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buildings
An introduction

Edited by
Derek Clements-Croome

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Buro Happold

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Preface

This book is an introduction to intelligent buildings and was conceived and planned by members of the Chartered Institution of Building Services Engineers (CIBSE) Intelligent Buildings Group which was founded by me in 2006. The book is not an official publication of the CIBSE. In addition we invited some other distinguished professionals to participate. The book has the support of the International Council for Research and Innovation in Building and Construction (CIB).

Each chapter provides a basic knowledge to enable a strategic view of the design and management issues involved to be formed by young professionals and students across all built environment disciplines. The last six chapters present a range of case studies by Buro Happold; Arup Associates; Atelier Ten; ZZA; Trend; and authors from Hong Kong and Okinawa. For those readers wanting more detail they should refer to the *Intelligent Buildings International Journal* and the second edition of the book *Intelligent Buildings: Design, Management and Operation* published by ICE Publishing in 2013.

I would like to thank our sponsor Skanska; Nicki Dennis and Alice Aldous of Taylor and Francis; in addition to the above mentioned companies my fellow CIBSE Intelligent Buildings Group authors: Richard Everett, Gareth Davies, Ken Gray, Alan Johnstone, Philip King, Peter McDermott and Mark Worall. In addition, Martin Davis, Lisa Gingell, Ziona Strelitz, Barış Bağcı, Francesca Galeazzi, Lau Po-chi, Lam Yuen-man Bonnie joined us.

Intelligent buildings are a vibrant part of the sustainability debate and they are a major feature in the many eco cities planned in various countries. Above all they affect the working and leisure lives of people. We hope you will enjoy this knowledge taster on a topic that stretches back into history but also forward to the future.

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Abbreviations

ACE	Association for Consultancy and Engineering
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
BEAMA	British Electrotechnical and Allied Manufacturers' Association
BERR	Department for Business, Enterprise and Regulatory Reform
BSRIA	UK Building Services Research and Information Association
CIB	International Council for Research and Innovation in Building and Construction
CIBSE	Chartered Institution of Building Services Engineers
CIC	Construction Industry Council
DCLG	Department for Communities and Local Government
DCMS	Department for Culture, Media and Sport
DEFRA	Department for Environment, Food and Rural Affairs
DTI	Government Department of Trade and Industry
FETA	Federation of Environmental Trade Associations
HVAC	Heating, ventilation and air-conditioning
ICT	Information computer technology
NAC	National Audit Council
OGC	Office of Government Commerce
RIBA	Royal Institute of British Architects
SEC	Group Specialist Engineering Contractors' Group
WLC	Whole life cost

Contents

<i>List of illustrations</i>	vii
<i>List of contributors</i>	xi
<i>Preface</i>	xii
<i>Abbreviations</i>	xiii

PART I	
Principles of design and management practice	I
1 Introduction	3
DEREK CLEMENTS-CROOME	
2 Building owner's perspective	8
MARK WORALL	
3 Why should a client invest in an intelligent building?	11
RICHARD EVERETT	
4 Bringing intelligence to buildings	15
GARETH DAVIES	
5 Human factors	25
DEREK CLEMENTS-CROOME	
6 Integration of people, processes and products	35
DEREK CLEMENTS-CROOME AND LISA GINGELL	
7 Robustness in design	45
KEN GRAY	
8 Passive and active environmental quality control	49
MARK WORALL	

9	Intelligent buildings management systems	59
	DEREK CLEMENTS-CROOME AND ALAN JOHNSTONE	
10	Integrated teams can deliver more for less	67
	MARTIN DAVIS	
11	BIM: A collaborative way of working	77
	PHILIP KING	
12	Post-occupancy evaluation	92
	DEREK CLEMENTS-CROOME	
13	Tenets for planning design and management of intelligent buildings	96
	DEREK CLEMENTS-CROOME	

PART II

Case studies 99

14	Intelligent buildings in practice: the Buro Happold experience	101
	PETER MCDERMOTT	
15	Post occupancy evaluation: University of Nottingham Jubilee Campus	110
	MARK WORALL	
16	Tall building design and sustainable urbanism: London as a crucible	124
	ZIONA STRELITZ	
17	Druk White Lotus School, Ladakh, India	145
	FRANCESCA GALEAZZI	
18	Energy saving potential for a high-rise office building	161
	BARIŞ BAĞCI	
19	An intelligent building index awarded building	175
	LAU PO-CHI AND LAM YUEN-MAN BONNIE	
20	Intelligent building management	187
	ALAN JOHNSTONE	

<i>Bibliography</i>	197
---------------------	-----

<i>Index</i>	213
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Illustrations

Figures

1.1	Classification of terms	7
4.1	Parasympathetic Nervous System	16
4.2	Sympathetic Nervous System	17
4.3	An illustration of the Turing Test	20
4.4	An example of a logical black box in an iBMS model	21
4.5	How a facility manager might see an iBMS with an example of the enabling technology required	21
4.6	A top-level IT view of a set of black-box systems	22
4.7	Google vs Apple Android vs IOS	23
6.1	The three facets of building performance	38
6.2	Profile of energy consumption in the conference room of the City Inn Hotel, Westminster	40
6.3	Educating staff resulted in a reduction in energy consumption in the conference room	41
6.4	Energy consumption in the conference room in August 2009	43
6.5	Energy consumption in the conference room in January 2010	43
8.1	UK commercial building energy consumption 2011	55
8.2	Typical heat losses in UK buildings	55
9.1	MASBO functional architecture	61
9.2	Model of control levels	62
9.3	The integrated building	64
9.4	Typical BMS dashboard	66
11.1	The wedge diagram	78
11.2	Thermal model	80
11.3	3D model	81
11.4	3D model – prefabrication	83
11.5	3D model	85
11.6	Ceiling void coordination	85

11.7	People and processes – not just technology	86
11.8	3D model – shell and core	86
11.9	3D model – distribution calculations	87
11.10	The model can be used for demonstration of space and access requirements, coordination, visualisation and prefabrication	88
11.11	Industry experience	89
11.12	Actual experience	89
11.13	CFD model	90
15.1	Photograph of Amenities Building and floor plans	112
15.2	Photograph of International House and floor plans	114
15.3	Photograph of Sir Colin Campbell Building and floor plans	117
16.1	Aerial view of City of London conveying its complexity	126
16.2	Framework of view controls in City of London relating to St Paul's Cathedral	127
16.3	Competition to the City of London: vertically extruded large orthogonal footprints at Canary Wharf	128
16.4	The Pinnacle's elevational treatment showing the frame around the building	129
16.5	Heron Tower: good daylight, sense of community and scope for easily accessible stairs within an office village	130
16.6	Heron Tower: animating the City through its vertical circulation	131
16.7	The bedrock of Heron Tower's environmental design	133
16.8	Mix of uses in different sections of The Shard	134
16.9	Scope for energy sharing with The Shard's mixed use design	135
16.10	The Shard's strongly modelled form	137
16.11	The Minerva Tower	137
16.12	Floorplan for The Minerva Tower	138
16.13	Daylight, external aspect and fine spatial quality between the blocks	138
16.14	Vertical transportation scheme for The Minerva Tower	139
16.15	The Leadenhall Building	140
16.16	Unifying and reinforcing the City's tall building cluster	140
16.17	Unifying and reinforcing an urban cluster: The Pinnacle	141
16.18	The Pinnacle's vertical gap on axis with the entrance	142
17.1	Ladakh, a high altitude desert	146
17.2	Ladakh, a high altitude desert	146
17.3	Ladakh; traditional villages are still closely linked to monasteries and a rural economy	146
17.4	Opening ceremony of the first school block in 2001	147
17.5	Local stone and timber building	147

17.6	Model of the masterplan	149
17.7	Local materials are used	150
17.8	Plan of the school courtyards	152
17.9	The school buildings are designed to gain maximum solar heat	152
17.10	Primary school: earthquake resistant timber portal frames	152
17.11	Junior school: knee-brace solution to reduce amount of timber used	152
17.12	Residences are organized around a landscaped courtyard and face due south	153
17.13	Internal view of a residential building	153
17.14	Temperature monitoring	153
17.15	Structural stability and earthquake design have been analysed with GSA software	155
17.16	Ventilated Improved Pit latrines: introduction of a solar flue eliminates fly problems and odours	155
17.17	Ventilated Improved Pit latrines: working principle of the solar flue and composting pits	155
17.18	Ventilated Improved Pit latrines: CFD analysis of ventilation performance of the solar flue	156
17.19	Photovoltaic panels power the water supply, lights and computers	159
17.20	Visualization of the new library building	159
17.21	Exploded view of the new library building	159
17.22	Young students at the opening ceremony in 2001	160
18.1	Baseline – chiller consumption vs. degree-days	163
18.2	Part of TST, which is included in the pilot scheme	165
18.3	ANSI/ASHRAE Standard 62–2001, Figure C-2	167
18.4	Annual energy consumption in MWhs	172
19.1	WFC located at CBD Beijing	178
19.2	WFC is a twin tower office building with column-free design	179
19.3	Winter Garden is built between two office towers	180
20.1	Radisson Blue Heaven Hotel	188
20.2	Integration network	189
20.3	National Gallery, London	191
20.4	Tablet with BMS graphics	194
20.5	Child-friendly BMS graphics	196

Tables

3.1	Typical examples of the 4E advantages of intelligent buildings	12
5.1	Maslow's Hierarchy of Needs in the Workplace	32
6.1	The views of all the interested parties in the traditional design and construction process need to be appreciated if mutual understanding is to be developed	37
8.1	Factors contributing to the assessment of thermal comfort	50
8.2	Adaptive response factors	50
8.3	Fabric	51
8.4	Ventilation	53
8.5	Heating	56
8.6	Cooling	57
8.7	Intelligent control	58
15.1	Project team	110
15.2	Predicted and actual annual carbon dioxide emissions of case study buildings based on SBEM rating	121
15.3	Actual annual energy consumption and carbon dioxide emissions of case study buildings	121
18.1	Monthly recorded chiller consumption and monthly degree-days	163
18.2	Monthly chiller operation data	164
18.3	Efficiency recommendations for water-cooled chillers	165
18.4	PAU consumption with new IAQ setpoint	168
18.5	Pump motor power consumption with VSDs	170
18.6	Comparison of lighting energy consumption with T12 and T5 tubes	172
18.7	Comparison of lighting energy consumption with incandescent light bulbs and compact fluorescent lamps	172
18.8	Energy saving potential summary	173
19.1	Weights of different types of buildings in IBI Version 3.0	177
19.2	Building ranking in IBIV3	177
19.3	Assessment results for WFC	179
19.4	Combined score of the intelligent building index	183
19.5	Ten modules of IBIV4	183
19.6	Scoring standards in IBIV4	184
19.7	Ranking of building intelligence by the combined score	185
19.8	Module names and number of elements difference in IBIV3 and IBIV4	185

Principles of design and management practice

Introduction

Derek Clements-Croome

An intelligent building is one that is responsive to the occupants' needs, satisfies the aims of an organisation and meets the long term aspirations of society. It is sustainable in terms of energy and water consumption and maintains a minimal impact to the environment in terms of emissions and waste. They are also healthy in terms of well-being for the people living and working within them and are functional according to the user needs.
(Clements-Croome, 2009)

Intelligent buildings should be sustainable, healthy, technologically aware, meet the needs of occupants and business, and should be flexible and adaptable to deal with change. The life cycle process of planning, design, construction, commissioning and facilities management, including post-occupancy evaluation, are all vitally important when defining an intelligent building. Buildings comprise many systems devised by many people, yet the relationship between buildings and people can only work satisfactorily if there is an integrated design, construction and operational team possessing a holistic vision.

Buildings affect people in various ways. They can help us to work more effectively, they can present a wide range of stimuli for our senses to react to, and they provide us with the basic human needs of warmth fresh air and security. Intelligent buildings are designed to be aesthetic in sensory terms, including being visually appealing; they are buildings in which occupants experience delight, freshness, a feeling of space. They should integrate daylight into their design, and should provide a social ambience which contributes to a general sense of pleasure and improvement in mood.

If there is to be a common vision, it is essential for architects, engineers and clients to work closely together throughout the planning, design, construction and operational stages of the building's total life cycle. This means that planners, consultants, contractors, manufacturers and clients must share a common vision and set of intrinsic values, and must also develop a single understanding of how patterns of work are best suited to a particular

building when served by the most appropriate environmental systems. A host of technologies are emerging that help these processes, but in the end it is how we think about achieving responsive buildings that matters. Intelligent buildings need to cope with social and technological change and are also adaptable to short-term and long-term human needs; however, from the outset this must be delivered through a vision and understanding of the basic function and character of the building.

Throughout history clean air, sunlight, sound and water have been fundamental to the needs of people. Today, sensitive control of these needs may use either traditional or new solutions, or a blend of these, but we have to remember that the built environment is fundamental to mankind's sense of well-being and it is the totality of this idea that we need to understand and value even in this low carbon economy age. Intelligent buildings respect these values for the individual, the business organisation and for society, and we can learn a lot about intelligent buildings by looking at the history of world architecture and seeing how people have adapted buildings to deal with the rigours of climate and the changing face of civilisation. There are also lessons from Nature; animals and plants that have evolved to use materials and expend energy optimally in a changing and dynamic environment. Similarly buildings are now having to absorb the impact of the technological age, but the implications of climate change and the need for healthy working conditions are now also dominating our thinking as people become more knowledgeable about their environment.

Modern buildings consume a great deal of energy and water in their construction and during their total life cycle operation. They use large quantities of materials and aggregates and generate waste and pollution at every stage of their existence. It is no longer acceptable to consider a building and its systems in isolation from its social impacts. The growth of megacities to over 10 million people by 2050 is now part of a rising trend towards urban living and development. Modern liveable cities do comprise intelligent and sustainable buildings and infrastructures, however, they are designed to show a respect for the natural environment in all respects. *Sustainable and Intelligent Cities* are composed of *intelligent buildings* supported by *intelligent infrastructures* and are created for the well-being of the residential, commercial and industrial communities which inhabit them.

In the future, there will need to be a consideration towards the influences buildings have on society, the local community and future generations. For this, we will need to consider the environmental, social and economic impacts of each building throughout the total processes of bringing it into being or deciding to refurbish existing ones. *Whole-life value* in which quality and whole-life costs are assessed is therefore paramount if we are to think long term and meet growing sustainability demands. However, this does not mean architecture has to be starved of human considerations; after all improving the quality of life is an essential ingredient of sustainable development.

For intelligent buildings to be sustainable and to sustain their performance for future generations, they must remain healthy and technologically up to date; they must meet regulatory demands; they must meet the needs of the occupants; and they must be flexible and adaptable enough to deal with change. Buildings inherently contain a variety of systems devised by many people, and yet the relationship between buildings and people can only work satisfactorily if there is *integration* between the supply- and demand-side stakeholders as well as between the occupants, the systems and the building envelope. *Systems thinking* is an approach essential in planning, design and management, together with the ability to create and innovate whilst remaining practical. The ultimate objective should be *simplicity* rather than complexity, which not only requires technical ability, but also requires the powers of interpretation, imagination and even intuition as part of the building process. Building Regulations can stifle creativity yet are necessary to set minimum levels of expectation and to satisfy basic health and safety requirements. However, we should aim our work well above these prescriptive requirements; after all, buildings form our architectural landscape, they generate the environment we inhabit and they should uplift the soul and the spirit of the people within them as well as those who visit them.

The key criteria for achieving good-quality intelligent buildings are defined by Strelitz (2006) as:

- satisfying stakeholder objectives and needs;
- meeting social and environmental needs; and
- recognition of available resources.

An intelligent building starts with a good client brief and should comprise of:

- a clearly articulated project vision;
- a recognition of the planning, design and procurement realities; and
- about whole-life value objective.

The creation of shared visions, effective teams, clear structures and robust processes ensures that the intelligent building being constructed will demonstrate the purpose for which it was conceived. Times are certainly changing so there needs to be an outlook by the project team which is long term and not just short term.

Key issues for intelligent buildings are sustainability (energy, water, waste and pollution); innovation such as the use of information and communication technology, robotics, embedded sensor technology, smart-materials including nanotechnology; adaptability and flexibility; health and well-being in the workplace; and an understanding of social change. Aesthetics as well as function are important in the sense that not just the visual appearance is