Intelligent Buildings

(MECH3023)

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Intelligent Buildings

- Defining Intelligent Buildings

Definition for Intelligent Buildings

- There is no universally accepted definition
- Definitions vary from place to place to suit the culture and needs
- There has been a statement 'IBs are not intelligent but they can make the occupants more intelligent' ;-)
- Most definitions try to ensure buildings are suitable for occupants to work and live in safely, comfortably, effectively and efficiently

First Intelligent Building

- City Place Building in Hartford, Connecticut, USA
- Inaugurated July 1983
- United Technology Building Systems Corporation (UTBS) provided each tenant with communication and shared tenant services, such as office automation, local area network (LAN), digital private automatic branch exchange (PABX) and computers

Some Definitions

- An IB is one in which the building fabric, space, services and information systems can **respond in an efficient manner** to the initial and changing demands of the owner, the occupier and the environment (*Arup, 2003*)

- An IB combines innovations and technology with skillful management to **maximize return** on investment (*International Symposium, Toronto, 1985*)

- An IB is one which has an **information communication network** through which two or more of its services systems are automatically controlled, guided by predictions based upon a knowledge of the building and usage, maintained in an integrated database. (*Leifer, 1988*)

- Refers to any structure designed to incorporate a **combination of electronic systems** for the convenience, comfort or safety of its occupants. Such systems include networks, facilities for data processing, office automation, telecommunications and building management systems. (*Lobb, 1988*)

- An IB is a **dynamic and responsive architecture** that provides every occupant with productive, cost-effective and environmentally approved conditions through a continuous interaction among its **four basic elements**:
  - places (fabric; structure; facilities);
  - processes (automation; control; systems);
  - people (services; users) and
  - management (maintenance; performance) and the inter-relation between them (*CIB Working Group, 1995*)

- An IB as one that provides a responsive, effective and supportive intelligent environment within which the organization can **achieve its business objectives** (*DEGW/Teknibank research project – The Intelligent Building in Europe, 1992*)

Definition of IB (USA)

- Intelligent Building Institute (IBI) states:
  - An IB is one which provides a productive and cost-effective environment through optimization of its four basic elements, i.e. structure, systems, services and management, and the inter-relationships between them.
  - IB helps building owners, property managers, and occupants realize their goals in the areas of cost, comfort, convenience, safety, long-term flexibility and marketability
  - Optimal building intelligence is the matching of solutions to occupant needs

Owner and Occupant Needs

Structure
Riser space
Slab-to-Slab ceiling heights
Raised floor and drop ceilings
Windows treatments
Roof and floor loading
Access to utilities (electricity, telephone, etc)
Fixtures, finishes and furnishings
Wiring and electrical closets
Fire-proofing materials
Curtain wall
Conduits

Systems
HVAC
Lighting
Power
Telecommunication
Information management
Wiring
Controls
Vertical transportation
Potable and flush water
Hot water
Access control
Fire services
Security
Etc….

Services
Office automation
Voice, data and video communication
Shared office meeting and computer room facilities
Fax and photocopying
Moves, adds and changes for customer
Telephone and computer equipment
Electronic mail and voice mail
Security management
After hour operation
Parking and other transportation
Cleaning and maintenance

Management
Maintenance management
Property management
Leasing management
Technology management
Energy and efficiency management
Trend analysis
Structural management and maintenance
Services management

Definition of IB (Europe)

- UK based European Intelligent Building Group states:
  - **IB is one that creates an environment which maximizes the effectiveness of the building's occupants while at the same time enabling efficient management of resources with minimum life-time costs of hardware and facilities.**
  - Interpretation
    - building developers need to understand precisely what buildings they should develop that will be both profitable and able to meet the users' needs
    - IT providers need to understand the relationship between the building, its occupants and the facilities they provide
    - Occupants need to understand what it means to occupy in an IB
  - The definition is more on the users' requirement than on technologies

Definition of IB (Singapore)

- The government stated that an IB must fulfill 3 conditions:
  - **Advanced automatic control** systems to monitor various facilities, including A/C, lighting, security, etc. to provide a comfortable working environment for the tenants
  - Good **networking infrastructure** to enable data flow between floors
  - Provide adequate **telecommunication** facilities

Definition of IB (Mainland China)

- 3A or 5A terminology
- 3A = communication automation (CA)
  office automation (OA)
  building management automation (BA)
- 5A = 3A *plus*
  fire automation (FA)
  maintenance automation (MA)

Definition of IB (Japan)

- Focus on 4 aspects:
  - A focus for receiving and transmitting information and supporting management efficiency
  - Satisfaction and convenience for occupants
  - More attentive building administrative services with lower cost
  - Fast, flexible and economical responses to changing sociological environments, diverse and complicated office work and active business strategies

Definition of IB (AIIB) – Asian

- An IB is designed and constructed on an appropriate selection of Quality Environment Modules to meet the users' requirements by **mapping** to the appropriate **building facilities** to achieve a long-termed building value.
- Two dimensions:
  - Building developers / owners / occupants (**deliverable items**)
  - Enabling technologies (**systems and services**)
- Integration generate the values of the building in terms of productivity, market values, etc. that can be **measurable**

- Allows different buildings will have a set of different design criteria
- Modules are selected and assigned in priorities, e.g. M1, M6, M4, M5, M3, M7, M2, M8
- Once a module is selected, a pre-selected set of facilities will be assigned accordingly
- http://www.aiib.net/ibi-details.htm for more details of IBI development

Quality Environment Modules

- M1 – Green Index
- M2 – Space Index
- M3 – Comfort Index
- M4 – Working Efficiency Index
- M5 – Culture Index
- M6 – High-tech Image Index
- M7 – Safety and Security Index
- M8 – Construction Process and Structure Index
- M9 – Cost Effectiveness Index
- M10 – Health and Sanitation Index

- M1 to M10 form the **fundamental level** (1st level)
- There are elements / **key features** that comprises the second level (IBI 3.0 2004 states 378 such elements)
- These key elements are items that designers should consider when designing an intelligent building

Categorising IB Definitions

The different definitions if IBs can be roughly categorised into the following directions:

- Performance-based definitions
  - Stating what performances a building should have
  - E.g. EIBG (European Intelligent Building Group), IBI (USA)
  - Emphasize on building performance and the demands of users rather than the technologies or systems provided
- Services-based definitions
  - From the viewpoint of services and/or quality of services
  - E.g. JIBI (Japanese Intelligent Building Institute)
- System-based definitions
  - Directly addressing the technologies and technology systems
  - E.g. Chinese IB Design Standard

Intelligent Buildings

- Elements and Components

Essential elements of IBs

- Intelligent buildings cannot be separated from the architectural design, building facades and materials
  - Intelligent architecture
  - Intelligent and responsive building facades

Intelligent Architecture

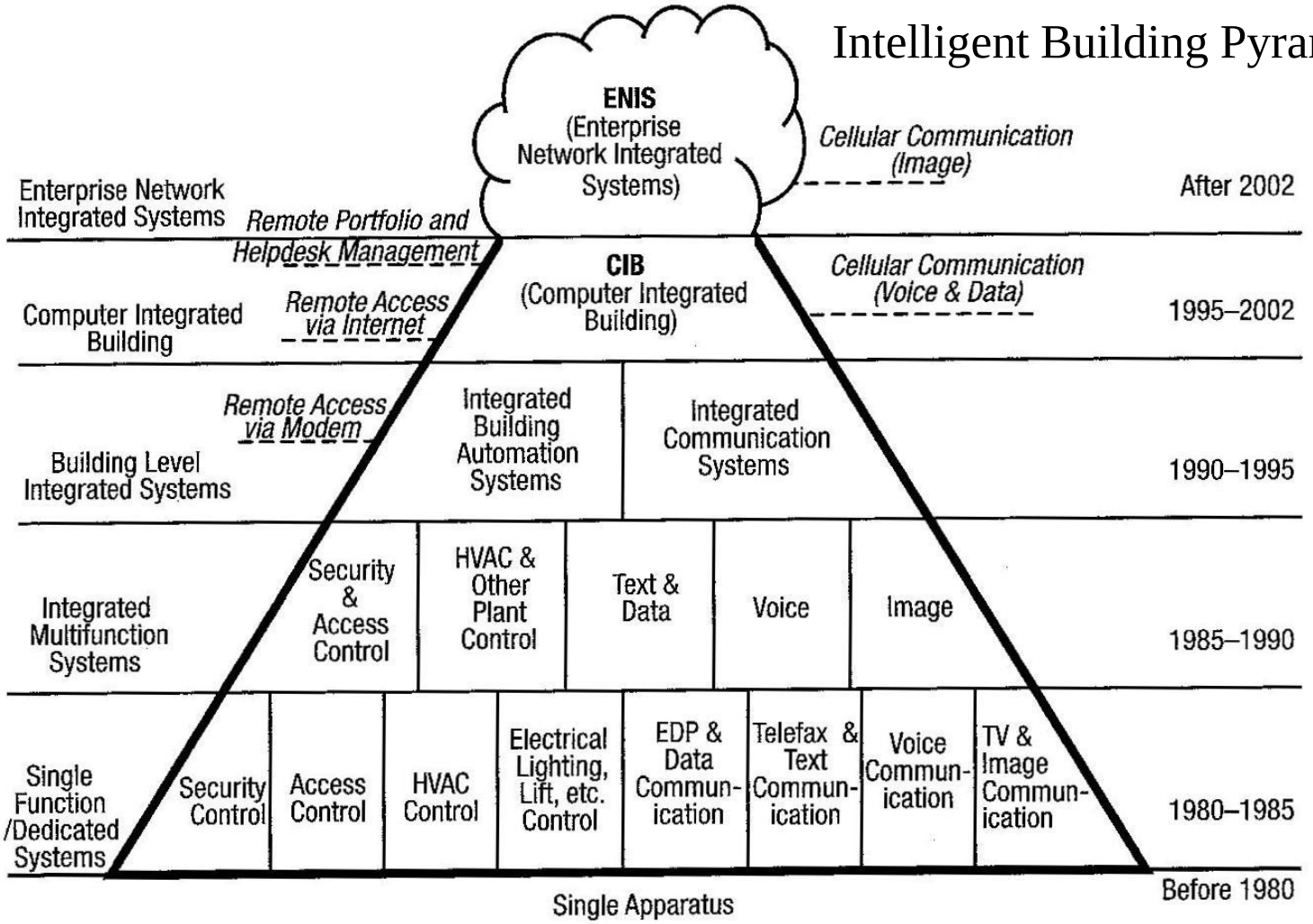
- Built forms whose integrated systems are capable of anticipating and responding to phenomena that affect the performance of the building and its occupants
- Areas of concern:
  - Intelligent Design – responding to humanistic, cultural and contextual issues, harmony with nature, proper use of resources
  - Appropriate use of intelligent technology – responding to cultural preferences of the occupants (not merely hightech)
  - Intelligent use and maintenance of buildings – incorporate intelligent facility management processes, simple to operate, energy and resource efficient

Intelligent and responsive building facades

- Intelligent facades can be
  - Centrally controlled with overriding capabilities
  - Changing thermophysical properties like resistance, transmittance, absorptance, permeability
  - Modifiable interior and exterior colour or texture
  - Communicating with video and voice capabilities
  - Optimized in cooling and heating for various climatic conditions

Evolution of Intelligent Buildings

Intelligent Building Pyramid

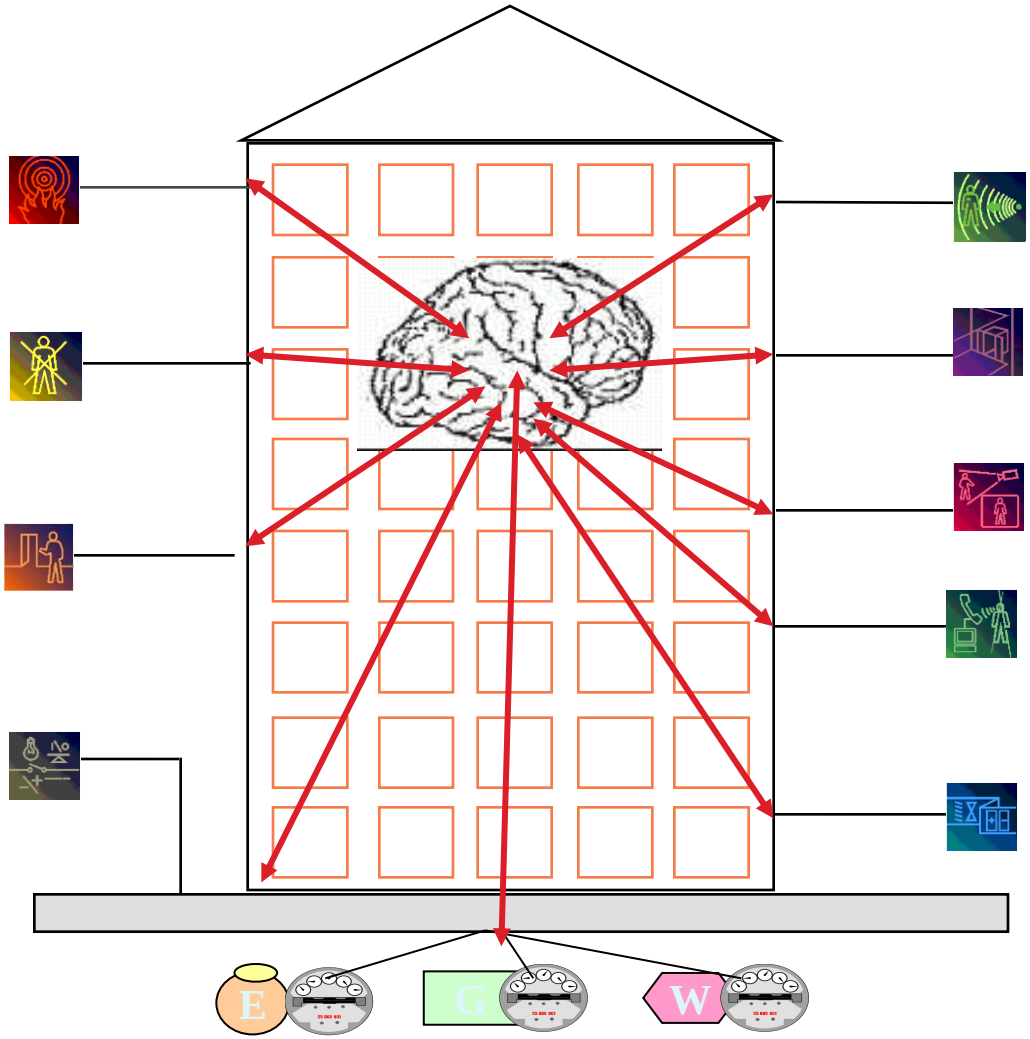


(Source: Intelligent Buildings and Building Automation, 2010, S.Wang, Spon Press)

Hardware Components of an IB

- Integration of various building systems
  - Energy management system
  - Lighting management system
  - Security systems & fire safety
  - Telecommunications & office automation
  - Local area networks (LANs)
  - Cabling management
  - Intelligent maintenance mgt. system (IMMS)
  - Computer aided facility management (CAFM)

Major elements of intelligent buildings



FIRE
Functionality checks
Detector service
Fire, Life, Safety

SECURITY
Doors
PIR
Integration

ACCESS
Doors
Buildings
Occupancy
Feed Forward

ENERGY
Utility Monitoring (Elec/Water/Gas/Oil)
Tenant Building
Air/Water
Heat
Lighting
Back-up Generation

LIGHTING
Schedules
Occupancy Sensing

LIFTS
Breakdown
Maintenance
Traffic Performance

COMMUNICATIONS
Voice/Video/Data

24/7 Monitoring
Breakdown
Plant Tuning
Conditioned Monitoring
Car Park Utilisation

HVAC
Air-Handling Unit
Boilers
Pumps
Fans
Energy Control
Variable Air Volume
Air Quality

(Source: Continental Automated Buildings Association (CABA), www.caba.org)

Hardware Components of an IB

- Four main aspects:
  - Facility management
    - Take care & maintain various functions for occupant comfort & operation
  - Information management
    - Office automation (OA), LAN, wiring
  - Communication
    - Tel/Fax, e-mail, video telecommunication
  - Control
    - DDC, building automation system

Hardware Components of an IB

- Major categories:
  - Energy efficiency
    - Energy management and control
  - Lifesafety systems
    - Fire alarm and security
  - Telecommunications systems
    - PABX telephone, videotext, cablevision, e-mail
  - Workplace automation
    - Data processing, word processing, CAD, information services

Hardware Components of an IB

- Common needs of intelligent building tenants:
  - Built-in Internet wiring
  - LAN/WAN connectivity
  - Conduits for cabling
  - High-tech HVAC
  - Wiring for high-speed networks

Hardware Components of an IB

- Critical performance qualities
  - Functional or spatial quality
  - Thermal quality
  - Air quality
  - Aural quality
  - Visual quality
  - Building integrity

Intelligent Buildings

- IB@Work
- IB@Home

IB @ Work

- Office space and commercial buildings
  - Speculative offices (USA or European)
  - Organizational/functional requirements
  - Impact of IT and business strategy
- Objectives
  - Responsive (to user needs / to climate)
  - Efficient (building design & systems)
  - Effective (operation & management)
  - Better integration (with IT & within systems)

IB @ Work

- Current and future development
  - New ways of working
    - More interaction
    - More collaboration (physically or electronically)
    - More individual autonomy
  - New patterns of space use
    - More group spaces
    - More shared spaces
    - More space for concentration
    - More intermittent space use

IB @ Work

- Major systems
  - Building automation system (BAS)
  - Office automation system (OAS)
  - Communication automation system (CAS)
- Criteria
  - Business value/benfits
  - Efficiency
  - Effectiveness

IB @ Home

- Present technology
  - Phones and intercoms
  - Home automation
  - Audio distribution (e.g. hi-fi speaker)
  - Video distribution (e.g. TV)
  - Video surveillance (e.g. security)
  - Structured wiring
  - Home theater, game station

IB @ Home

- Home automation (see also www.caba.org)
  - Climate control and energy management
  - Home networking
  - Home theatre
  - Integrated lighting control
  - Multi-room A/V systems
  - Residential gateways
  - Safety and security
  - Structured wiring
  - Whole house automation

IB @ Home

- Future home
  - Home networking
  - Internet appliances
  - Webcam, web phones
  - e-books, video walls
  - Home office
  - Virtual clinic/hospital
  - ……

Surf the web without wires!

House_n: MIT Home of the Future (http://architecture.mit.edu/house_n/)

IB @ Home

- **House_n**: research by Massachusetts Institute of Technology (MIT) Dept of Architecture (http://architecture.mit.edu/house_n/)
  - The PlaceLab (living laboratory for studying people and their interaction with technologies)
  - Open Source Building Alliance (OSBA)
  - Just-in-time persuasive user interfaces for motivating healthy behaviors
  - Ubiquitous computer interfaces for the home