a phase rotation meter, and demonstrate proper uses of electrical test equipment and tools.

i. Determine and record input and output voltage of a transformer.

j. Install and service electrical heating devices.

k. Install and service electromechanical valves and devices.

l. Install, repair and troubleshoot single-phase and three-phase AC motor control circuits and interpret all data on nameplates of the motors.

m. Test an AC motor for overload and short-circuit conditions and, if needed, remove and replace the motor.

n. Interpret the transformer nameplate data and demonstrate correctly-chosen taps for the voltage needed.

o. Install and maintain emergency lighting systems, such as infrared systems.

p. Conduct preventive maintenance on electrical equipment, motors and control systems.

q. Troubleshoot, repair and/or replace control circuit components, such as time delay relays, solenoids, pressure switches, limit switches, timers, counters and other common electrical components.

5. Mechanical Systems

The technician must be able to:

a. Troubleshoot, service, remove and replace mechanical components within the philosophy of building management and job description duties.

b. Operate all mechanical systems and perform system checks. (Example: the emergency generator system and the emergency fire pump[s].)

c. Identify types of bearings, seals, drives, linkages, valves and other common mechanical components and explain how they are used in mechanical systems.

d. Remove, replace, service and maintain mechanical equipment with components to include drives, linkages and valves.

e. Properly assemble, align and adjust mechanical equipment in accordance with manufacturer's specifications.

6. Pneumatic and Electrical Control Systems

The technician must be able to:

a. Read and work from fluid power schematics and drawings.

b. Identify fluid power system components and the purpose and function of each component.

c. Troubleshoot, calibrate, remove, repair and/or replace thermostats, valves, solenoids, cylinders, triggering switches and limit switches, actuators, manifolds, tubing, fittings and other components normally found in fluid power systems.

d. Adjust, maintain and calibrate fluid power systems.

e. Install, replace, maintain and service pneumatic systems and equipment to include compressors, filters, strainers, check valves, flow controls, sequencers, regulators, piping systems and valves.

f. Service, maintain, remove and replace pneumatic actuators and controls on HVAC systems.

g. Service and maintain air compressors as required by manufacturer's specifications.

h. Remove and replace belts as necessary.

i. Troubleshoot, repair or replace motors and motor control components as necessary.

7. Emergency Power and Life Support Systems

Emergency Power System

The technician must be able to:

a. Explain the operation of emergency power systems.

b. Start and run emergency power systems as required by frequency time schedules.

c. Perform preventive maintenance checks on the system by checking oil levels, battery terminals, cooling levels, belts, connections, charging systems, manual switches and other components as defined in preventive maintenance schedule.

d. Service and maintain the electrical generation systems as required by manufacturer's specifications and job duties assigned.

Life Support Systems

Acting according to code requirements, the technician must be able to:

a. Read and interpret all blueprints and schematics involving life support systems to include smoke alarms, sprinkler systems, emergency fire pumps, stairwell pressurized fans, exhaust fans and emergency phone systems.

b. Service and maintain life support systems according to:

- The philosophies of building management,
- State and federal statute requirements, and
- Job description/duty assignments.

c. Perform visual checks of smoke detector systems, clean and blow out all detectors and perform preventive maintenance on the system and valves as required.

8. HVAC Systems

Note: The technician performs work on the HVAC systems as defined by the manager and as detailed in the job description.

The technician must be able to

a. Explain the operation procedures of the HVAC system.

b. Service and maintain the system to ensure efficient operation.

c. Explain the refrigeration cycle.

d. Troubleshoot, remove and replace system components as necessary to maintain an effective level of operations as licensure requires.

e. Perform preventive maintenance, service and repair in accordance with manufacturer's specifications and job requirements in the following areas and on the major components:

- Cooling Systems
  - (1) Evaporators
  - (2) Compressors
  - (3) Condensers
  - (4) Metering devices
  - (5) Basic lubrication systems
  - (6) Auxiliary components

- Air-handling Unit Systems
  - (1) Primary Components
    - (a) Vane axial fans, variable pitch (fixed blade)
    - (b) Squirrel cage, forward- and reverse-curved blades, inlet guide vane systems
  - (2) Secondary Components
    - (a) VAV Systems (Variable Air Volume)
    - (b) Fan-powered mixing boxes
    - (c) Fan coil units

- Condensation Drain Systems
  - (1) Compressors
  - (2) Cooling systems components

- Water Treatment Systems
  - (1) Take samples and record data as prescribed by an applications engineer.
  - (2) Maintain/treat water in cooling and/or heating systems to prevent excessive levels of:
    - * corrosion,
    - * scaling, and
    - * biological growth.

- Pump Types and Applications
  - (1) Identify pump types and applications.
  - (2) Perform preventive maintenance.
  - (3) Remove, repair, replace and align the following pumps according to manufacturer's specifications:
    - (a) Centrifugal

(b) Reciprocating
(c) Recirculating
(d) Sump
(e) Positive Displacement

9. Security and Surveillance Systems

(Note: Mostly contract maintained)

The technician must be able to:

a. Explain and operate security and surveillance.

b. Check both audio and visual systems for proper operation.

c. Test and service the systems as required by preventive maintenance schedules.

d. Assist contractors who have the primary responsibility for security systems maintenance and repair.

10. Information/Communication Systems

(Note: Information/communication systems are mostly contract maintained.)

The technician must be able to:

a. Use a working knowledge of information/communication systems to perform basic troubleshooting functions.

b. Troubleshoot a nonfunctioning video information terminal to determine if the problem is related to:

* dedicated HVAC system,
* alternate fire protection system,
* power/cable connections,
* software,
* hardware,
* power fluctuation.

11. **Codes and Licenses**

The technician must be able to:

a. Perform all duties and job functions in accordance with codes and license requirements.

b. Relate inspection procedures and documentation to insurance rates and equipment warranties.

c. Use and interpret code books.

12. **Contingency Plans**

The technician must be able to take appropriate procedural steps in response to:

a. Building evacuation

b. Electrical outage

c. Bomb threats

d Glass breakage

e. Other contingencies

CHAPTER 8

PRELIMINARY CURRICULUM

This chapter outlines a curriculum for training technicians to operate and maintain intelligent building systems. A core curriculum model is recommended because this type of curriculum maximizes the efficient use of an institution's resources by avoiding redundant course offerings from program to program. For example, if the curricula for eight to ten different technical fields are examined, it will be discovered that over two-thirds of the courses are similar in all the fields. Given this fact, a "common core" curriculum can serve the educaton and training requirements of nearly all technologies.

The *common* core has two components: a basic core and a technical core. The basic core consists of courses in mathematics, physical science, communications, and socioeconomics. The *technical* core provides broad-based skills in areas such as electronic devices, mechanical and fluid power systems and instrumentation and control. The majority of the courses that a student takes when enrolled in a common core curriculum belong to the basic and technical core.

The second part of the curriculum is the *specialty sequence*. This sequence consists of five to six courses that are unique to a given occupational field. The specialty sequence ensures that the student attains a specified level of expertise in a chosen technical specialization.

A curriculum chart for intelligent building systems technicians is shown on the following page. The basic core courses are identified under the categories of "Applied Math and Science," "Communications," and "Socioeconomics." The technical core and specialty courses are clearly labeled.

Descriptions of each course in the proposed curriculum are given in the pages that follow the curriculum chart. Competencies that were validated by the Intelligent Building Advisory Committee are listed under the relevant courses as "Areas of Competence."

Some of the courses do not have areas of competence listed. These courses are important foundation courses for the specialty courses, but the competencies they address were not specifically identified by the advisory committee.

The advisory committee for this study suggested that an internship might be added to the curriculum. The internship is not reflected in the curriculum proposed here, but adding it would equip students with real-world, on-the-job experience that is not possible with training conducted exclusively in classrooms and laboratories. The advisory committee strongly expressed the opinion that such experience, however gained, is essential before a person can be considered thoroughly trained as an intelligent building systems technician.

It should be kept in mind that a fully developed curriculum ready for implementation was not the goal of this study. The curriculum development work accomplished here, however, will provide a foundation and guidelines for further work when a commitment is made to establish such a program.

COURSES IN BASIC CORE

Algebra/Trigonometry (Substitute Applied Math I)

This course is a combination of algebra and trigonometry. The first part is designed to develop and update algebraic skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics covered in this portion include fractions and graphs, exponents, radicals, linear equations, determinants, factoring, quadratics, and various techniques for solutions of equations and systems of equations.

The second part of this course is designed to develop trigonometric skills to enable technicians to solve practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics covered include trigonometric functions of angles, vectors, solutions to oblique triangles, graphs of trigonometric functions, j-operators, inverse functions and logarithms.

Analytic Geometry and Calculus (Substitute Applied Math II)

This course is designed to develop analytic geometry and calculus skills required for technicians to solve practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, optical technologies, and control systems. The calculus portion stresses the importance of rates and summations in technology.

Applied Physics for Technicians

Applied Physics for Technicians meets the needs of technicians by unifying basic concepts of physics into four major systems: mechanical, fluid, electromagnetic, and thermal. Each segment of the course addresses a specific concept and applies it to a variety of problems in each major system. The general pattern of defining, explaining, and demonstrating the application of each unifying concept in the four systems is continued throughout the course.

Technical Communications

Technical Communications provides the student with a knowledge of formats and procedures used in industry and business to communicate technical information to meet a variety of needs. Students learn to describe and document technical processes, operating procedures, and specifications for systems. In addition, students demonstrate technical communication skills by designing a communications flow chart to be used in a vertical management organization.

Areas of Competence

Use verbal communication skills to:

Talk to peers/next-shift engineers about problems with systems or equipment to ensure ongoing maintenance of normal operational situations and emergency maintenance for crisis situations.

Report to supervisors and building managers about current status of all systems and possible future system problems based on observations, log records and experience.

Consult with tenants on the phone and in person about service and maintenance requests/problems.

Provide information to building security and fire department personnel in emergency situations.

Provide assistance to contract service vendors as they perform contract maintenance and repair on building systems and equipment.

Use written communication skills to:

Write understandable and legible documentation of system events in all logs as required.

Document completion of maintenance tasks on preventive maintenance logs.

Write messages and reminders to next-shift operators and technicians to ensure ongoing maintenance.

Document completion of tenant maintenance requests on proper forms.

Computer Basics

This course provides the student with knowledge and skills to use the microcomputer as a tool to monitor processes and solve technical problems typically encountered by technicians. Topics taught include microcomputer architecture, programming concepts, branching, looping, arrays, functions, subroutines, data files, graphics and applications.

Areas of Competence

Operate computer hardware and utilize software capabilities.

Explain how computer monitoring of building systems is accomplished, what information is available, how to use it and how to save that information if it is needed for reference/documentation.

Use the computer to monitor systems and to search and record system information as required to perform job duties.

Report systems information to proper personnel for immediate action and record such data in a log in the correct manner at the appropriate time.

Economics in Technology

This course teaches students how to make economic analyes of plant operations, including equipment installation, upkeep of facilities and equipment, inventory cost and control, contracted and noncontracted labor and services, and estimating costs of specific projects. Through assigned laboratory projects, the student demonstrates the ability to estimate the cost and savings of more efficient methods of producing a product or providing a service in industry or business.

Industrial Relations

This course examines human behavior in the context of organizations and interpersonal relations. It includes leadership, the psychology of organizations and social environments (including labor unions), career development, communications and group processes. Appropriate case problems are reviewed and discussed to provide the student with skills needed to effectively communicate with tenants and customers.

Areas of Competence

Maintain positive customer relations with building tenants.

Establish and maintain good working relationships with peers.

Maintain positive relationships with supervisors and building managers.

Maintain cooperative working relationships with service contract vendors.

COURSES IN TECHNICAL CORE

Fundamentals of Electricity and Electronics (Substitute DC and AC Electricity)

This course provides a foundation in the principles of electricity and magnetism. Theory and laboratory skills learned include basics of electricity and magnetism, electrical charge in motion, DC circuit analysis, AC circuit analysis, magnetic circuits and devices, reactance, and impedance.

Analog Circuits and Active Devices (Substitute Semiconductors)

This course provides the student with a knowledge of the most common circuit applications for analog devices. Amplifiers, oscillators and other circuits employed in industrial measurements and controls are taught, as is the theory of operation behind AM, FM and SSB.

Digital Electronics (Substitute Pulse Digital Electronics and Digital Logic)

This course provides the student with a knowledge of common digital circuits and the skills to install, service, maintain and troubleshoot digital circuits such as multivibrators, counters, shift registers and memories. Students study bus structures and data transmission techniques. They demonstrate the skill of setting up and interfacing systems components.

Industrial Electrical Power and Equipment

This course covers the source, distribution, and use of electrical power in industrial plants. It provides the student with a knowledge of electrical power as it arrives at the plant substation and how to utilize electrical equipment to transform it to useful voltages, distribute it effectively and protect it from overcurrent conditions. Equipment used in training includes transformers, switchgear, fuses, and relays. In addition, the course provides the student with the skill to install, service and troubleshoot electromechanical equipment required to convert electrical power into useful, rotational mechanical energy. Equipment includes AC and DC motors, motor controllers and synchromechanisms.

Areas of Competence

Perform basic tasks such as reading and interpreting blueprints and schematics, identifying common electrical components found in a circuit, making necessary calculations, and safely using basic electrical skills.

Identify the location of electrical distribution centers, controls, panels, transformer locations and have a general knowledge of secondary power distribution in the building.

Troubleshoot, remove and/or replace light switches, bulbs, controls, fixtures and components.

Identify, test and make minor repairs on three-phase circuits.

Test, remove and replace power interrupting devices (fuses and circuit breakers) and properly identify characteristics of and selection criteria for these devices.

Identify equipment and component specifications from a ledger or a print.

Confirm that circuits are properly sized and wired in accordance with a print.

Read a volt ohmmeter, a voltage tester, a phase rotation meter and demonstrate proper use of electrical test equipment and tools.

Determine and record input and output voltage of a transformer.

Install and service electrical heating devices.

Install and service electromechanical valves and devices.

Install, repair and troubleshoot single-phase and three-phase AC motor control circuits and interpret all data on nameplates of the motors.

Test an AC motor for overload and short-circuit conditions and, if needed, remove and replace the motor.

Interpret the transformer nameplate data and demonstrate correctly chosen taps for the voltage needed.

Install and maintain emergency lighting systems, such as infrared systems.

Conduct preventive maintenance on electrical equipment, motors and control systems.

Troubleshoot, repair and/or replace control circuit components, such as time-delay relays, solenoids, pressure switches, limit switches, timers, counters and other common electrical components.

Technical Graphics

This is an introductory course that provides the technician with basic skills and techniques used to communicate information and ideas graphically. Topics include an introduction to freehand sketching, basic drafting techniques and procedures, schematic drawing and computer graphics.

Mechanical and Fluid Power Systems

This course teaches how motion and power can be transferred by either mechanical devices or fluid power systems.

The Mechanical Devices and Systems section of the course is a study of the principles, concepts, and applications of various mechanisms encountered in industrial applications. These mechanisms include belt drives, chain drives, and linkages. This section of the course covers operational principles, uses, maintenance, troubleshooting, and procedures for repair and replacement. The laboratory applications emphasize practical maintenance, equipment installation, and specification and selection of replacement components from manufacturers' catalogs.

The Fluid Power section of this course provides the student with an overview of fluid power technology and a working knowledge of the components used in fluid power circuits. Hydraulic and pneumatic systems are discussed. Topics include fundamentals of fluid dynamics, conventional fluid circuits and fluid power components. Both motion and power can be transferred from one place to another with the proper application of fluid power systems.

Areas of Competence

Mechanical Systems

Troubleshoot, service, remove and replace mechanical components within the philosophy of building management and job description duties.

Operate all mechanical systems and perform system checks.

Identify types of bearings, seals, drives, linkages, valves and other common mechanical components and understand how they are used in mechanical systems.

Remove, replace, service and maintain mechanical equipment with components to include drives, linkages and valves.

Properly assemble, align and adjust mechanical equipment in accordance with manufacturer's specifications.

Pneumatic and Electrical Control Systems

Read and work from fluid power schematics and drawings.

Identify fluid power systems components and the purpose and function of each component.

Troubleshoot, calibrate, remove, repair and/or replace thermostats, valves, solenoids, cylinders, triggering switches and limit switches, actuators, manifolds, tubing, fittings and other components normally found in fluid power systems.

Adjust, maintain and calibrate fluid power systems.

Install, replace, maintain and service pneumatic systems, including compressors, filters, strainers, check valves, flow controls, sequencers, regulators, piping systems and valves.

Service, maintain, remove and replace pneumatic actuators and controls on HVAC systems.

Service and maintain air compressors as required by manufacturer's specifications.

Troubleshoot, repair or replace motors and motor control components as necessary.

Instrumentation and Control

This course introduces the student to the concepts of I&C. Students learn the methods of obtaining the primary data inputs—temperature, pressure, level and flow. The course also covers the basics of automatic process control, the elements of a process control system, signal transmission and time-related functions. The student demonstrates the skills needed to operate and maintain conventional I&C systems as well as closed-loop process control systems.

Computer Applications (Substitute Microprocessors I)

Provides an introduction to the hardware and software architecture of microprocessor systems used in applications of signal processing and control. Specifically, the course covers techniques for both analog and digital and applies these techniques to real-world control problems.

SPECIALTY COURSES

Fundamentals of HVAC Systems

This course provides the student with a thorough knowledge of the design and work cycle of an HVAC system. Attention will be directed toward heating systems (electrical resistance and boilers), refrigeration equipment, air handling systems, and the controls that monitor and regulate these systems. The student will demonstrate the ability to operate an HVAC system, interpret blueprints and schematics and technical data, maintain and interpret computer printouts, perform minor adjustments, calibrations and filter changes, and make other preventive checks as necessary.

Areas of Competence

<u>Sources, Interpretation and Uses of Data and Record Keeping</u>

Read, understand and follow explicit technical data on electrical, electromechanical, pneumatic, HVAC, emergency power, security and life support systems.

Evaluate all systems for proper operation and adjust, calibrate, or perform preventive maintenance according to job description and requirements of preventive maintenance schedule.

Develop and maintain a log (history) on operating performance of specified equipment, calibration, adjustments and repairs performed according to job requirements.

Interpret the maintenance record-keeping system, perform necessary preventive maintenance according to schedule, and properly and accurately record all data necessary to maintain all systems.

Evaluate productivity, assist in purchasing, and assist in performance evaluations as needed.

HVAC Systems

Explain the operation procedures of the HVAC system.

Service and maintain the system to ensure efficient operation.

Explain the refrigeration cycle.

Operation and Maintenance of HVAC Systems

This course is designed to provide the student with the knowledge and skills required to operate, maintain, service, troubleshoot, and balance an HVAC system. The student demonstrates the ability to test, calibrate, adjust, remove, replace and align equipment and components in accordance with manufacturer's specifications. Major areas in this course include cooling systems, evaporators, compressors, condensation, metering devices, lubrication systems and auxiliary components. In addition, the course covers the primary and secondary components of the air handling system, the condensation system, the water treatment system and pumps.

Areas of Competence

Troubleshoot, remove and replace system components as necessary to maintain an effective level of operations as licensure requires.

Perform preventive maintenance, service and repair in accordance with manufacturer's specifications and job requirements in the following areas and on the major components as listed:

Cooling Systems

1. Evaporators
2. Compressors
3. Condensers
4. Metering Devices
5. Basic Lubrication Systems
6. Auxiliary Components

Air-Handling Unit Systems

1. Primary Components
   - (a) Vane axial fans, variable pitch (fixed blade)
   - (b) Squirrel cage, forward- and reverse-curved blades, inlet guide vane systems
2. Secondary Component
   - (a) VAV Systems (Variable Air Volume)
   - (b) Fan-powered mixing boxes
   - (c) Fan coil units

Condensation Drain Systems

1. Compressors
2. Cooling Systems Components

Water Treatment Systems

1. Take samples and record data as prescribed by an applications engineer.
2. Maintain/treat water in cooling and/or heating systems to prevent excessive levels of: corrosion, scaling, and biological growth.

Pump Types and Applications

1. Identify pump types and applications
2. Perform preventive maintenance.
3. Remove, repair, replace and align the following pumps according to manufacturer's specifications:
   - (a) Centrifugal
   - (b) Reciprocating
   - (c) Recirculating
   - (d) Sump
   - (e) Positive Displacement

Energy Management Systems

The Energy Management course provides a broad knowledge base in energy analysis and procedures for auditing building systems, lighting systems, HVAC systems, and auxiliary equipment systems. The course also provides instruction in cost analysis that directly relates to the savings that can be expected from implementation of energy management projects. In addition, the student develops a knowledge and skill base through operating a computer-controlled energy management system and making decisions from collected data.

Safety and Security Systems

The student in this course is provided with a thorough knowledge of security and surveillance systems, emergency power systems, and life support systems. The student learns to operate each system, to read and interpret blueprints and schematics of each system, to test each system, to perform preventive maintenance, to react in emergencies in accordance to codes, laws and policies, and to effectively monitor these systems by computer.

Areas of Competence

Emergency Power and Life Support Systems

Explain the operation of the emergency power system.

Start and run emergency power systems as required by frequency time schedules.

Perform preventive maintenance checks on the system by checking oil levels, battery terminals, cooling level, belts, connections, manual switches and other components as defined in preventive maintenance schedule.

Service and maintain the electrical generation systems as required by manufacturer's specifications and assigned job duties.

Read and interpret all blueprints and schematics involving life support systems, including smoke alarms, sprinkler systems, emergency fire pumps, stairwell pressurized fans, exhaust fans and emergency phone systems.

Service and maintain life support systems according to: the philosophies of building management, state and federal statute requirements, and job description/duty assignments.

Perform visual checks of smoke detector systems, clean and blow out all detectors, and perform preventive maintenance on the system and valves as required.

Security and Surveillance Systems

(Note: Security and surveillance systems are mostly maintained by contracted services.)

Explain the capabilities of the security and surveillance systems and explain how they operate.

Check both audio and visual systems for proper operation.

Test and service the systems as required by preventive maintenance schedules.

Assist contractors who have the primary responsibility for security systems maintenance and repair.

Inspection and Codes

The Inspection and Codes course covers required inspections, pre-inspections, and the frequency of inspection. It also addresses the agencies that are involved in inspection, how to document procedures and how to display inspections and/or licenses. Other areas of instruction include national, state, and local code requirements that describe the manner in which work is to be performed and the certification of personnel performing the work. Students will also learn how properly conducted and documented inspections affect insurance rates and the warranty coverage of facility equipment. Students will also learn how to use and interpret information from code books.

Areas of Competence

Perform all duties and job functions in accordance with codes and license requirements.

Relate inspection procedures and documentation to insurance rates and equipment warranties.

Use and interpret code books.

Communication Systems

This course is designed to provide the student with a knowledge of telecommunications, information systems, and personal communication systems. Students learn how to identify the major components of each system and describe how the system works. Students also learn to service, make minor adjustments to, and troubleshoot a nonfunctional unit in regard to power and cabling. Special emphasis is placed on consideration of interface and proper protection of communication cables when work is being performed or other services are installed.

Areas of Competence

(Note: Communication systems are mostly maintained by service contract.)

Use a working knowledge of the building's information/communication systems to perform basic troubleshooting functions.

Troubleshoot a non-functioning video information terminal to determine if the problem is related to:

- dedicated HVAC system,
- alternate fire protection system,
- power/cable connections,
- software,
- hardware,
- power fluctuation.

APPENDIX A

SURVEY INSTRUMENTS

TRAINING NEEDS SURVEY

BUILDING OWNERS AND FACILITY MANAGERS

The accompanying questionnaires ask for information about building control systems, office automation, and telecommunication services in buildings that your company or organization owns or manages in your metropolitan area.

PLEASE FILL OUT ONLY ONE OF THE ENCLOSED QUESTIONNAIRES.

Complete Questionnaire A if you can respond for ALL BUILDINGS that your company owns in your metropolitan area.

Complete Questionnaire B if you can respond for only ONE BUILDING or ONE COMPLEX of buildings.

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QUESTIONNAIRE A

TRAINING NEEDS SURVEY

Name ____
Position ____
Company or Institution ______________________________________
Address ____
City ____________________ State ____________ Zip ____________

In the space below, please write the name(s) of the building or buildings for which you can answer this questionnaire.

____

____

____

____

____

____

Please complete and mail this questionnaire by May 22.

Center for Occupational Research and Development
601 Lake Air Drive
Waco, Texas 76710

QUESTIONNAIRE A

TRAINING NEEDS SURVEY

____ 1. How many buildings does your company or institution own or manage in your metropolitan area? *(Please write the number in the blank.)*

____ 2. How many of the buildings indicated in question 1 provide telecommunication services to tenants—for example, basic telephone service, long distance service, data lines? *(Please write a number in the blank. Write 0 if the answer is NONE.)*

3. What is your best estimate of the number of additional buildings in your metropolitan area—both new and retrofitted—in which **telecommunication** services will be offered by your company in the time periods listed below. *(Include ONLY the number of buildings in which telecommunications services will BEGIN to be offered in each time period listed.)*

	1988-90	1991-95	1996-2000
Retrofitted buildings			
New buildings			

____ 4. In your metropolitan area, how many buildings owned or managed by your company or institution provide office automation services to tenants—for example, electronic mail, local area networks, data base services? *(Please write a number in the blank. Write 0 if the answer is NONE.)*

____ 5. What is your best estimate of the number of additional buildings in your metropolitan area—both new and retrofitted—in which **office automation** services will be offered by your company or institution in the time periods listed below. *(Include ONLY the number of buildings in which office information services will BEGIN to be offered in each time period listed.)*

	1988-90	1991-95	1996-2000
Retrofitted buildings			
New buildings			

____ 6. In your metropolitan area, how many buildings owned or managed by your company or institution have **computer-controlled, automated building control systems** in areas such as HVAC, lighting, security and fire protection. *(Please write a number in the blank. Write 0 if the answer is NONE.)*

7. How many buildings referred to in question 6 have the specific systems listed below? *(Write the number of buildings in each blank.)*

____ a. Computer-controlled, automated HVAC

____ b. Computer-controlled, automated lighting

____ c. Computer-controlled, automated security

____ d. Computer-controlled, automated fire protection

8. How many of the buildings owned or managed by your company or institution have building control systems that can be characterized by the features listed below. *(Please write the number of buildings in each blank. Each building may be included in more than one blank.)*

____ a. Time-initiated (start/stop) energy controls

____ b. Temperature sensing/monitoring

____ c. Load-initiated building controls

____ d. Programming capability

____ e. Centralized building/complex control center

____ f. Control of building/complex from remote location

____ 9. What is your best estimate of the number of buildings in your metropolitan area—both new and retrofitted—in which computerized, **automated building control systems** will be installed by your company in the time periods listed below. *(Include ONLY the number of buildings in which computerized, automated building control systems will BEGIN operating in each time period listed.)*

	1988-90	1991-95	1996-2000
Retrofitted buildings			
New buildings			

10. How many of the buildings referred to in questions 2, 4, and 6 fall into each of the size categories listed below? *(Please write the number of buildings in each blank.)*

____ a. 0 - 100,000 sq. ft.

____ b. 100,000 - 250,000 sq. ft.

____ c. 250,000 - 500,000 sq. ft.

____ d. 500,000 - 1,000,000 sq. ft.

____ e. Over 1,000,000 sq. ft.

____ 11. What is the total number of building operators/engineers employed full time to work in the buildings referred to in questions 2, 4, and 6?

12. What percent of the building operators/engineers referred to in question 10 work with each type of system listed below? *(Please write the percent of engineers in each blank.)*

____% a. Telecommunication systems

____% b. Office automation systems

____% c. Computer-controlled, automated building control systems

13. Which of the following duties are performed by the engineers referred to in question 10? *(Please check all that apply. Write N/A if this type of duty is not normally performed by engineers.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and equipment

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)*____

14. What percent of total maintenance for each of the types of systems listed below is done by outside vendors or service contractors in buildings owned by your company or institution? *(Please write a percent in each blank. Write N/A in a blank if your company's building(s) do not have the system listed.)*

____ a. Telecommunication systems

____ b. Office automation systems

____ c. Computer-controlled, automated building control systems

15. What are the most important sources for training building operators/engineers to operate and maintain building control systems? *(Rank the sources listed below in order of importance. Rank the most important source number 1.)*

____ a. In-house training or experience

____ b. Short-term vendor training

____ c. Training by professional associations (such as BOMI)

____ d. Armed forces

____ e. High school vocational education

____ f. Two-year colleges/technical schools

____ g. Four-year colleges

____ h. Other *(specify)*______________________________

16. What is the education level of your company's building operators/engineers? *(Please write the percent of engineers in each blank that have attained the stated education level as their HIGHEST education.)*

____% a. Less than high school diploma

____% b. High school diploma

____% c. Associates degree from two-year college or technical school

____% d. Bachelors degree

17. Please rank-order the areas listed below in terms of your building operators'/engineers' training needs. *(Rank the area where the NEED for training is the GREATEST number 1. Write N/A in a blank if the area does not apply at all.)*

____ a. HVAC

____ b. Security systems

____ c. Lighting systems

____ d. Fire protection/life safety systems

____ e. Electrical power/wiring

____ f. Electronic controls

____ g. General computer literacy

____ h. Computer programming

____ i. Control software

____ j. Telecommunications hardware

____ k. Telecommunications software

____ l. Telecommunications signal transmission (hard wire, power-line carrier, radio, microwave, fiber optics)

____ m. Office automation/information systems

____ n. Math

____ o. Communication

____ p. Organization/planning

____ q. Interpersonal relations

____ r. Other *(specify)* ________________________________

Questions 18-24 relate to the following description of a particular type of technician—an intelligent building systems techician:

Intelligent building systems technicians install, repair, troubleshoot, program, and operate automated building-control systems, and they understand how various automated systems interact and interface with each other and with mechanical equipment. They have broad-based electronic and mechanical skills relating to building electrical and mechanical operations, automated building-control systems, and building communication and information technologies. They have a background in computers that includes PC operation, simple communication protocols, methods, and interface requirements. They have a knowledge of HVAC systems, including the basic refrigeration cycle, temperature monitoring and other instrumentation and controls. Intelligent building systems technicians may work independently, under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

18. Are technicians that fit the description above available now? *(Please check the appropriate blank.)*

____ a. Yes, they are commonly available.

____ b. They are available, but not commonly.

____ c. They are rarely available.

____ d. They are not available.

____ 19. What percent of the operators associated with buildings owned by your company or organization fit the description given above of an "intelligent building systems technician?" *(Please write a percent in the blank.)*

20. How well qualified would the technician described above be to operate and maintain buildings that have computer-controlled, automated systems? *(Please check the appropriate blank.)*

____ a. Very well qualified

____ b. Moderately qualified

____ c. Moderately poorly qualified

____ d. Very poorly qualified

21. Does your company presently hire—or would it hire if they were available—"intelligent building systems technicians" described on the previous page? *(Please check the appropriate blank.)*

____ a. Yes

____ b. No

____ c. Maybe

22. If your company hired "intelligent building systems technicians," which of the following duties would they perform? *(Pleasc check all that apply. Write N/A if this type of duty would not be performed by technicians.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and equipment

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)*________________ ______________________________

23. How would you aad to or modify the description of "intelligent building systems technician" to describe a better qualified technician? *(Please write your suggestions in the blanks below.)*

____

____

____

____

24. If you would be interested in hiring "intelligent building systems technicians," please estimate to the best of your ability the TOTAL number of such technicians that your building or company would employ by each of the following years. *(Please write a number in each blank.)*

____ a. 1988

____ b. 1990

____ c. 1995

____ d. 2000

QUESTIONNAIRE B

TRAINING NEEDS SURVEY

Name ______________________________

Position ______________________________

Company or Institution ______________________________

Name of Building or Complex ______________________________

Address ______________________________

City ____________________ State __________ Zip __________

Please complete and mail this questionnaire by May 22.

Center for Occupational Research and Development
601 Lake Air Drive
Wacc, Texas 76710

QUESTIONNAIRE B

TRAINING NEEDS SURVEY

1. Does your building or complex have computer-controlled, automated building control systems in areas such as HVAC, lighting, security and fire protection? *(Please check the appropriate blank below.)*

____ a. Yes

____ b. No

2. If you answered NO to question number 1, please complete the following statement by checking the item that most closely reflects your opinion.

My building or complex will probably have computer-controlled, automated building control systems by—

____ a. 1990

____ b. 1995

____ c. 2000

____ d. Never

3. If you answered YES to question 1, please check the specific building control systems listed below that are in your building or building complex. *(Please check all that apply.)*

____ a. Computer-controlled, automated HVAC

____ b Computer-controlled, automated lighting

____ c. Computer-controlled, automated security

____ d. Computer-controlled, automated fire protection/life safety

4. Which of the features listed below are incorporated into your building control systems? *(Please check all that apply.)*

____ a. Time-initiated (start-stop) energy controls

____ b. Temperature sensing/monitoring

____ c. Event-initiated building controls

____ d. Programming capability

____ e. Centralized building/complex control center

____ f. Control of building/complex from remote location

5. Does your building or building complex provide telecommunication services to tenants—for example, basic telephone service, long distance service, data lines? *(Please check the appropriate blank.)*

____ a. Yes

____ b. No

6. If you answered NO to question number 5, please complete the following statement by checking the item that most closely reflects your opinion.

My building or complex will probably offer telecommunication services to tenants by—

____ a. 1990

____ b. 1995

____ c. 2000

____ d. Never

7. Does your building or building complex provide office automation services to clients—for example, electronic mail, local area networks, data base services? *(Please check the appropriate blank below.)*

____ a. Yes

____ b. No

8. If you answered NO to question number 7, please complete the following statement by checking the item that most closely reflects your opinion.

My building or complex will probably offer office automation services to tenants by—

____ a. 1990

____ b. 1995

____ c. 2000

____ d. Never

9. What is the square footage of your building or complex? *(Please check the appropriate size category below.)*

____ a. 0 - 100,000 sq. ft.

____ b. 100,000 - 250,000 sq. ft.

____ c. 250,000 - 500,000 sq. ft.

____ d. 500,000 - 1,000,000 sq. ft.

____ e. Over 1,000,000 sq. ft.

____ 10. What is the total number of building operators/engineers employed full time to work in your building? *(Please write the number of engineers in the blank.)*

11. What percent of the building operators/engineers referred to in question 10 work with each of type of systems listed below? *(Please write the percent of engineers in each blank.)*

____% a. Telecommunication systems

____% b. Office automation systems

____% c. Computer-controlled, automated building control systems

12. Which of the following duties are performed by the engineers referred to in question 10? *(Please check all that apply. Write N/A if this type of duty is not normally performed by technicans.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and equipment

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)*____________________________________

13. What percent of total maintenance of each of the types of systems listed below is done by outside vendors or service contractors for your building or building complex? *(Please write a percent in each blank. Write N/A in a blank if your building or complex does not have the system listed.)*

____ a. Telecommunication systems

____ b. Office automation systems

____ c. Computer-controlled, automated building control systems

14. What are the most important sources for training building operators/engineers to operate and maintain building systems? *(Rank the sources listed below in order of importance. Rank the most important source number 1.)*

____a. In-house training or experience

____b. Short-term vendor training

____c. Training by professional associations (such as BOMI)

____d. Armed forces

____e. High school vocational education

____f. Two-year colleges/technical schools

____g. Four-year colleges

____h. Other *(specify)*______________________________

15. What is the education level of your company's building operators/engineers? *(Please write the percent of operators in each blank that have attained the stated education level as their highest education.)*

____% a. Less than high school diploma

____% b. High school diploma

____% c. Associate's degree from two-year college or technical school

____% d. Bachelor's degree

16. Please rank-order the areas listed below in terms of your building operator/engineers' training needs. *(Rank the area where the NEED for training is the GREATEST number 1. Write N/A in a blank if the area does not apply at all.)*

____ a. HVAC

____ b. Security systems

____ c. Lighting systems

____ d. Fire protection/life safety systems

____ e. Electrical power/wiring

____ f. Electronic controls

____ g. General computer literacy

____ h. Computer programming

____ i. Control software

____ j. Telecommunications hardware

____ k. Telecommunications software

____ l. Telecommunications signal transmission (hard wire, power-line carrier, radio, microwave, fiber optics)

____ m. Office automation/information systems

____ n. Math

____ o. Communication

____ p. Organization/planning

____ q. Interpersonal relations

____ r. Other *(specify)* ____

Questions 17-23 relate to the following description of a particular type of technician—an intelligent building systems technician:

Intelligent building systems technicians install, repair, troubleshoot, program, and operate automated building-control systems, and they understand how various automated systems interact and interface with each other and with mechanical equipment. They have broad-based electronic and mechanical skills relating to building electrical and mechanical operations, automated building control systems, and building communication and information technologies. They have a background in computers that includes PC operation, simple communication protocols, methods, and interface requirements. They have a knowledge of HVAC systems, including the basic refrigeration cycle, temperature monitoring, and other HVAC intrumentation and controls. Intelligent building systems technicians may work independently, under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

17. Are technicians that fit the description above available now? *(Please check the appropriate blank.)*

____ a. Yes, they are commonly available.

____ b. They are available, but not commonly.

____ c. They are rarely available.

____ d. They are not available.

____ 18. What percent of the operators/engineers associated with your building or complex fit the description given above of an "intelligent building technician?" *(Please write a percent in the blank.)*

19. How well qualified would the technician described above be to operate and maintain buildings that have computer-controlled, automated systems? *(Please check the appropriate blank.)*

____ a. Very well qualified

____ b. Moderately qualified

____ c. Moderately poorly qualified

____ d. Very poorly qualified

20. Do you presently hire—or would you hire if they were available—"intelligent building systems technicians" described on the previous page? *(Please check the appropriate blank.)*

____ a. Yes

____ b. No

____ c. Maybe

21. If your company hired "intelligent building systems technicians," which of the following duties would they perform? *(Please check all that apply. Write N/A if this type of duty would not be performed by technicians.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and instrumentation

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)*____

22. How would you add to or modify the description of "intelligent building systems technician" to describe a better qualified technician? *(Please write your suggestions in the blanks below.)*

____

____

____

23. Please estimate to the best of your ability the TOTAL number of positions for "intelligent building system technicians" that might exist in your building or complex, if such technicians were readily available, by the years indicated below. *(Please write a number in each blank.)*

____ a. 1988

____ b. 1990

____ c. 1995

____ d. 2000

TRAINING NEEDS SURVEY 2

Name ____

Position ____

Company or Institution ______________________________

Name of Building or Complex __________________________

Address ____

City ______________________ State ______________ Zip ____________

Please complete and mail this questionnaire by May 22.

Center for Occupational Research & Development
601 Lake Air Drive
Waco, Texas 76710

TRAINING NEEDS SURVEY 2

1. Are any of the following technologies or services incorporated into the building or building complex for which you hold responsibility? *(Check all that apply.)*

____ a. Telecommunications (for example, basic telephone service, long distance service, data lines)

____ b. Office automation (such as electronic mail, local area networks)

____ c. Computer-controlled, automated HVAC

____ d. Computer-controlled, automated lighting

____ e. Computer-controlled, automated security

____ f. Computer-controlled, automated fire protection/life safety

____ g. None of the above systems are incorporated

2. Which of the features below are incorporated into your building control systems? *(Please check all that apply.)*

____ a. Time-initiated (start-stop) energy controls

____ b. Temperature sensing/monitoring

____ c. Load-initiated building controls

____ d. Programming capability

____ e. Centralized building/complex control center

____ f. Control of building/complex from remote location

3. What is the square footage of your building or complex? *(Please check the appropriate size category below.)*

____ a. 0 - 100,000 sq. ft.

____ b. 100,000 - 250,000 sq. ft.

____ c. 250,000 - 500,000 sq. ft.

____ d. 500,000 - 1,000,000 sq. ft.

____ e. Over 1,000,000 sq. ft.

____ 4. What is the total number of building operators/engineers employed full time to work in your building or complex? *(Please write the number of engineers in the blank.)*

5. What percent of the building operators/engineers referred to in question 4 work with each of the types of systems listed below? *(Please write the percent of engineers in each blank.)*

____ a. Telecommunications systems

____ b. Office automation systems

____ c. Computer-controlled, automated building control systems

6. Which of the following duties are performed by the engineers referred to in question 4? *(Please check all that apply. Write N/A if this type of duty is not normally performed by engineers.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and instrumentation

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)* ________________________________

7. What percent of total maintenance of each of the types of systems listed below is done by outside vendors or service contractors for your building or complex? *(Please write a percent in each blank. Write N/A in a blank if your building or complex does not have the system listed.)*

____ a. Computer-controlled, automated building-control systems

____ b. Telecommunication systems

____ c. Office automation systems

8. What are the most important sources for training building operators/engineers to operate and maintain building systems? *(Rank the sources listed below in order of importance. Rank the MOST IMPORTANT source number 1.)*

____ a. In-house training or experience

____ b. Short-term vendor training

____ c. Training by professional associations (such as BOMI)

____ d. Armed forces

____ e. High school vocational education

____ f. Two-year colleges/technical schools

____ g. Four-year colleges

____ h. Other *(specify)*: ____

9. What is the education level of your company's building operators/engineers? *(Please write the percent of operators in each blank that have attained the stated education level as their HIGHEST education.)*

____ a. Less than high school diploma

____ b. High school diploma

____ c. Associate's degree from two-year college or technical school

____ d. Bachelor's degree

10. Please rank-order the areas listed below in terms of your building operators'/engineers' training needs. *(Rank the area where the NEED for training is the GREATEST number 1. Write N/A in a blank if the area does not apply at all.)*

____ a. HVAC

____ b. Security systems

____ c. Lighting systems

____ d. Fire protection/life safety systems

____ e. Electrical power/wiring

____ f. Electronic controls

____ g. General computer literacy

____ h. Computer programming

____ i. Control software

____ j. Telecommunications hardware

____ k. Telecommunications software

____ l. Telecommunications signal transmission (hard wire, power-line carrier, radio, microwave, fiber optics)

____ m. Office automation/information systems

____ n. Math

____ o. Communication

____ p. Organization/planning

____ q. Interpersonal relations

____ r. Other *(specify)*______________________________

Questions 11-17 relate to the following description of a particular type of technician—an intelligent building systems technician:

Intelligent building systems technicians install, repair, troubleshoot, program, and operate automated building-control systems, and they understand how various automated systems interact and interface with each other and with mechanical equipment. They have broad-based electronic and mechanical skills relating to building electrical and mechanical operations, automated building control systems, and building communication and information technologies. They have a background in computers that includes PC operation, simple communication protocols, methods, and interface requirements. They have a knowledge of HVAC systems, including the basic refrigeration cycle, temperature monitoring, and other HVAC instrumentation and controls. Intelligent building systems technicians may work independently, under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

11 Are technicians that fit the description above available now? *(Please check the appropriate blank.)*

____ a. Yes, they are commonly available.

____ b. They are available, but not commonly.

____ c. They are rarely available.

____ d. They are not available.

____ 12. What percent of the operators/engineers associated with your building or complex fit the description given above of an "intelligent building systems technician?" *(Please write a percent in the blank.)*

13. How well qualified would the technician described above be to operate and maintain buildings that have computer-controlled, automated systems? *(Please check the appropriate blank.)*

____ a. Very well qualified

____ b. Moderately qualified

____ c. Moderately poorly qualified

____ d. Very poorly qualified

14. Does your company presently hire—or would it hire if they were available—"intelligent building systems technicians" as described on the previous page? *(Please check the appropriate blank.)*

____ a. Yes

____ b. No

____ c. Maybe

15. If your company hired "intelligent building systems technicians," which of the following duties would they perform? *(Please check all that apply. Write N/A if this type of duty would not be performed by technicians.)*

____ a. Inspection of system devices and instrumentation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Monitoring of computerized controls and instrumentation

____ f. Programming automated systems

____ g. Training

____ h. Other *(specify)* ____

16. How would you add to or modify the definition of "intelligent building systems technician" to describe a better qualified technician? *(Please write your suggestions in the space below.)*

____

____

____

17. Please estimate to the best of your ability the TOTAL number of positions for "intelligent building systems technicians" that might exist in your building or complex, if such technicians were readily available, by the years indicated below. *(Please write a number in each blank.)*

____ a. 1988

____ b. 1990

____ c. 1995

____ d. 2000

TRAINING NEEDS SURVEY 3

Name ____

Position ____

Company ____

Address ____

City ______________________ State ____________ Zip ______________

Please complete and mail this questionnaire by May 22.

Center for Occupational Research & Development
601 Lake Air Drive
Waco, Texas 76710

TRAINING NEEDS SURVEY 3

1. Indicate the category that best describes the business of your company. *(Please check the appropriate blank.)*

____ a. Manufacturer

____ b. Vendor/supplier/dealer

____ c. Consultant/designer

____ d. Contractor for service/installation/maintenance

____ e. Other *(specify)*____

2. Please check any of the following types of products that your company makes, distributes, or services. *(Check all that apply.)*

____ a. Computer-controlled, automated HVAC systems

____ b. Computer-controlled, automated lighting systems

____ c. Computer-controlled, automated security systems

____ d. Computer-controlled, automated fire protection/life safety systems

____ e. Telecommunication systems related to building controls

____ f. Office automation systems

____ g. Telecommunication systems and/or services (data/voice communications not necessarily related to building controls)

____ h. Other *(specify)*____

____ 3. What is the total number of technicians employed by your company who work with one or more of the building systems listed in question 2? *(Please write a number in the blank.)*

4. What percent of the technicians referred to in question 3 work with each of the types of systems listed below? *(Please write the percent of technicians in each blank. Write N/A in a blank if your company is not active in an area listed.)*

____ a. Building control systems

____ b. Telecommunications

____ c. Office automation/information systems

5. Which of the following duties are performed by the technicians referred to in question 3? *(Please check all that apply. Write N/A if this type of duty is not normally performed by technicians.)*

____ a. Installation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Programming automated systems

____ f. Training

____ g. Sales

____ h. Other *(specify)* ____

6. If your company is involved with the types of intelligent systems listed in question 2, what are the most important sources for training technicians to work on those systems? *(Rank the sources listed below in order of importance. Rank the most important source number 1. Skip this question if none of the systems apply to your company.)*

____ a. In-house training or experience

____ b. Short-term vendor training

____ c. Training by professional associations (such as BOMI)

____ d. Armed forces

____ e. High school vocational education

____ f. Two-year colleges/technical schools

____ g. Four-year colleges

____ h. Other *(specify)*________________________________

7. What is the educational level of your company's technicians? *(Please write the percent of technicians in each blank that have attained the stated education level as their HIGHEST education.)*

____ a. Less than high school diploma

____ b. High school diploma

____ c. Associate's degree from two-year college or technical school

____ d. Bachelor's degree

8. Please rank-order the areas listed below in terms of your technicians' training needs. *(Rank the area where the NEED for training is the GREATEST number 1. Write N/A in a blank if the area does not apply at all.)*

____ a. HVAC

____ b. Security systems

____ c. Lighting systems

____ d. Fire protection/life safety systems

____ e. Electrical power/wiring

____ f. Electronic controls

____ g. General computer literacy

____ h. Computer programming

____ i. Control software

____ j. Telecommunications hardware

____ k. Telecommunication software

____ l. Telecommunications signal transmission (hard wire, power-line carrier, radio, microwave, fiber optics)

____ m. Office automation/information systems

____ n. Math

____ o. Communication

____ p. Organization/planning

____ q. Interpersonal relations

____ r. Other *(specify)*____

Questions 9-15 relate to the following definition of a particular type of technician—an intelligent building systems technician:

Intelligent building systems technicians install, repair, troubleshoot, program, and operate automated building-control systems, and they understand how various automated systems interact and interface with each other and with mechanical equipment. They have broad-based electronic and mechanical skills relating to building electrical and mechanical operations, automated building-control systems, and building communication and information technologies. They have a background in computers that includes PC operation, simple communication protocols, methods, and interface requirements. They have a knowledge of HVAC systems, including the basic refrigeration cycle, temperature monitoring, and other HVAC instrumentation and controls. Intelligent building systems technicians may work independently, under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

9. Are technicians that fit the definition of "intelligent building systems technician" available now? *(Please check the appropriate blank.)*

____ a. Yes, they are commonly available.

____ b. They are available, but not commonly.

____ c. They are rarely available.

____ d. They are not available.

____ 10. What percent of the total technician staff of your company fits the description of an "intelligent building systems technician" given above? *(Please write the percent in the blank.)*

11. How well qualified would the technician described above be to perform the duties required of technicians by your company? *(Please check the appropriate blank.)*

____ a. Very well qualified

____ b. Moderately qualified

____ c. Moderately poorly qualified

____ d. Very poorly qualified

12. Does your company presently hire—or would it hire if they were available—"intelligent building systems technicians," as they are described on the previous page? *(Please check the appropriate blank.)*

____ a. Yes

____ b. No

____ c. Maybe

13. If your company hired "intelligent building systems technicians," which of the following duties would they perform? *(Please check all that apply. Write N/A if this type of duty would not be performed by technicians.)*

____ a. Installation

____ b. Service, preventive maintenance

____ c. Troubleshooting

____ d. Repair

____ e. Programming automated systems

____ f. Training

____ g. Sales

____ h. Other *(specify)* ________________________________

14. How would you add to or modify the description of "intelligent building systems technician" to describe a better qualified technician? *(Please write your suggestions in the space below.)*

____

____

____

15. If your company would be interested in hiring "intelligent building systems technicians," please estimate to the best of your ability the TOTAL number of such technicians your company would employ by each of the following years. *(Please write a number in each blank.)*

____ a. 1988

____ b. 1990

____ c. 1995

____ d. 2000

APPENDIX B

LETTERS ACCOMPANYING SURVEY INSTRUMENTS

May 11, 1987

Dear Sir or Madam:

Please take a few minutes of your time to help postsecondary education in Texas by completing the enclosed questionnaire.

This questionnaire is part of a study that is sponsored by the Coordinating Board of Texas Higher Education. The goal of the study is to determine the need for a curriculum for training technicians and building operators to install, operate, and maintain computerized, automated building systems. The study includes surveys targeted to building owners and managers, building engineers, vendors, manufacturers and consultants. All findings of the study will be reviewed and assessed by an advisory committee comprised of experts in the field.

This study is being managed and conducted by The Center for Occupational Research and Development, a nonprofit organization that helps two-year postsecondary institutions assess needs and develop curricula in areas of new and emerging technologies.

By taking the time to complete this questionnaire, you will provide a valuable service to both Texas education and the businesses and industries that may employ the technicians trained in the proposed curriculum.

Please complete and return the questionnaire in the enclosed envelope by May 22.

Thank you.

Sincerely,

Ron Thomson
Project Manager

RT/pt
Enclosure

June 3, 1987

Dear Sir or Madam:

We are sending you the questionnaire on training needs for building systems for the second time. What is learned in this study will become the basis for training programs that are implemented by Texas community colleges, so your response is very important.

Please take the time now to complete this questionnaire.

This study is sponsored by the Coordinating Board of the College and University System in Texas and is being carried out by the Center for Occupational Research and Development, a nonprofit educational service organization that works with two-year postsecondary schools in assessing needs and developing curricula for new technologies.

Please return the questionnaire in the enclosed envelope by June 19.

Your cooperation is appreciated.

Sincerely,

Ron Thomson
Project Manager

RT/pt
Enclosure

APPENDIX C

COMMENTS FROM SURVEY ABOUT DEFINITION OF "INTELLIGENT BUILDING SYSTEMS TECHNICIAN"

Survey respondents answered the question, "How would you add to or modify the description of 'intelligent building systems technician' to describe a better qualified technician?" All comments are listed below.

The definition is complete.

Unless qualified by City of Houston Stationary Engineers License, we could not hire them.

The description is sufficient. I think you need to find a better title than "intelligent building systems technician." I can't offer any suggestions. I have a problem with "intelligent buildings" portion of your title.

Same—plus some emphasis on plumbing and electrical knowledge.

Ability to design systems, help design engineers.

Some mechanical repair expertise.

Capable of relating to customers' problems with determination to "fix the problem." Capable and willing to communicate effectively with customers and management.

Appears to be comprehensive as defined.

Walks on water.

Building maintenance manager or building cost control manager.

I might modify the definition to the following, "certified building system technician."

For our plant, he must troubleshoot and repair production machinery also.

Strong instrumentation skills for installation and design.

I would not add or subtract from the definition.

They must have good people skills (communication) to aid various departments that they would serve.

Before completion of training they are required to serve an apprenticeship in a building under the direct supervision of an operating or chief engineer.

Must possess a high degree of commitment, large measure of common sense and above average motivating factor.

For large building complex you hire electricians, plumbers, carpenters, control technicians and building technicians, not just building technicians.

Must have the personality to deal with a broad scope of other personalities and within the full spectrum of educational achievement, from grade school level to holders of doctorate degree.

Environmental systems technician.

Must know basic control theory, i.e. difference between proportional control and proportional plus integral control.

In our institution only one man of this caliber would be required—he would supervise a crew of 6 to 8 to service equipment.

More apprenticeship programs—more co-op programs. Reinstall draft.

These people would be good for building operations, but would have to be more diversified to fit into building operations.

The technician needs good interpersonal skills and skills in organization and administration. Also, he needs communication skills.

They must communicate with less trained workers and with administrators. Neither of whom understands the technician's job.

Existing definition already provides for a high standard in this field.

"May work under the supervision of an engineer or maintenance manager/supervisor." (Delete "member of team" or reference to supervising others.)

In-house training.

They must be patient and willing to do "hands on" repair.

Need to know HVAC, plumbing, electrical to be well rounded for use in small complexes. Your description makes them channeled in one area. Multi-skill is the way of the future.

Building and grounds service department.

Teach them basics at school and let industry, with OJT, train them for particular systems.

The description does not need to include computer programming but be able to input info and read out data from a menu.

Seems adequately covered.

Should work well with and relate well to other people.

Looks fairly descriptive as is.

Boiler and pneumatic controls training.

Hospital needs require special training on life support type equipment.

Mechanical ability to make minor repairs to HVAC equipment.

In addition to your description, add interpersonal communication and relations.

Suggest he have knowledge of life safety systems—fire and escape.

He would also do HVAC troubleshooting and repair from time to time as there wouldn't be a full time job on the "intelligent building system."

Basic and advanced computer training.

Description seems adequate to me.

Knowledgeable in contract administration and interface with contractors.

No matter how intelligent the technician, he must make some policy regarding use/abuse of systems.

A GOOD COMMUNICATOR.

Building automation services.

They would also have to be "hands-on" worker involved in general daily operations of building.

They should be capable of troubleshooting and repairing high voltage equipment including 12,000 kva, 480 and UPS systems.

Plumbing, motor repair skills, general mechanical abilities

Are able to easily communicate in nontechnical terms to administrative personnel and problems or situations.

Working for someone else, making $40,000 - $60,000 a year. [Too costly.]

Must be able to communicate with all levels of people on a daily basis and be even-tempered and courteous.

"Certified building system technician."

They must have good communication and people management skills.

Grade I Building Engineer.

Tenant relations/customer relations; communication skills; prioritizing work.

I would not add to or modify the description.

Add Grade I, II, III to description.

"Proficient," "intelligent," "skilled" in these and other language translates "technician." Possibly want to shorten description to only use "Building Systems Technician" (not to be repetitious).

Communication skills

Change basic to working knowledge.

Maintain all systems' preventive maintenance program.

Management of time skills.

Tenant relations is very important asset in all applicants we consider for hire.

Must be willing to continue with education and remain on top of current information in the computer field. Must know the comfort control levels which deals with tenant relations.

Need more HVAC capability.

The technician described usually is employed by one of the control vendors and is interested only in the controls area; therefore, he is not very likely to stay interested in the day-to-day operation and maintenance for which he would be held partially responsible.

HVAC needs to include chillers and cooling towers as well as freon type systems.

Interpersonal relations (communications).

Hands on extensive experience in maintenance.

Actual control programming varies greatly from manufacturer to manufacturer; however, the control loop theory is the same. Therefore, a thorough knowledge of control systems and a basic understanding of computer/microprocessor operations will prove to be more applicable than actual programming ability.

Broad knowledge of energy (heat recovery) conservation HVAC systems. Should attend local ASHRAE meetings.

I would not call him a "technician," I would try to classify him as an "engineer" or "plant engineer."

Sentence 1 of the definition should continue: "as well as be able to operate and maintain all other building systems, eg., condenser, chilled and domestic water systems, construction and preventative maintenance programs (restroom fixtures, chillers, boilers, cooling tower, air handler units, etc.)."

More mechanical system knowledge, not necessarily mechanical component knowledge.

Add LCCBA.

Actual design of systems.

Should have computer background and control applications background. Good general knowledge of building electrical, HVAC and security systems.

Also, responsible for accurate documentation and input to the training function provided to the end user.

One who can also manage and motivate personnel.

Be able to explain problems to customers.

An understanding of system balanced operation and just what it took to obtain it, and what a modification to the "system" balance means to overall balance of system.

OJT

Process control applications

Marketing skills, salesmanship

APPENDIX D

LIST OF INTELLIGENT BUILDINGS IN TEXAS

This list of intelligent buildings in Texas was compiled using the Urban Land Institute's nationwide list and buildings mentioned by members of the advisory committee. This list should not be considered complete or definitive.

AUSTIN

Austin Centre
Arboretum
First City Center
Littlefield Building
One American Center
Republic Plaza
San Jacinto
100 Congress
301 Congress

DALLAS

Allied Bank Tower
Centrum
The Crescent
Cityplace
Colonade Complex
Concord Center
Dallas Galleria
Infomart of Dallas
Interfirst Plaza
Las Colinas
Lincoln Center
Lincoln Plaza
LTV Center
One McKinney Plaza
One Spectrum Center
Park Central
San Jacinto Tower
Stanford Corporate Center
Texas Commerce Bank—Irving
Trans Texas Tower
Union Bank
Valley Ranch
Waterside Commons
Williams Square
88 North Central Expressway
10100 North Central Expressway

HOUSTON

Greenway Plaza
Heritage Plaza
Tower 800
UnitedBank Plaza

SAN ANTONIO

Texas Teleport

APPENDIX E

INTELLIGENT BUILDING ORGANIZATIONS

The International Intelligent Buildings Association, Inc.

1815 H. Street, NW
Washington, DC 20006
(202) 296-6301

The International Intelligent Buildings Association (IIBA) is a worldwide federation of architects, engineers, trade associations, building developers, and service providers who are affected by and interested in the intelligent buildings industry. IIBA is a not-for-profit trade association open to all such organizations and individuals in all countries. Its mission is to serve the multiplicity of disciplines that foster and promote the intelligent building concept that buildings should be more attuned to the specific needs of prospective tenants and should serve both occupants and owners profitably.

Intelligent Buildings Institute

2101 L Street, NW, Suite 300
Washington, DC 20037
(202)457-8477

The Intelligent Buildings Institute is a not-for-profit professional association serving all sectors of the intelligent buildings community, domestic and international, with a broad spectrum of programs. Activities include collecting and disseminating marketing information and promotion, developing guidelines and standards for implementing intelligent building technologies, and assuming advocacy roles on legislative and regulatory actions that have an impact on the intelligent building industry. Members of IBI come from every segment of the intelligent buildings community.

Intelligent Buildings Institute Foundation

The Intelligent Buildings Institute Foundation is the educational and scientific partner of the Intelligent Buildings Institute, organized to undertake research and educational programs beyond the scope of the Institute itself.

APPENDIX F

ANNOTATED BIBLIOGRAPHY

Books, Pamphlets and Reports

Jones Lang Wootcn Investment and Corporate Real Estate Services. *Intelligent Buildings*. New York: May 1986.

The Jones Lang Wootton report on intelligent buildings provides a qualitative description of the intelligent building industry and a quantitative analysis of leasing data for intelligent buildings. Using the Urban Land Institute's list of the nation's 125 major planned and existing intelligent buildings, JLW gathered data on 37 of these buildings, selected because they were in cities in which JLW operates. Nineteen of the cities sampled were in the Washington, DC area. JLW reported that intelligent office buildings are not necessarily leasing faster than ordinary buildings of the same size, age, quality and location and are no less prone to rising vacancy rates. JLW determined that only 50% of tenants in the buildings sampled subscribe to the shared services offered.

Thomas Cross and Michelle Gouin. *Intelligent Buildings*. Homewood, IL: Dow Jones-Irwin, 1986.

This is a guide to intelligent buildings aimed primarily at the business audience unfamiliar with the subject. It includes information about building control systems, but the emphasis is on information and telecommunications technologies. The book's strong point is that it compiles a lot of information about technology enhancements. Its weak points are the somewhat confusing organization of topics and the inclusion of some "hype."

IBIS I and *IBIS II*. Boulder, CO: Cross Information Company.

These two reports are directed to building developers and owners, and they overwhelmingly emphasize the telecommunications side of intelligent buildings. Out of 101 sections, only three are devoted to environmental and energy control systems. Only the table of contents of these reports could be obtained for review.

Gerald Davis, Franklin Becker, Francis Duffy, William Sims. *ORBIT-2*. Norwalk, CT: Harbinger Group Inc., 1987

This study of Organizations, Buildings and Information Technology, focuses on two central issues:

- What kind of offices cope best with organizational change, which is often inextricably intertwined with the use of increasingsly sophisticated information technology?

- What strategy to manage facilities will yield their full potential, now and in future years?

The *Orbit-2* study documents the organizational trend in many businesses and industries from low-change, routine work to high-change, nonroutine work. The study also points out the changing nature of new information technologies. The need for flexible, cooperative and knowledgeable facilities management is emphasized.

"Intelligent Building Definition," *Guideline*, First Edition. Washington, DC: Intelligent Building Institute.

This pamphlet provides a comprehensive definition of "intelligent building" and discusses the characteristics of such buildings. The definition encompasses four elements of buildings: building structure, building systems, building services, and building management. In addition to defining "intelligent building," the pamphlet describes a methodology that prospective building occupants can use to evaluate building intelligence relative to their needs. A glossary of terms commonly used in the intelligent building industry is also included.

"Modernization 1987," Special Issue of *Buildings*, June 1987.

This special issue examines the modernization of older buildings from many perspectives and showcases award winning modernized structures. In 1987, for the first time ever, more commercial construction dollars are projected to be spent on modernizing older buildings than in constructing new ones. Reporting on where modernization dollars are spent, the magazine reveals that energy conservation continues to be a big concern and that systems such as HVAC, lighting, and energy management are among those products most commonly incorporated into modernized buildings.

Dean Schwanke. *Smart Buildings and Technology-Enhanced Real Estate*, Volumes I and II. Washington, DC: The Urban Land Institute, 1985.

This clear and comprehensive report provides an excellent overview of the intelligent building industry. The advances both in building systems automation and in telecommunications are covered at a level that gives insight into the technological aspects without loading the lay reader with mystifying jargon or specifications. The participation of the various parties involved in the industry—including developers, entrepreneurs, and regulatory agencies—is explained clearly. The market forces and the current state of the industry are described without hype or glamorization. Ten case histories of intelligent buildings provide the reader with an appreciation of the variety and complexity within the smart building industry. There is no attempt to make definite predictions concerning the market, but the reader is left with the notion that shared tenant services and smart building systems can be sold and implemented successfully, especially when the project is planned knowledgeably and marketing and services are adequate. The industry is presented as fluctuating and likely to experience further change and growth.

Volume II is a compendium of project profiles of smart buildings all over the country. The profiles are much shorter than the case histories of Volume I, but they give basic information such as location, square footage, developer, service provider, completion date, and telephone numbers.

Vine, Edward L. *Report on Energy Management Practices* (in progress). Berkeley, CA: Lawrence Berkeley Laboratory, University of California.

The Building Energy Systems group at LBL is surveying schools and hospitals across the country to determine their energy management practices, including the use of intelligent systems for energy control. Their report will be available in the third quarter of 1987 and will enter the public domain. At the time of CORD's search, their data was in but had not undergone complete analysis. However, upon request, they extracted data concerning the number of hospitals that have installed computerized HVAC and lighting controls.

ARTICLES

Alan B. Abramson, P.E., and Anthony P. Nuciforo. "Upgrading to the Technologies of the '80s: Security," *Specifying Engineer*, August 1984.

Designing a system for an existing building requires a thorough survey of the facility, including location of operable windows, different types of walls and ceilings, mechanical shafts and conduits, etc. A security philosophy should then be developed by owners/managers and architects/engineers, considering factors such as business functions, hours and traffic patterns. A decision is made concerning the type of security system suitable for retrofit. The system chosen may be a local alarm system (alarm sounds in vicinity), a proprietary alarm system (relay to remote security center), or a central station alarm system (relay to outside agency). Signal transmission may be hard-wired (each monitored point has dedicated wires), multiplexed (each monitored point has an electronic address along a data trunk cable) or wireless; hard-wired and multiplexed are generally considered more reliable, and each has its advantages.

James Carlini. "Cabling: a hidden asset," *Network World*, March 24, 1986.

Cabling distribution has become a critical concern for tenant telecommunications managers and property managers in multitenant facilities. The responsibility for vertical distribution of cabling rests upon the property manager. Horizontal cabling capabilities must be considered by end users. Management needs to assess what is in place in the total cabling distribution, establish a cable management software package, and establish a long-term plan for the evolution of the current cabling system.

Carlini & Associates, Inc. "Cabling Issues When Leasing Space," *Business Communications Review*, March-April 1987.

Inside wiring has become the responsibility of property managers and building owners. Often they are inheriting the cabling errors, poor record keeping, misuse and mismanagement of the regional operating companies and tenants who formerly controlled the wire closets. Managers are advised to assess the wiring needs of their organizations, starting now, because "tomorrow will be twice as bad."

James Carlini. "Shared Services—Management Perspective," *Network World*, May 26, 1986

In this interview, Stephen P. Duerkop, senior group vice president in charge of the Western Group of JMB Property Management Division, offers the real estate perspective on shared tenant services. He feels that the shared tenant services concept should be applied with the practical needs of tenants in mind rather than for the sake of technology or as a marketing tool. He emphasizes the need to evaluate vendors of communications services to find the vendor whose business needs and service orientation match the needs of the property owner.

James Carlini. "Shared Services New to Tenants," *Real Estate*, No. 17, September 6, 1985

The concept of shared tenant services and building intelligence is not well understood among many developers, owners and facilities managers. In a recent survey, Carlini discovered that not all users, or tenants, knew what shared tenant services meant. There is a multilevel acceptance to shared tenant services, and a better understanding is needed at every level: developer, financier (appraiser), leasing agent, facilities manager, and tenant. There are no cookbook approaches in this industry; every situation is unique and requires careful evaluation. Eventually, the question of "How smart a building do we need?" will become as common as "How much space do we want to lease?"

James Carlini. "Measuring a Building's IQ," *Real Estate Review*, Vol. 15, No. 3, Fall 1985.

Applying new information technologies to buildings requires an interdisciplinary approach to planning. Among the many factors to be considered are furniture design, lighting needs, electric power consumption, and changes in cooling requirements brought about by equipment, wiring requirements, and cabling requirements.

James Carlini. "New Test Tells Building's 'IQ,'" *Commercial Renovation*, August 1986.

The Carlini Building Intelligence Test ranks buildings in two main categories: 1) mechanical, electrical, automated and life safety systems; and 2) communications, information, and cabling systems, intelligent buildings personnel. Points are awarded for capabilities in each area, and the scores can be compared with those of other buildings overall and within subcategories. The test is intended to help tenants evaluate the intelligence of designated buildings.

Victor M. Cassidy. "A New Office Tower with the Latest in Energy Controls," *Specifying Engineer*, February 1984

333 Wacker Building in Chicago has a direct digital control system for its HVAC system. The DDC uses a programmable digital computer as the primary controller, with electronic sensors to measure variables such as temperature and pressure in milliseconds. The computer compares the sensors' signal to the programmed value and sends a control signal directly to the control device, such as a valve or damper actuator. Using direct digital controls, it is possible to perform these functions: synchronize fans of VAV system, optimize a chiller plant based on cost of operation, set minimum outside air percentage based on temperature ratios, notify the plant operator that a problem exists before tenants begin to experience discomfort.

Dennis J. Conaghan. "Incorporating Basic Values in the Smart Building," *National Real Estate Investor*, v. 28, December 1986.

Smart buildings need to include consideration of basic qualities that make a building attractive to tenants, such as aesthetic values, employee security, on-site food services and other nontechnological services as well as technologically based amenities such as telecommunications services.

Thomas B. Cross, "What Makes a Building Intelligent?" *Data Communications*, March 1986

Building intelligence is primarily a matter of the structure's network of communications technologies, a PBX or Centrex with features such as shared voice and data transmission, dedicated data switches, automatic route selection, tenant partitioning, modem pooling, text message centers, and teleconferencing. The PBX or Centrex may also be used to link sensors and controllers in an EMCS (energy management and control system) to allow for monitoring, equipment programming, intervention, graphic displays, alarms and printouts. An uninterrupted power supply and power conditioners are used to back up and protect the network.

Thomas Cross. "Intelligent Buildings: The Business Case," *Journal of Property Management*, March-April 1985.

In order to produce buildings that are both technologically advanced and marketable, developers need to undertake tenant evaluation and cost analysis before building or retrofitting. Tenant evaluation should include face-to-face interviews with personnel at various levels in various functions in order to determine the communication needs and patterns of the prospective tenants. Intelligent buildings are not a means to reduce expenses or generate profits; they are a way to make the property more competitive by increasing productivity.

Gregory F. DeLuga. "Building Automation and Fire Management... Separate or Integrated Systems?" *Specifying Engineer*, April 1983.

HVAC control and fire protection systems share many features in common. The types of components, the equipment controlled, and the locations of the components are almost identical in many cases, and their functions overlap substantially. Therefore, integrated systems provide advantages, especially in a large multistory (more than six) building or a large medical facility where two centralized separate systems controlling certain equipment jointly would be required. In all cases, the needs and circumstances of the owner and facilities management group should be considered.

"Practical Methods—Energy-management System Saves $52,000 a Year," *Electric Construction and Maintenance*, July 1986.

A computerized energy-management systems (EMS) is saving Beecham Cosmetics Company $52,000 a year at its 335,000 sq ft facility. The system controls up to 64 loads divided among 17 receivers, 10 of those for lights and the other 7 for controlling 32 HVAC units; the total system cost was $71,000. An important aspect of energy savings with the new system was the initial time spent learning about energy use in the plant.

"Brain strains—Smart Building Market Flunks Superiority Test," *Engineering News Record*, July 1986.

The Jones Lang Wootten report is cited as evidence that shared tenant services are not doing well in the marketplace. Intelligent buildings are not leasing faster than other buildings and the percentage of building tenants who actually subscribe to STS is said to be less than 50%. The president of the International Intelligent Building

Association counters these arguments, saying that smart buildings are too new to evaluate. He also says that Sharetech folded, not because of market pressures, but because of a "strategic change in direction."

Steve Fey. "Energy Management Retrofitting Demands More of the Engineer," *Specifying Engineer*, August 1984.

Energy management retrofitting requires more extensive knowledge and planning on the part of engineers. The process should include: a building audit that includes questions about building use and management as well as about equipment; a knowledge of energy management that distinguishes between standard temperature control and energy management; selection of equipment; installation; and design for change and future growth.

David M. Fisher. "The Intelligent Building: How Close Is It?" *Specifying Engineer*, September 1985.

The popular concept of the intelligent building is one that is fully integrated into a common backbone communications network, but the concept has not yet been realized. Integration is not the same thing as intelligence, however, and many capable, or intelligent, subsystems already exist; the problem is designing them to communicate with each other to coordinate operations. The new concept of expert systems is a form of computer programming that uses rules rather than algorithms. The rules are constantly being used to evaluate the current situation so that action can be taken or new rules considered. Expert systems are well suited to the integration of building systems and may make integrated, intelligent buildings more commonplace. (This article includes clear explanations of direct digital control and a glossary of 21 intelligent building terms.)

Mary Jo Foley. "Smart-building Vendors Try to Outsmart the Market," *Electronic Business*, May 1, 1986.

The intelligent building industry—described primarily in terms of telecommunications and information services—is off to a rocky start. The demise of Sharetech, a leading STS vendor, is one indicator of the industry's growing pains. Numerous studies and industry forecasts are cited, the most positive from Frost & Sullivan and Honeywell, the least encouraging from Arthur D. Little, Inc. research company. (All of the forecasts cited predate the withdrawal of United Technologies from the STS market.)

Rick Friedman. "Smart Buildings Designed to Hone Competitive Edge," *The Office*, April '86.

Smart buildings are defined as having at least 300,000 square feet and the following attributes: data processing and information transfer cabling systems built into the structure when it is designed; electronic, fire, security and surveillance systems; wire management, or a planned approach to extensive wiring needs, including telecommunications. The Union Trust Tower in Baltimore, Maryland, is seen as a prototype of the bank building of the future. It has a PBX system, a wiring system that handles voice and data transmission simultaneously, and fiber-optic cables that link the tower to the bank's day-to-day operations four blocks away.

Joseph G. Honescko. "Integrated Buildings: A Concept That Grows," *The Office*, September, 1986.

Integrated systems account for 15% of the building systems market and that share is expected to grow to 40% by 1995. The retrofit of the Seafirst Building in Seattle, Washington is an example of how integrated systems, including telecommunication and office automation services, can increase the firm's ability to attract quality tenants.

Leeza L. Hoyt. "Preparing for the Office of the Future," *Journal of Property Management*, March/April 1985.

Office automation technology requires increased flexibility in spatial arrangements and increased space for office automation equipment. Good facilities management must occur on several different levels, considering everything from individual workers' functional needs to the control of real estate costs and optimizing assets.

Robert E. Jones, Sr. "Smart Building—General Contractors Add Expertise to Building Design," *National Real Estate Investor*, v. 28, April 1986.

There is a growing trend to involve the general contractor at a very early stage of project development of intelligent buildings. The more technological options available, the more decisions have to be made at the start of the project. Industry experts are divided about preplanning: some say that the initial cost of wiring can be reduced by 30% by adequate preplanning; others warn against planning and wiring for systems that may not be cost-effective or marketable. The contractor has to have the expertise to provide valuable input into the planning process for an intelligent building.

H. Keith. "Reinstalling the 'Fourth Utility,'" *Electric Construction and Maintenance*, September 1986.

The fourth utility is a cabling system to provide the means for data and voice communications between individuals, departments and buildings on a common site. One study indicated that information in most businesses is distributed mostly (50 to 90%) within the local business facility. Further, statistics indicate that 20 to 50% of office personnel and equipment are moved every year. In light of these work patterns, precabling for local area networks makes economic sense.

Paul Kemezis. "Newsfront—The Shared Tenant-services Debacle and Lessons from It," *Data Communications*, September 1986.

The liquidation of ShareTech, the AT&T-United Technologies partnership in the shared tenant services industry, has brought the bandwagon of shared tenant services to a sudden halt. A major factor in ShareTech's demise was the fact that many leasing tenants already had their own exchange. Overconfidence, careless management, and overselling of the STS concept have been instrumental in the industry decline. Also significant is the 40% drop in PBX prices over the last four years and the uncertainty over regulation of STS by states. Some analysts are still optimistic about STS, however, citing over 220 projects under way in early 1986, including some special-use projects in which shared tenant services do very well.

Laszlo G. Kutas, PE. "Intelligent Way to Buy Smart Buildings," *Heating/Piping/Air Conditioning*, January 1986.

In many cases, the economic benefits of intelligent building systems have been greatly diminished by problems in space temperature control, energy management functions, initial building start-up, etc. Many of these problems could be prevented by a more appropriate design and construction process, one in which the mechanical engineer for the HVAC system is involved in design of the building automation system, beginning at the earliest stages. Such an integrated approach allows for better design, smoother implementation and more effective long-term service.

James P. Meagher. "Dumb Buildings . . . More Downside in Houston," *Barron's*, July 14, 1986.

Intelligent buildings are not attracting tenants as predicted. Location and size of a building still outweigh extras such as telecommunications hookups. All new buildings seem to be leasing at the same rate. (Most information based on the Jones, Lang, Wootton study.)

Richard Neubauer and Robert Heller. "Building Intelligence Into Buildings," *American City and County*, May 1985.

The two main aspects of building intelligence are building automation systems (BAS) and telecommunications. Together, they can increase productivity, flexibility and efficiency. The technology for total building integration is available; the software for total, functional integration is lacking, although it is under development.

Megan Jill Paznik. "Intelligent Buildings Get Smart Enough To Save You A Bundle," *Administrative Management*, January 1987.

Intelligent building systems, if properly managed and serviced, can provide significant savings to tenants, and they can be profitable to building owners and telecommunications companies. Small-zone billing is one way that intelligent building controls can save money for tenants; building controls allow for heating and lighting of small work areas rather than an entire floor or several floors for those who want to work during off-hours. Shared tenant telecommunications services can save tenants on long distance rates and also provide services that would not otherwise be available to small tenants. However, the shared tenant service business is not a sure thing, and in buildings in which subscription rates are lower than 60%, some providers are losing money.

David Peters and Willard Wyman. "Upgrading Older Buildings to the Technologies of the '80s: HVAC," *Specifying Engineer*, August 1984.

Buildings built before the '73 oil embargo have HVAC systems that are oversized and inefficient. Since a large percentage of a building's operating expenses are attributable to HVAC, it is necessary to modernize in an age of energy conservation. A retrofit is often the solution. Retrofit is defined as "a modification or addition to existing hardware that improves operating economy, efficiency, reliability or ease of maintenance and operation."

James H. Plankenhorn. "Security in High-rise Structures—People, Property," *Specifying Engineer*, April 1983.

Security systems for high-rise structures may include many different features: key-card access, central alarm systems, closed-circuit television monitoring, multiplexing (allowing data-gathering and transmitting from many points throughout the building), backup power for central alarm system, alternative alarm system, on-site security personnel, and others.

Douglas R. Porter. "Regulatory Review—Growth Management Style," *Urban Land*, December 1986.

The 1983 recession and the 1986 drop in oil prices hit Texas hard, and as a result, the unemployment rate rose to 9.3% in July 1986. Unless oil prices increase substantially, urban growth is expected to remain very slow for the next several years. (This may be considered a potential factor in the intelligent buildings market.)

Real Estate Research Corporation. "Emerging Trends in Real Estate: 1987," *Urban Land*, January 1987.

Real estate development activity will be affected by changes in tax law and by continuous overbuilding in some areas. New office construction is expected to decrease dramatically in 1987 as the vacancy level continues to be the single most important feature of the office market. The decline in rents is not expected to abate until 1989 or beyond. Tenants are being offered substantial concessions. Nevertheless, older tenanted buildings maintain their value and financing is available for investment in such buildings.

John Ruffolo. "How to Design for the Microcomputer," *Specifying Engineer*, August 1984.

Implementing microcomputer use in the workplace requires special design considerations for installation. Many factors must be considered: 1) type of use of the micro (stand-alone, smart terminal, networked); 2) environmental and space requirements based on job functions; 3) changes in air conditioning needs because of micro use; 4) telecommunications links between the micros (if they are to be networked); 5) lighting quality; 6) electrical power needs, including power conditioning.

Dean Schwanke. "Advanced Technology for Small Tenants," *Urban Land*, January 1985.

The new telecommunications tenant service business can be divided into three categories of participants: large telecommunications or building systems corporations with tenant service subsidiaries; telecommunications subsidiaries created by developers; and small entrepreneurial companies dedicated to the shared tenant service business. Electronic Office Centers of America (EOCA) fits into the latter category and has successfully marketed shared tenant services to the Merchandise Mart and Apparel Center of Chicago. EOCA's success hinges partly on the nature of the project, a collection of thousands of very small tenants, most in similar businesses, and partly on EOCA's philosophy that the STS business is both market-driven and service-oriented.

Dean Schwanke. "The Miami Center—High-Tech Mixed-Use Development," *Urban Land*, June 1984.

One type of provider for new telecommunications tenant services is the telecommunications subsidiary created by developers. The Miami Center is provided telecommunications service by Holywell Telecommunications, set up by the developer Holywell Corporation. Holywell Telecommunications not only markets its shared PBX, but also sells and services individual PBX systems to clients in the building. Other services include an in-house LAN, a long distance network, an energy management control system, a building directory system, an elevator lock-out system, and various services related to the PBX system.

Bob St[illegible]es. "Last Word—There Is Always a Market for the Best," *National Real Estate Investor*, v. 28, September 1986.

Today, buildings with sophisticated amenity packages prove to be the major reason that tenants move to new locations, even if they have to pay more initially. Amenities may include covered parking, restaurants and health clubs located within the office tower, energy-saving control systems, and limited-access security systems.