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intelligent buildings

An introduction

Edited by
Derek Clements-Croome

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University of Reading
SKANSKA
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Buro Happold
Routledge
Taylor & Francis Group
LONDON AND NEW YORK
earthscan
from Routledge
The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

First published 2014
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
Intelligent buildings: an introduction/edited by Derek Clements-Croome.
pages cm
Includes bibliographical references and index.
1. Intelligent buildings. I. Clements-Croome, Derek, editor of compilation.
TH6012.1575 2013
696–dc23 2013009877

ISBN13: 978–0-415–53113–9 (hbk)
ISBN13: 978–0-203–73771–2 (ebk)

Typeset in Sabon by
Swales & Willis Ltd, Exeter, Devon

Printed and bound in Great Britain by
TJ International Ltd, Padstow, Cornwall

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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 Francesa 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

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Chapter 1

Introduction

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> 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