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Intelligent and Green (Smart) Buildings

1.1 INTELLIGENT BUILDINGS

Traditionally, a building was viewed as a *passive* element of the workplace. Today, that has changed. A building is now recognized as a *dynamic* structure that supports the people and technologies working within its four walls. And with the cost of personnel comprising more than 80 percent of a typical organization's office expenses, a building that cannot meaningfully contribute to the productivity of workers and to the overall cost-effectiveness of an organization is a building few can afford.

To meet contemporary and future needs, a building must establish an environment that is hospitable to those who work within it as well as to the changing technologies on which their productivity relies. To maintain an intelligent building is to control operating costs through technology and improved services.

An *intelligent* building is one which provides a productive and cost-effective environment through optimization of its four basic elements *structure*, *systems*, *services*, and *management* and the interrelationship between them. Intelligent buildings help building owners, property managers, and occupants realize their goals in the areas of cost, comfort, convenience, safety, long-term flexibility, and marketability.

The development of information technology has seen a rapid growth of systems able to *measure*, *evaluate* and *respond* to change. As a result we are seeing a corresponding evolution in the way we design our built environment and the demands that we put on our buildings. This is resulting in a growth in the development of Intelligent and Green buildings that are capable of incorporating the opportunities offered by these developments.

One of the benefits of the rapid evolution of information technology has been the development of systems that can measure, evaluate, and respond to change. An enhanced ability to control change has sparked developments in the way we design our physical environment, in particular, the buildings in which we work. As a result, we are witnessing significant growth in the area of "Intelligent Buildings"—buildings that incorporate information technology and communication systems, making them more comfortable, secure, productive, and cost-effective.

A building that incorporates information technology and communication systems to make the physical environment more comfortable, interactive, secure, productive and cost-effective is named as an "Intelligent Building".

An intelligent building employs many tightly integrated mechanical and electrical systems that do everything from controlling the building's *environment*, *lighting*, and *security* to maintaining high-speed data networks and emergency backup power generators.

In the design community (*engineers*, *architects*, *interior designers*) the phrase is often restricted to a particular building type: the *office* or *commercial* or *institutional* building including extensive telecommunication capabilities, designed to allow rapid reconfiguration of the interior layout in response to changing client needs.

The term "intelligent" is generally applied to refer to a new generation of high-tech buildings with the following state-of-the art features:

- Flexibility to adapt to changing use of the space and technology.
- Minimizing energy and operations cost while maximizing the effectiveness of operations personnel.
- Energy Saving Controls in HVAC and lighting Control
- Convenience services like paging, Public Address information system, complaint management
- Infrastructural services viz. server form, office system, mass mailing system, video-on-demand,presentation, space-management, telecommunications, building management system
- Security services e.g. alarm signal, CCTV, access control system, fire alarm, intrusion alarm

- Business and financial planning and survey services for example technical, fixed assets database, warehouse records, invoicing systems
- Energy management Systems and energy saving devices
- Means of Solar Harnessing

These systems incorporated in a building save energy while increasing reliability, security and efficiency. They can detect and repair a malfunctioning part of the building or its services, avoid serious consequences including a fire.

In the early l980s, trade magazines began running stories on "intelligent buildings." Publications concerned with mechanical systems published articles on automation systems making buildings more energy-efficient. Magazines serving the communications industry told how advanced telecommunications systems have made buildings more efficient and therefore more intelligent.

As a result of extensive press coverage and supplier advertising, there has been growing pressure on owner/developers to build intelligent buildings. The intelligent buildings are said to be more attractive and easier to lease. Existing buildings, lacking the attractive features of the newer, more intelligent ones may lose tenants to their more intelligent competitors.

One definition, which resulted from the International Symposium May 28 and 29, 1985 in Toronto is as follows: "*an intelligent building combines innovations, technological or not, with skillful management, to maximize return on investment*."

With this definition in mind, one can discern a means of coming up with a simple explanation of intelligent buildings. The basis of the explanation is the simple comparison of features of the "dumb" building with features now being employed in today's intelligent buildings.

1.2 THE ATTRIBUTES OF INTELLIGENCE IN BUILDINGS

Intelligence is the faculty of *thinking*, *reasoning*, and *acquiring* and *applying knowledge*.

In 1985 at an international symposium in Toronto, a definition of IB was established—a building united by a single innovative building management system that successfully maximizes investment return. At the present, the Intelligent Building Institute (USA) considers a building "intelligent" if it provides productive and economically effect means to optimization of the following four elements:

- structure;
- service systems;
- managements systems;
- interrelated systems.

In Russia, the company 'EcoProg' has been working with the IB concept since 1994 and defines it as follows: "IB" means that the building has capacity to adapt to changes in the surrounding environment. In other words, such a building has an engineering infrastructure capable of adapting to future changes.

As per Colliers International, according to international standards, for a building to be called "intelligent", it must have around thirty different regulated systems. These systems include elevators, ventilation, air conditioning, energy supply, water, access, telephone service, Internet service and more.

If the appropriate systems are in place, buildings of a wide variety of use designation can be considered "intelligent," including office buildings, retail space, sports facilities, hotels, manufacturing facilities, residential buildings and more.

Each type of building has a certain set of functions that are more important. For example, for a retail center, the comfort and safety of its visitors are perhaps most important. For an office building, which might be built to last decades, the reduction of service and operational expenses are of primary importance.

The opinion held by almost the players on the Moscow IB market can be summed up in the words of E. Vergilis, a member of the National Council of Russia on Intelligent Buildings: "IB is a building that corresponds to the technical and social standards of a class A building and that also offers the maximum modern comforts from the point of view of providing for the efficiency of companies and organizations in that building. For an IB, its ability to provide for the workers operating in the building via intelligent resources is of utmost importance."

All characteristics that apply to class A facilities apply to IB.

However, characteristics that apply only to intelligent constructions. An IB differs from other buildings in the following manner:

- Continuous monitoring and the possibility to manage the functions of all systems of the building from a central location;
- Accident warning and automated emergency response measures; automated lighting and microclimate controls

depending on weather, time of day, functional schedule of building and technical needs;

- Automated lease and utility billing;
- Central access control, closed-circuit television monitoring and automated HVAC systems.

According to the specialist, an IB can guarantee the following:

- lower operational costs;
- lower electricity use;
- greater equipment reliability;
- lower material expenses;
- greater worker efficiency;
- insurance discounts;
- lower service cost for the lifecycle of the building.

The second reason and partially the first reason here are related to lower use of electricity, which is a key characteristic of IB.

1.2.1 Investment

The cost of an intellectual building is greater than that of regular building on account of the extra expenditures on the building management system and the cost of planning that system.

According to 'EcoProg', the expenses for a 5000-sq.-meter intelligent office building are arrayed as follows:

10% of the cost of construction goes toward the informational infrastructure; up to 40% of the cost of construction goes toward the engineering systems, including equipment; 4-7% of the cost of construction goes toward the project development, including the system optimization.

1.2.2 Insurance

Insuring an intelligent building is no different from insuring an ordinary one. However, as A. Poludenny of the insurance company 'Ingosstrakh' reports, "In the case of an IB, the operations of which are more proficient from the professional point of view, many of the possible risks are minimized." Thus, the cost of insuring an IB is significantly less than that of a regular building, although not quite zero. In this case, everything depends on the accumulative risk and other factors. The intelligent building is clearly the building of the future. With proper marketing, such buildings will lease up more easily, and at higher rates too, by virtue of the services offered.

Intelligent building owners will gain, often at the expense of other building owners.

Risks tied to the operations of construction projects, including construction and subsequent operation of an IB include the following:

- Risks of natural disasters;
- Risks of a technological origin;
- Risks appearing as a result of responsibility gaps;
- Risks related to the work of the architects and planners;
- Other traditional property risks;
- Risks arising due to losses incurred from the interruption of the commercial capacity of the building as a result of structural damage or collapse.

1.2.3 High Technology

The high technology concept of intelligent buildings was introduced in the United States in the early 1980s. Although no formal definition exists, intelligent buildings use electronics extensively and are high-technology related. In fact, the National Academy of Sciences in Washington, DC had a committee dealing with "electronically-enhanced" buildings. In recognition of the electronic aspects of an intelligent building, we can divide the operation into four categories:

- energy efficiency
- lifesafety systems
- telecommunications systems
- workplace automation

The ultimate dream in the design of an intelligent building is to integrate the four operating areas into one single computerized system. All the hardware and software would be furnished by a single supplier who would use compatible equipment and common CPUs and trunk wiring. Such integration is far from being realized; however, several manufacturers are presently capable of supplying all four categories mentioned, all as part of a single contract.

1.2.4 Energy Efficiency

Intelligence with respect to energy in an intelligent building consists of the reduction of energy use to the bare minimum.

Computerized systems are used extensively. Such systems go by many names: Building Automation System (BAS), Energy

Management System (EMS), Energy Management and Control System (EMCS), Central Control and Monitoring System (CCMS) and Facilities Management System (FMS).

Some strategies used to reduce energy consumption in intelligent buildings are (typically in case of HVAC applications):

- Programmed start/stop
- Optimal start/stop
- Duty cycling
- Setpoint reset
- Electric demand limiting
- Adaptive control
- Chiller optimization
- Boiler optimization
- Optimal energy sourcing

1.2.5 Lifesafety Systems

Intelligence with respect to lifesafety in an intelligent building consists of the use of high technology to maximize the performance of fire alarm and security systems while at the same time minimizing costs. Lifesafety factors involved in intelligent buildings are:

- Reduced manpower dependence
- Closed-Circuit Television
- Card Access Control
- Smoke Detection
- Intrusion Alarms
- Emergency control of Elevators, HVAC systems, Fire alarm and Doors
- UPS, Voltage Stabliser system, Spike Arrestors and Emergency Power Supply
- Emergency Power supply and Batteries

1.2.6 Telecommunications Systems

Intelligence with respect to telecommunications in an intelligent building consists of the offering to tenants of many sophisticated telecom features at a considerably reduced cost due to the fact that the equipment is shared by many users. Some of the telecom features involved in intelligent buildings are:

- EAPBX telephone system with VoIC

- VLAN,WLAN and VPN
- Local and Tele Video-conferencing
- Electronic mail
- Presentation and Projection Facilities
- Wireless Communication including wi-fi and blue Tooth

1.2.7 Workplace Automation

Intelligence with respect to workplace automation in an intelligent building consists of the use of high-tech office automation systems to render the operation of a company more efficient. This can be done at a reduced cost to tenants by virtue of the equipment being shared. Some of the factors involved in workplace automation in intelligent buildings are:

- Centralized Data Processing
- Word Processing
- Computer Aided Design
- Information Services
- Mobile and E-coomerce

1.2.7.1 Typical Services. Typical services that can be offered are:

Message Center : The message center is a back-up telephone switchboard for tenants. It answers all tenants' telephones and is connected to printers conveniently located in or near the offices of tenants for immediate delivery of messages. When a telephone line is busy or doesn't answer after four rings, the message center answers the call automatically. The terminal and the center display the name of the person whose phone is ringing so that the operator can answer the call courteously and accurately. The caller's company, telephone number, brief message, time of call, and the operator's name are then recorded and immediately printed in the recipient's office.

Word Processing : Word processing includes the electronic creation, revision, storage, retrieval, and transmission of correspondence documents. With pick-up and delivery service, 24-hour document turnaround during business hours and premium one-hour turnaround, a word processing service offers convenience and economy.

Computer-Assisted Design : With computer-assisted design, the owner has accurate and easy-to-read drawings that can be used to reduce the cost of carrying out any sort of modification whether it be architectural, structural, mechanical, or electrical.

Teleconferencing : Teleconferencing is an alternative to expensive travel budgets and can be made available to the owner's tenants.

Electronic Mail : Through electronic mail, instantaneous communications can be established worldwide on a system designed to reduce cycle time and produce savings to the tenants.

Computer Services : The owner can provide computer services offering hardware and software to its tenants at a discount.

1.3 INTELLIGENT BUILDINGS—CONTROL THEORY

The essence of Building Management Systems and Intelligent Buildings is in the control technologies, which allow integration, automation, and optimisation of all the services and equipment that provide services and manages the environment of the building concerned.Programmable Logic Controllers (PLC's) formed the original basis of the control technologies. Later developments, in commercial and residential applications, were based on 'distributed-intelligence microprocessors'.

The use of these technologies allows the optimisation of various site and building services, often yielding significant cost reductions and large energy savings. There are numerous methods by which building services within buildings can be controlled, falling broadly into two method types:

- *Time based*—providing heating or lighting services, etc., only when required, and
- *Optimiser Parameter based*—often utilising a representative aspect of the service, such as temperature for space heating or illuminance for lighting.

1.4 INTELLIGENT BUILDINGS—AMOUNT OF ENERGY SAVINGS

Until recent years, energy efficiency has been a relatively low priority and low perceived opportunity to building owners and investors. However, with the dramatic increase and awareness of energy use concerns, and the advances in cost-effective technologies, energy efficiency is fast becoming part of real estate management, facilities management and operations strategy.

The concepts are also now making significant inroads into the domestic residential housebuilding sectors.

For lighting, energy savings can be up to 75% of the original circuit load, which represents 5% of the total energy consumption of the residential and commercial sectors.

Energy savings potential from water heating, cooling, or hot water production, can be up to 10%, which represents up to 7% of the total energy consumption of the domestic residential and commercial sectors.

Experiences from studies in Austria suggest potential heating and cooling energy savings are up to 30% in public buildings. Even allowing for the fact that buildings used in the study may have been those with particularly high energy usage, the figure is an impressive one. (Source: EU2 Analysis and Market Survey for European Building Technologies in Central & Eastern European Countries—GOPA)

1.5 INTELLIGENT BUILDING : EXTENT OF AUTOMATION

The concept of an intelligent building is, and will probably remain, ill-defined. In its most general sense it should mean a building that in some way can sense its environment, reach decisions about the state of that environment and communicate those decisions. In practice this should mean that a building can adjust some aspect of the interior or exterior environment in response to a change in some other aspect of that environment. Let us vizualise through one example:

After a half-hour commute by metro train, Meena arrives at the office to begin her workday. As she approaches the building's front door, a smart security system identifies her and unlocks the doors. After she passes through the entrance on the ground floor, an intelligent identification system senses her entry and energizes her personal workspace on the 20th floor. The system turns on her office lights, starts her computer, pulls up her electronic mailbox, and adjusts the local temperature based on her personal settings.

Although this example is fictitious, it's not that far from reality. Intelligent buildings with the same capabilities, as well as many more innovative features, are just around the corner. But keep in mind, "intelligent building" means different things to different people.

To an architect, an intelligent building may be one that's energy efficient and flexible; using materials such as raised floors and movable interior walls for quick low-cost renovations. Building managers will likely dream of digital control systems and the ability to maintain temperatures within a few degrees of the thermostat setting. He or she might also want such a building to constantly monitor exterior conditions and automatically adjust for rate of air exchange and energy savings.

Still others may talk about Personal Environment Systems; where workers have the ability to customize individual work areas for temperature, acoustics, and fresh air ratios. IBM and Digital Equipment Corp. look at the this concept as a logical extension to processing opportunities, while control companies such as Honeywell and Johnson Controls focus on traditional markets with new digital solutions.

The primary features of an intelligent building include:

- full communications and computer network infrastructure;
- building security system;
- energy—saving equipment and controls;
- flexible work areas; and
- environmental control systems.

The demand for intelligent buildings is growing steadily, although people tend to specify types of equipment and services (since there is no standard list of equipment that makes up an intelligent building). Systems now in demand are those that give the building and its tenants greater flexibility, increased productivity, and expanded services. People tend to buy specific communications, control, energy management, and computer network systems; not some unknown package of systems sold under the tag "Intelligent Building." Your job is to tie these systems together so they become transparent to the occupants. Your first order of business should be to understand what the customer is willing to pay for.

1.6 INTELLIGENT AND INTEGRATED BUILDING MANAGEMENT SYSTEMS

Central to an 'intelligent building' is a Building Management System which can control, monitor and optimise services such as lights, heating, security, alarms, access control, ventilation, air-conditioning, and in modern buildings that extensively use computer systems, secure the networks and databanks.

The field of Intelligent Buildings, Intelligent Homes, Building Management Systems (BMS) encompasses an enormous variety of technologies, across commercial, industrial, institutional and domestic buildings, including energy management systems and building controls. The function of Building Management Systems is central to 'Intelligent Buildings' concepts; its purpose is to control, monitor and optimise building services, eg., lighting; heating; security, CCTV and alarm systems; access control; audio-visual and entertainment systems; ventilation, filtration and climate control, etc.; even time and attendance control and reporting (notably staff movement and availability).

The BMS is often seen as the neural network which allows the core service functions within the building to perform accurately, effectively and efficiently. Whilst this is true to a certain extent, it is also a very services-centric view. This is because an intelligent building can be measured in a whole wealth of different dimensions which, when integrated correctly through the design, construction and management processes add real value to the investment in the building.The BMS are discussed in detail in chapter 3 to 8.

These various dimensions can be described in four broad-brush groups:

- Elecromechanical and electronic Services;
- Information Technology
- Structure Elements and
- Space/Envirinment.

For the building to be efficient and successful, each of these elements must work sensibly with the others to meet the clients needs to maximum effect. This requires a holistic perspective from not only the client but also from the building professionals involved in the design, construction and management of the building.

The potential within these concepts and the surrounding technology is vast, and our lives are changing from the effects of Intelligent Buildings developments on our living and working environments. The impact on facilities planning and facilities management is also potentially immense. Any facilities managers considering premises development or site relocation should also consider the opportunities presented by Intelligent Buildings technologies and concepts.

Just to have the idea the system can be designed to handle airconditioning, electrical generators, and utilities, including water levels in the overhead tanks. The lighting system is occupancy-based wherein lights for a bay goes up automatically when the first person enters it and switches off when the last person leaves it. By far the most advanced security features are at the data centre: a proximity card for primary access, a biometric authorisation using fingerprint and a third level security in the form of infra-red sensors. The system can be used even to monitor attendance and staff movement and availability.

For example, in the case of a fire, the fire alarm communicates with the security system to unlock the doors. The security system communicates with the HVAC system to regulate the flow of air to prevent the fire from spreading.

Besides this, roving cameras pan 360 degrees to monitor the entire data centre 24 × 7 hours, 365 days. Movement detectors also sweep the centre. There are separate access cards for different user groups for the switch rooms, electrical rooms and the library.

The entire campus has many fixed CCTV cameras, which also record images at strategic points, with monitoring from a single point.

As outlined in the paragraph above, the object of using Intelligent Building ideas is to reduce costs by reducing the running cost of a building. An Intelligent Building reduces its running cost over a conventional building by using freely available energy sources to heat it and cool its environment. The ways in which an Intelligent Building takes advantage of these resources area many, however, there are several underlying approaches:

Many of the systems described above have been used in the design of buildings for centuries. Today however, with the advent of modern I.T. systems that can enable a building to measure, evaluate and respond to change, we are in a position to become more and more effective in using freely available resources.

Sensors inside and outside the building can now measure not only temperature, humidity, wind speed and lighting levels, but ensure that a building responds to issues such as occupancy levels and mood changes. Communications technology now even allows us to interact remotely with a buildings control systems. This enables us to reprogram a building to change to suit our requirements and alert it to changes in future demand so that a building can prepare itself for change.

Although certain design principles, if utilised, tend to take on a certain appearance (such as the use of glass for greenhouses for solar gain), the reality is that Intelligent Buildings can take on many forms, from a massive structure to a light weight frame. Building an Intelligent Building is an approach rather than an aesthetic.

Many, if not all of the ideas expored above can be used or adpated to fit into or become part of the existing building fabric. Sometimes the new installation can be so discrete that the visitor might not even be aware that any adaptatation has taken place. This is particularly important where the building is of architectural or historic interest.

In a sense, building automation is all about flexibility. A well-designed building automation/management system ensures that all the components - heating, ventilation, air conditioning, lighting, fire safety, security, standby power and power quality, refrigeration systems, audio/visual control, etc. - are responsive to changing conditions.

Flexibility is also critical in the area of interoperability. Closed, proprietary systems go against the philosophy of building automation and complicate the design, installation and functionality of building management systems. Simply put, proprietary systems compromise flexibility.

With this general definition most existing contemporary buildings are to some extent “intelligent” already. The simplest example of such intelligence would be the thermostat in an HVAC system. It senses the thermal environment, compares the temperature to a set point and communicates to a device that either adds or removes heat from the internal environment (a furnace, boiler or “air conditioner”). That this function is provided by a simple mechanical device (often a bimetal strip opening or closing a circuit) doesn’t detract from its intelligence as we’re defining it. A smoke detector sending an alarm to a fire department would be an example of a device affecting the external environment.

This type of activity is not normally considered as intelligence within Architectural Engineering. What distinguishes an intelligent building in practice is a more complex order of sensing, deciding and communicating. Probably most important is that there is more than a single input variable involved, that there is more than a binary decision possible, or that more than one building system will be affected by the communication.

Integrated systems can be achieved by having one manufacturer provide multiple systems and by having all the intelligent systems in a building use BACnet as a high level interface. This can be achieved using completely proprietary systems with BACnet gateways. This is not optimal, but is satisfactory. Optimal is going to Native BACnet as the standardised core of the installation. This will reduce integration costs.

Any size building will benefit from the integration of building services. The implementation of integration has been very slow because of procedural difficulties and integration costs. The advent of BACnet has removed the cost implication.

Practically however, the mechanical and electrical services are designed and tendered separately. It takes commitment by the Architect and the client to drive the process. On most projects integration collapses during construction, even if it is just within the mechanical services. Simply attempting to get the chiller talking to the BMCS can be a pain to coordinate.

1.7 MECHANICAL AND ELECTRICAL SYSTEMS (SUB SYSTEM) CONTROL

Another common use of the phrase, particularly in the engineering community, is to address the use of computer programs to provide coordination of the many building subsystems involved in the regulating the interior thermal environment of the building (HVAC) and providing power to all building systems. The goal is usually to reduce the operating cost of the building while maintaining the desired environment for the building occupants.

Because of the many subsystems contributing to the energy costs of operating a building these computer programs can be extremely complex. They can extend well beyond the current Building Automation Systems (BAS) that typically address issues of energy savings by reducing system control of unoccupied spaces, and shedding loads to prevent electrical utility demand charges.

Opportunities for integrating other subsystems into the overall Mechanical and Electrical Systems intelligent building include:

- Active control of traditionally passive elements such as glazing or wall thermal transmission
- Anticipatory strategies—e.g. incorporating weather forecasts into control strategies or incorporation of utility cost or demand forecasts into the operation.
- Adaptive learning - continuous learning from the building occupants and adapting control strategies.
- Individual occupant tracking - tracking building occupants while actively and seamlessly adapting building systems to the individual's wants and needs (e.g. setting a room's temprature and lighting levels automatically when a homeowner enters)

- Fault detection, notification and adaptation for equipment, particularly critical equipment in the mechanical and electrical systems.

Beyond these energy-focused applications of the intelligent building concept there are many other possible uses for similar strategies. Some possibilities include:

- Building Security
- Usage charges for building facilities
- Wayfinding within the building
- Lighting customization to provide different moods
- Preventive maintenance tracking of building materials

1.8 DISTRIBUTED OR CENTRAL INTELLIGENCE

One of the key questions regarding an intelligent building is how the system will handle computing. One method is to have a central computer handle all control functions. Another is to use separate computers for various systems. Typically, a combination of the two methods works best.

For example, it's common for an office building to supply base services and for the tenants to pay for supplemental services.

The building provides basic security access, fire alarm systems, and telephone and communications cabling from the point of service to every occupied space. From this point, it's up to the tenant to provide his or her own telephone system as well as supplementary security and fire protection equipment. However, for a truly intelligent building, you must tie supplemental security and fire equipment in with the central building systems.

1.9 COMMUNICATIONS METHODS IN INTELLIGENT BUILDINGS

Of all the pieces making up an intelligent building, none is more important than the communications system. Beyond traditional cabling like twisted pairs, coaxial, and fiber-optic, you can find almost any type of communications media in modern buildings, including: wireless infrared links (IR); radio frequency (RF) signals; microwave transmissions (usually from one building to another; not inside one building); and laser links (used in the same way as microwave links).

In most cases, communications within an intelligent building includes a mix of technologies, with each media moving signals from one place to another, or from one system to another. The signals may represent a phone call, computer file, security signal to open a door, thermostat calling for more heat, or window receiving a signal to "go-opaque."

1.10 STRUCTURED WIRING/CABLING

The distributed wire network is the primary link between all individual control systems. In most instances, it's a pair of wires looped throughout the facility. Someone must supervise the network for "loss of integrity," which is necessary for the UL listing of the life-safety systems.

As the number of automated workstations increases, housing the wires and fiber-optic cables that energize, connect, and control the various systems becomes a more vital consideration.

Systems contractors must find a way to install the equipment and its wiring wherever they can find a space. In an intelligent building, you should plan both horizontal and vertical paths for communication and control wiring from the outset with a provision for future changes. For horizontal distribution, twisted pairs of copper wires are still common while you can use fiber-optic cables for vertical and inter-building communication.

Integrating various computer systems can be difficult; unless they all accept the same software and interconnections. An industry-wide effort to establish appropriate protocols for computer-aided environmental controls and energy management systems enables a "host" system to accept new subsystems.

There's also a design issue: the necessity for redundant cabling and using separate conduit located some distance from the initial cable. Life-safety systems don't require this redundancy for UL compliance, but consulting engineers and suppliers often consider it to be a good engineering practice. Manufacturers of integrated systems think the cost of this redundant network is not excessive in relation to the amount of additional safety it brings to the system.

For nonlife safety systems, especially for renovations or retrofits, you may have an opportunity to use existing power lines as the communication distribution network. This alternative allows easy system upgrade or installation with minimal disruption to walls or ceilings. However, manufacturers caution you to check the electrical distribution system for power line integrity before proceeding with final design.

1.11 PROGRESSIVE EVOLUTION OF INTELLIGENT BUILDINGS (IB)

The historic development of the IB concept throughout the world can be broken into several stages (see Table 1.1). Only in the most recent stages of development have such buildings begun to appear in the Russia.

The first "intelligent" construction projects appeared in Russia in the 1980s when the country was preparing for the Olympics.

Builders and planners initially took this term to simply mean controlled access or automated fire alarms. In reality, these projects just had a few elements of a true IB. The airport Sheremetevo and the hotel 'Cosmos' are two examples of such buildings from that era.

The term intelligent building (IB) has been floating around the market for about 30 years. The first references to IB appeared back then in articles related to the effort to make buildings more energy efficient. It was suggested in these articles that telecommunication companies should develop the technical infrastructure of a building in such a way as to make building structures more effective and give them a certain degree of intelligence.

Over the past 30 years we have seen a progressive evolution of three generations of systems, each leading the development of operation systems for around a decade and providing the foundation for the next generation.

From the mid-1980s, centralised building-management systems provided the opportunity to improve the control and interaction between individual building systems such as lighting, access control, and energy management.

From the mid-1990s, this first generation of intelligent building systems was augmented by distributed or bus technologies, which supported the improved management and control of building systems and individual pieces of plant and equipment.

Now (*i.e.* in year 2006) we are living through the *third generation*, of *networked systems*, which allow us to connect different buildings together on a global basis as well as linking them into business IT systems. This demonstrates a progressive and robust development of intelligence in buildings, providing an understandable model for building investors, users and designers.

When we compare progress made over the last 25 years by intelligent buildings with that made by green buildings, an idea that only emerged some 10 years later, we can see the challenge clearly.

Real IB projects only began appearing in complete form in the 1990s. Since the mid-1990s, more and more attention has been paid to energy efficiency in North America, Japan, China, India and many European countries. Higher priority was given to the energy-saving solutions that managed to simultaneously increase the quality of the microclimate inside the buildings. In this manner, a world market formed for the products and services necessary to create IB.

In November, 1985 issue of Engineering Digest carried an article showing how steel framing and cellular steel flooring have contributed to building intelligence. Fortune, Forbes, and Business Week have all carried extensive articles on the intelligent building business.

This situation begged the question of what to do with the older, less intelligent existing buildings. In New York, the Rockefeller Center created its own telecommunications corporation to implement a sophisticated shared telecommunications system in all of its 19 buildings.

The ORBIT study carried out by the Harbinger Group of Connecticut showed that many existing buildings in North America lacked the "intelligence" to effectively handle the information technology systems used by the businesses that are tenants in buildings.

Perhaps because the industry is not yet out of its adolescence, there is not really a standard definition of an intelligent building. One developer once said that it's "a building that is fully leased." It follows then that any feature helping to lease the building fully could be considered intelligent. In the context of today's high technology needs, the features themselves would be high technology features.

With Toronto's definition in mind, one can discern a means of coming up with a simple explanation of intelligent buildings. The basis of the explanation is the simple comparison of features of the "dumb" building with features now being employed in today's intelligent buildings.