**intelligent buildings design and building management systems**

**overview of 'intelligent buildings' and 'intelligent homes' technologies**

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 & attendance control and reporting (notably staff movement and availability). 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. This free summary article is contributed by Gary Mills, a leading UK-based expert in the field of Intelligent Buildings, Intelligent Homes, and Building Management Systems.

The origins of Intelligent Buildings and Building Management Systems have roots in the industrial sector in the 1970's, from the systems and controls used to automate production processes and to optimise plant performances. The concepts and applications were then adapted, developed and modularised during the 1980's, enabling transferability of the technology and systems to the residential and commercial sectors.

**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.

**heating - time-based control**

Time-based controls can be used to turn on and off the heating system (and/or water heating) at pre-selected periods (of the day, of the week, etc). Optimiser Parameters: whatever the conditions, the controls make sure the building reaches the desired temperature when occupancy starts.

**heating - optimiser parameter-based (temperature) control examples**

* Temperature control: protection against freezing or frost protection generally involves running heating system pumps and boilers when external temperature reaches a set level (0°C).
* Compensated systems: will control flow temperature in the heating circuit relative to external temperature. This will give a rise in the circuit flow temperature when outside temperature drops.
* Thermostatic radiator valves: these sense space temperature in a room and throttle the flow accordingly through the radiator or convector to which they are fitted.
* Proportional control: involves switching equipment on and off automatically to regulate output.
* Other methods can include thermostats, occupancy sensing PIR's (passive infra-red sensors), and manual user control.

**lighting control methods**

Different control systems exist, again time-based control and optimiser parameter-based where a level of illuminance or particular use of lighting is required.

* Zones: lights are switched on corresponding to the use and layout of the lit areas, in order to avoid lighting a large area if only a small part of it needs light.
* Time control: to switch on and off automatically in each zone to a preset schedule for light use.
* Passive Infra-Red (PIR) Occupancy sensing: In areas which are occupied intermittently, occupancy sensors can be used to indicate whether or not anybody is present and switch the light on or off accordingly.
* Light level monitoring: this consists of switching or dimming artificial lighting to maintain a light level measured by a photocell.

**building management systems and intelligent buildings - 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)

**building management systems and intelligent buildings - environmental and greenhouse gas benefits**

Greenhouse gas emission reductions depend on and correlate to reductions in energy use.

Intelligent Buildings and Building Management Systems technologies contribute directly to the reduction in energy use, in commercial, industrial, institutional and domestic residential sectors.

In short, Intelligent Buildings and suitably applied Building Management Systems are good for the environment.

Legislation and environmental standards; health and safety regulations; and global trends towards improving indoor air quality standards are all significant drivers of - and provide a continuous endorsement of the need for - Building Management Systems and the Intelligent Buildings technologies.

Government Initiatives around the world are also driving the development and adoption of Building Management Systems technologies. For example the UK Carbon Trust allows Enhanced Capital Allowance (ECA) to be offset against taxation on energy efficient systems, which enables savings of around 30% for all energy-related Building Management Systems and Intelligent Buildings equipment, and the associated installation and design costs.

**building management systems and intelligent buildings - market trends**

Careful interpretation is required. In the UK, adoption of controls technologies into the new build and major refurbishment sectors is relatively high: Estimates a few years ago of the UK market for Building Management **Control Systems** for new build and major refurbishment, all sectors, suggest market adoption of (as at 1994 - Source UK1 An Appraisal of UK Energy RTD, ETSU -1994):

* Heating controls 70%.
* Hot water system controls 90%.
* Air conditioning controls 80%.

However according to European Commission as many as 90% of all **existing buildings** have **inapplicable or ineffective** controls, many of which require complete refurbishment of control systems.

Moreover conventional control systems stop short of automated Intelligent Buildings full capabilities. A significant human element is required for optimal effective operation even if control systems correctly specified and installed.

Given typical installations and equipment there is often a difficulty for building occupants (residential) or managers (commercial) to operate them correctly. Usage and correct operation are vital for effective results.

Education of users; improved systems-design user-friendliness, and the provision of relevant instructions and information are all critical to enable theory to translate into practice, and for potential effectiveness and savings to be realised.

**building management systems and intelligent buildings - practical benefits**

Energy-effective systems balance a building's electric light, daylight and mechanical systems for maximum benefit.

Enhanced lighting design is more than an electrical layout. It must consider the needs and schedules of occupants, seasonal and climatic daylight changes, and its impact on the building's mechanical systems.

**lighting systems**

Adding daylight to a building is one way to achieve an energy-effective design. Natural daylight 'harvesting' can make people happier, healthier, and more productive. And with the reduced need for electric light, a great deal of money can be saved on energy. Nearly every commercial building is a potential energy saving project, where the electric lighting systems can be designed to be dimmed with the availability of daylight. **Up to 75% of lighting energy consumption can be saved.** In addition, by reducing electric lighting and minimizing solar heat gain, controlled lighting can also reduce a building's air conditioning load.

**mechanical systems**

The HVAC system and controls, including the distribution system of air into the workspaces, are the mechanical parts of buildings that affect thermal comfort. These systems must work together to provide building comfort. While not usually a part of the aesthetics of a building, they are critical to its operations and occupant satisfaction.

The number one office complaint is that the workplace is too hot. Number two is that it's too cold.

Many people cope by adding fans, space heaters, covering up vents, complaining, conducting 'thermostat wars' with their co-workers, or simply leaving the office. Occupants can be driven to distraction trying to adjust the comfort in their space. Improper temperature, humidity, ventilation, and indoor air quality can also have significant impacts on productivity and health. When we are thermally comfortable we work better, shop longer, relax, breathe easier, focus our attention better.

In order to provide a comfortable and healthy indoor environment the building mechanical system must:

* Provide an acceptable level of temperature and humidity and safe guard against odours and indoor air pollutants.
* Create a sense of habitability through air movement, ventilation and slight temperature variation.
* Allow the occupant to control and modify conditions to suit individual preferences.

**resistance to building management systems and intelligent buildings technology**

* "Our buildings are already energy-efficient." (Is the whole building energy-efficient, or is the landlord limiting his focus to common areas and gross leased spaces?)
* "We prefer the equipment with the lowest first cost when fitting out tenant space." (Does the specifier have any idea who will bear the increased operating costs of such a strategy?)
* "We need a two-year simple payback or less." (Is this still realistic, given that the percentage return on money markets is literally one-tenth what it was 20 years ago?)
* "Tenants pay all energy costs, and will get all the savings." (Do tenants really pay all energy or just the energy over a pre-set base year or expense stop?)
* "We're selling the building." (Should we assume then that lowering the operating expenses and reaping the increased asset value are not important?)

**intelligent homes**

**building management systems for residential applications**

With the widespread adoption of digital technologies there will be a profound change in how we communicate with others. Even how, in our homes, we shop for goods and services, receive news, manage our finances, learn about the world, and, conduct business, manage resources, find entertainment, and maintain independence and autonomy as we enter old age.

These activities increasingly take place in the home. As our perception of banks, shops, universities, communities, and cities change in response to new technologies, so home building management systems are taking on an extraordinary new importance.

As it exists today the home cannot meet these demands or take advantage of new opportunities created by social and technological changes. Most people live in spaces poorly tailored to their needs.

Until recently, the majority of homes were wired with little more than the main electrical circuits, a few phone lines, and a few TV cables. Times have changed. Electrical and security system contractors routinely install low voltage communication network cables for a wide range of intelligent home or 'smart home' systems.

Services and equipment that utilise these networks include: security; home theatre and entertainment; telephones, door-phones and intercoms; PC and internet networks; surveillance cameras; driveway vehicle sensors; communicating thermostats; motorized window blinds and curtains; entry systems; and irrigation systems.

**smart homes**

'Smart home' is an alternative term for an intelligent residential building, or an intelligent home. A few years ago these concepts weer considered futuristic and fanciful. Now they are reality. These terms are now commonly used to define a residence that uses a control system to integrate the residence's various automation systems.

Integrating the home systems allows them to communicate with one another through the control system, thereby enabling single button and voice control of the various home systems simultaneously, in pre-programmed scenarios or operating modes.

The development of smart home systems focus on how the home and its related technologies, products, and services should evolve to best meet the opportunities and challenges of the future. The possibilities and permutations are endless. Here are some examples:

**smart home example scenario 1**

A scenario such as 'I'm Home' could be triggered by pressing one button on a key-ring remote-control from your vehicle as you approach the driveway. The control system receives the key-ring remote-control's command. This will then trigger a pre-programmed sequence of functions. For example starting by turning on the lighting in the driveway, garage, hallway, and kitchen. It then disarms the security system, opens the garage door, unlocks the interior garage entry door, adjusts the heating to a preset temperature, and turns on the whole-house audio system playing your favourite cd, whilst drawing you a bath.

The control system is programmed to meet specific user requirements, initiating sequential automatic operation of the home systems, in response to 'one button' commands based on the situation and or time.

**smart home example scenario 2**

At 7:30am and you awake to the sound of your favourite cd playing in the background; the lights in your bedroom switch on; 'fading up' to allow you to wake up in your own time. The downstairs intruder alarm system is de-activated. In the kitchen the coffee machine turns on to make a drink. The ground floor curtains and blinds open; the towel heater in the bathroom warms the towels. And you haven't even got up yet.

This simple example demonstrates how smart home technology will change people's lives. Designing systems that group together and automate everyday simple tasks, improve quality of life and reduce stress levels.

I am grateful to Gary Mills of [Fusion Group](http://www.fusionibs.co.uk/) for providing much of the content in this article. Fusion specialise in the design of intelligent buildings, and living and working environments, which includes design for energy efficiency and climate change considerations. If you are in the UK and interested in receiving a Transparent Building CD-ROM which includes information relating to these subjects please email your enquiry to gary.mills@fusionibs.co.uk, or call: (UK) 08450 204 360.

References

www.eca.gov.uk

www.actionenergy.org.uk

www.defra.gov.uk

www.thecarbontrust.co.uk

www.clipsal.com/cis

www.europa.eu.int/comm