INTELLIGENT BUILDINGS

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Contents

Summary

The emergence of intelligent buildings is founded on the rapid development of microcomputer and internet technology as well as the advance of information and communication technology. With the help of these technologies, office affairs have shifted from the traditional pattern of labor intense and large volume to the flexible, diverse, efficient, user-friendly, and highly reliable operations. Meanwhile the growing popularity of broadband networks has brought the Evernet system into residential buildings earlier than expected. As a result, the era of information appliances (IA) has become reality. The IA is gradually fitting in our everyday living. The automated equipments which were originally used in the intelligent office buildings are being installed in the residential buildings and houses as well. The intelligent houses and the intelligent communities are taking shape.

To reduce the energy consumption, the development of “green buildings” has become a global movement of the building industry to conserve energy, to effectively utilize resource, and to improve the indoor environment control. To minimize energy consumption and to increase equipment efficiency are the objectives in the development of intelligent buildings. By installing mini sensors and automation

climate control facilities in the building, the energy consumption can be significantly reduced and the quality of indoor environment can be improved also. Combining the concept of green building and the technologies used in the intelligent building, an intelligent green building which is safe, healthy, convenient, comfortable, efficient, and energy conserving can be built.

In addition to the history and the prospects of the development of intelligent building, this article also studies the evaluation systems and the design guidelines adopted by countries such as Japan, Taiwan, and Hong Kong, to grade the level of building intelligence and to design the intelligent buildings respectively. The design guidelines and evaluation systems of the intelligent building from different countries are compared. The extra cost needed to install the automation equipments and management systems is estimated in terms of life cycle cost of the building also. Intelligent building is an important element in the high-tech information society. The inter-connected information network can release the problem of over population in urban area and overload of the infrastructures as well. Through the construction of urban infrastructure and the inter- and intra-city information systems, the intelligent city will become reality in the near future.

1. Introduction

The phase of "intelligent building" means many things to many different people (Duffy, 1988). However, an intelligent building is generally expected to be adaptable for the changes of occupants' needs and also the advance of information technology and computer technology. The rapid growth of microcomputer technology over the last 10 years has spurned the unmitigated implementation of computer technology in office business systems. The development and liberalization of the telecommunication technology have, likewise, fostered internationalization and efficiency of office business systems. Computer networks have led to shared resources within the company. The use of miniature and high-performance sensors make the office workspace more user-friendly. Office affairs have shifted from the traditional working pattern of labor intense and large volume to the flexible, diverse, efficient, user-friendly, and highly reliable operations.

As more information and communication equipments installed in the building, the required power supply has increased with the increase in electrical cable capacity and complexity. Computer technology has improved the functions and controllability of machines, while the management of building has become more user-friendly, energy-efficient, and reliable by integrating with computer systems. Intelligent building indeed is the type of building which is designed to facilitate the implementation of high-capacity information and communication systems to the buildings.

The first energy crisis in 1973 led people to re-examine the ways of energy being used and generated awareness on energy conservation. Energy experts point out that up to 14% of the global energy consumption is spent in operating buildings (ABRI, 2001) and there is trend that the percentage will continue to increase. To reduce the energy consumption, the development of "green buildings" has become a global movement of

the building industry to conserve energy, to effectively utilize resource, and to improve the indoor environment control. Through the efficient use of energy and resources, the ultimate objective of the green building is to construct buildings which have low environmental impact and are also safe, healthy, environmentally sound, and comfortable to live and work. It is also the basic goal of hi-tech buildings with environmental symbiosis to achieve equilibrium among man, building, and the environment.

To achieve the above goals, it is needed to expand and integrate the management systems of intelligent building to green building. So the benefits of different technologies used in the green buildings can be maximized. In other words, implementing the intelligent building systems to green buildings is the key to the continuing development of green buildings. Buildings without appropriate flexibility and expansion capabilities to meet the requirements of environment will be easily phased out by the trend of information and energy conservation. So, to minimize the energy consumption and to increase the equipment efficiency are the objectives in the development of intelligent buildings. By installing sensors and automation facilities, the energy consumption can be significantly reduced and the quality of indoor environment can be improved also. As a result, buildings which are safe, healthy, convenient, comfortable, efficient, and energy conserving can be built.

Due to the rapid progress in network technology and the information system, the ways of living and working have been directly and indirectly affected. Traditional residential buildings are no longer capable to satisfactorily accommodate the impact brought about by the developing technology. So, the scope of intelligent buildings has gradually extended from office building automation to residential building automation. The concept of intelligent houses and intelligent communities will be the future trend of the building industry.

In addition, due to the growing popularity of broadband networks, the Evernet system has been brought into residential buildings earlier than expected. The era of information appliances (IA) has become reality. The IA is gradually fitting in our everyday living. So, the primary issue in designing the intelligent residential buildings is to connect, through a networked system, the home information system and automated equipments into a “home network system.” This will enable all the connected devices to provide integrated services to improve the safety, convenience, and efficiency of everyday living. As a result, a comfortable and healthy quality of life can be provided.

However, the office automation and the home automation have also brought about problems on adaptability of residents, information security, and systems integration. So, how to implement appropriate information and communication systems, automation equipments, and open system platforms to the building and also consider the building functions, available space, and individual user demands are important issues in designing intelligent buildings. By doing so, a user-friendly, information-oriented environment that is safe and convenient may be created to satisfy the diverse and personal requirements of the occupants.

2. Development of Intelligent Buildings

2.1 Background

Intelligent building (IB) was advocated by UTBS (United Technology Building Systems) Corporation in the U.S.A. in 1981 and became a reality in July, 1983 with the inauguration of the City Place Building in Hartford, Connecticut, U.S.A. (So & Chan, 1999). Although communication and automated facilities might have been used to certain degree in other buildings prior to the City Place Building, the term of "intelligent building" was not used. Even the investors and the designers of the City Place Building did not anticipate that they would build such a building that would sufficiently reflect the advance of technology and the emerging of information society. The United Technologies Buildings System (UTBS) which was an affiliate of United Technologies (UT) played a key role in integrating the building facilities with computer net work for the City Place building. UTBS was not only a client of the City Place, it also took part in installing the air conditioning, elevators, and fire prevention facilities for the building. By connecting the local area networks to digital private branch exchange (DPBX) device, communication equipments, and information equipments of the building, UTBS improved the energy efficiency of the building and also the overall safety of the building. In addition, UTBS was the first to introduce the shared tenant service (STS) system, which provided inexpensive communication and office automation services to tenants. Through the system, tenants were able to access high level communication and information services without having to invest in expensive communications and information equipments. The available services included discounts on long distance telephone calls, word processing, electronic data transmission, use of microcomputers, and data access. To support the STS system, UTBS purchased telephone lines from AT&T in volumes at a lower cost.

The concept of intelligent buildings evolved from the accumulated knowledge in architecture. By introducing communications, information, and automation technologies and equipments to the building, it will enable the building operation and building management to be safer, more efficient, and more energy saving. As a result, the building will provide a convenient and comfortable environment to the occupants to live and work.

2.2 Emergence of Intelligent Buildings

To understand the social background and technological developments that led to the emergence of intelligent buildings and to identify the prospects of future developments, this section will identify the reasons for the emergence of intelligent buildings by looking into the development of building technology:

(1) **Rapid development of communications and computer technologies:** After the 1970's, competitions in aerospace industry and demands for advanced technology by the Moon Landing project facilitated many technology breakthroughs on the hi-tech products. The first and second energy crises also led to evoke the environmental awareness and the concept of sustainable development. As a result, products which previously were limited in kind but huge in volume became more diversified and

lesser in volumes to meet the requirements of energy efficiency, increased safety, and improved compatibility. As the technology became more popular and commercialized, hi-tech products were no longer elusive.

For instance, the memory capacity and computing power of microcomputers have increased drastically during decades of development. But the microcomputer itself has become more compact and less expensive. This phenomenon does not only apply to the microcomputer, it also benefits almost all industries. For the building industry, advancement in computer technology is one of the major driving forces leading to the emergence of intelligent buildings. Consequently, the use, management, maintenance, and environmental control of buildings have also improved vastly.

(2) **Implementation of the Telecommunications Law and policies**: Unrestricted transmission of information is the primary requirement of the information community. The policy of telecommunications liberalization is the key factor for communications automation and networking. The United States and Japan revised their telecommunications laws and policies in 1982 and 1985, respectively. For its part, Taiwan allowed private operations of fixed network systems in 2000. The telecommunications liberalization policy of Taiwan includes: privatization of telecommunications and opening the integrated networks of telecommunications and microcomputers. Consumers will be able to benefit from inexpensive access to communication services. Data and information can be transmitted more swiftly and conveniently. It made the living more diverse and many new concepts of office space were generated, such as the paperless office and home office.

(3) **Competition of High End Office Buildings**: Typically, office buildings are concentrated in city center for the convenience of business operations. This has resulted in inflated real estate prices and office leasing rates. The use of elevators as means of vertical transportation in buildings has given rise to taller and more massive buildings. As building facilities become more complicated, operation and management of such facilities require some intelligent systems that are highly automated and integrated. At the same time, builders add more facilities to their high end buildings to gain better return on investment. By using the high performance, low cost, and well developed technologies, the intelligent building systems are extensively used in buildings. These advanced features increase the profits of the buildings as well as the reliability and life supportability of building.

Based on the evolution of intelligent buildings indicated above, it can be foreseen that intelligent buildings will become the mainstream of buildings in the future. But the developments of intelligent buildings may vary from countries to countries due to the difference in cultural background and environment conditions. Therefore, the construction of intelligent buildings should take into account the background, prevailing conditions, local culture, and market demands of that particular regions. A global planning and forecast on the development trends of intelligent buildings are needed.

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Biographical Sketches

Show-ling Wen is an Associate Professor of Architecture and the Director of Intelligent Building Simulation laboratory at the Chinese Culture University in Taipei, Taiwan. Dr. Wen has done a great deal of research on the development of intelligent buildings (IB) in the subtropical island environment such as the major cities in Taiwan. The research results have indicated that the facilities used for the indoors climate control of IB are technically sophisticated and mostly imported from the developed countries located in the cooler and less humid environment. Many hardware and software problems have occurred and been identified in Dr. Wen's research. The facilities management systems to deal with the problems encountered in the IB of the subtropical islands are currently under developing at Dr. Wen's Laboratory.

Mr. Chiang-Pi Hsiao is the Director General for the Architecture and Building Research Institute, Ministry of the Interior (ABRI, MOI), being responsible for the overall administration and management of a variety of architectural research plans. Mr. Hsiao has undertaken the research and administrative affairs for building environmental control, water resource management, and intelligent construction technology through serving different positions in the ABRI, the Construction and Planning Agency,

and Taiwan Water Company for more than forty years. Recently, his research focused on the establishment of the intelligent building evaluation system as well as its application. Under his active leadership and experienced supervision, a series of policies, specifications, and guidelines for intelligent building development were completed and three National Laboratory Groups were established.