INTELLIGENT-BUILDINGS
A COMPUTER SCIENCE VIEW

"A house is a machine for living in." Le Corbusier, 1921

Intelligent Buildings Group
University of Essex

cswww.essex.ac.uk/intelligent-buildings
robots@essex.ac.uk

People:

- Victor CALLAGHAN
- Graham CLARKE
- Sue SHARPLES

Current Focus of Research:

- Using IB for care provision
- For residential or domestic applications
- Only part of work may be generalisable to other IB applications

© Intelligent Agents Group, University of Essex

What Are Intelligent Buildings ?

Building Industry:

- Use term intelligent, to describe the way the design, structure, services and management of a building can ensure that the building is flexible and adaptable, and therefore profitable, over its full life-span.

Computer Science:

- Our view is different.
- Centres around use of computers for controlling aspects of building services.
- Explanation is aim of this talk.

© Intelligent Agents Group, University of Essex

IB Generations

- computer-controlled buildings have existed for over 20 years

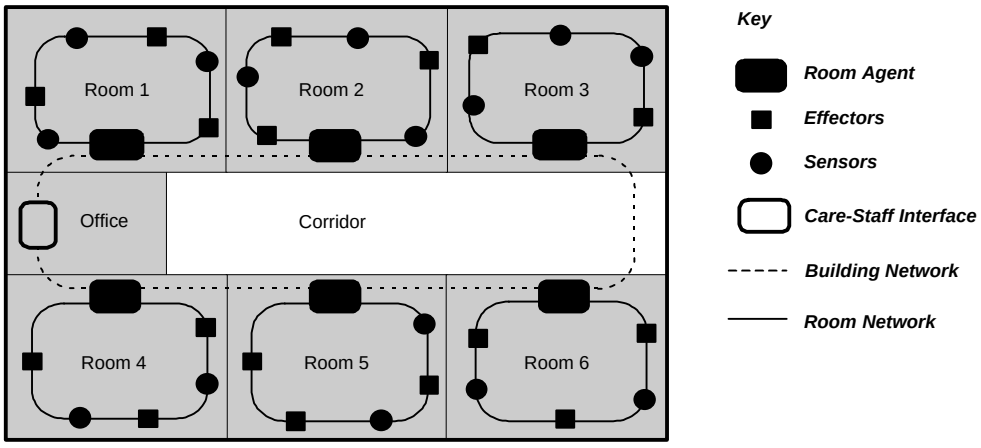
1st. numerous independent *self-regulating* (automatic) sub-systems

2nd. as 1st but connected via specialised *network* (eg BACnet, ESHA Lonworks, CEbus, X10 etc) and various physical media for remote/centralised control (eg simple scheduling)

3rd. as 2nd but *self-governing* (autonomous) systems ie learn, make their own rules (and perhaps collaborate) etc

© Intelligent Agents Group, University of Essex

Computer Controlled Building Example



What is in the Rooms ?

Sensors	Effectors
temperature	heaters
light	lights
pressure pad	alarms
appliances	appliances
window	windows
smoke	doors
occupancy	
movement	
person ID	
call alarm	

plus other global sensors (time, external light level, other agents etc)

© Intelligent Agents Group, University of Essex

Intelligence

- Buildings - so far have not contained any significant '*intelligence*' in *human* or computer science terms
- intelligence - "those systems that automate activities we associate with needing human thought …. generally involving purposeful behaviour, decision making, problem solving, learning etc" (adapted from Bellman 1978)
- Equivalent to putting a person (an *embedded-agent* in computer science jargon) "into" a building control system (this is the hard bit our research is focused on)
- Based on "assumption" of significant benefits from having an artificial person (*embedded-agent*) in control of building systems.

© Intelligent Agents Group, University of Essex

Are there benefits to having a person (agent) overseeing control (rather than simple automation)?

We answer *yes* based on the unique qualities arising from:

Technical Issues (Examples):

- **Learning -** allows the system to particularize itself to individuals (rather than most scientific solutions which seek to generalise).
- **Reasoning –** allows the system to make more difficult analysis and decisions.
- **Collaboration –** agents can pool information to increase the quality of information and decisions.

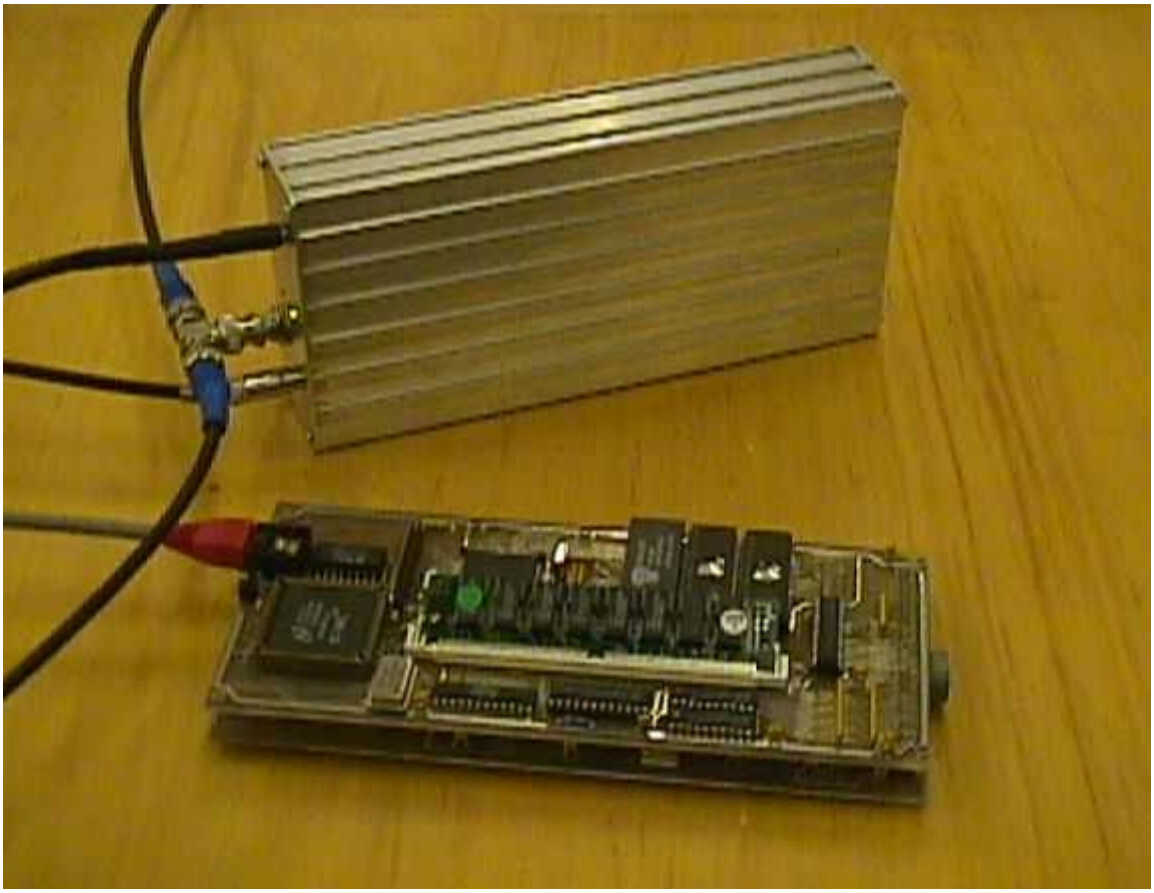
© Intelligent Agents Group, University of Essex

User Issues (Examples for Care Situation)

- **Philosophically**
  - allows systems to be more compatible to our human condition as free willed individuals – ie provides a system that adapts to us rather than forcing solutions for the "average person" upon us.
- **Financially**
  - Reduces energy costs above simple automation, as it is able to fit changing needs more closely.
  - Reduces the man-hour supervision costs (eg take over some routine monitoring and support tasks)
  - Increases personal productivity (eg enables people to complete difficult tasks independently)
  - Eliminates need for reprogramming or updating (making it a cheaper long term solution)
- **Quality of Life**
  - Increases personal comfort
  - Increases safety and security
  - Lessens dependence on others (eg support independent living by providing a care agent)
- **Functionally**
  - Is less "visible" than simple automation (and therefore *less annoying*)
  - Inherently individual-centric (empowers individuals by customising environment to them)
  - Deals with unplanned or evolving situations
  - Acquires useful higher level information (eg changes of behaviour)
  - Simplifies user interface

© Intelligent Agents Group, University of Essex

The Embedded-Agents



An IB Embedded-Agent

© Intelligent Agents Group, University of Essex

How Embedded-Agents Work

Works using ***behaviour*** based approach (taken from robotics)

"*a law for attainment or maintenance of goals*"

- **Manual Behaviour**– maps the occupant's explicit commands directly onto devices in the building (ie allowing the building to be at least as competent as one without the agent).
- **Economy Behaviour** – responsible for conserving energy where possible (eg predicting use).
- **Comfort behaviour** – seeks to optimise the local building environment to maximise the occupant's comfort (eg optimum room temperature for activity)
- **Enablement Behaviour** – in-built "helper" that has learnt how, and stands ready, to assist the occupant accomplish difficult tasks (eg for an older person might be setting a building into a going to bed state). Can be manually "called" or free-running.
- **Emergency Behaviour** – detects and acts in an emergency (eg accident, fire etc).
- **Safety Behaviour** – prevent controlled situation going outside some limit (eg prevent scalding water etc).
- **Dynamic Behaviours** – mechanism for learning new behaviours

© Intelligent Agents Group, University of Essex

Computer Science Definition of an Intelligent Building

"a building that utilises computers to govern its environment autonomously (eg manage user comfort, energy-consumption, security, safety etc) and to maximise support for occupant activities (eg personal enablement etc)"

…… and if we included communication technology then we might add into the support aspects information access, inter-personnel contact etc,

© Intelligent Agents Group, University of Essex

Some IB Examples

Commercial Buildings

- the Honeywell Metro Centre, California
- the PRC Headquarters, in Washington
- the NMB Bank Headquarters in Amsterdam
- the Federal Building East in Oregon
- Plaza Towers in Illinois
- Deaconess Hospital, St. Louis
- European Bank for Reconstruction, London

Care Applications

- SmartBo - Vallingby Sweden
- The Helsinki Model House - Helsinki, Finland
- AID House - Edinburgh, Scotland

Notable projects

- European Intelligent Buildings Group (Integer)
- Microsoft Smart House (Bill Gates)
- MIT (Smart Room Project)
- BT Telecare

Companies Active in Area

- Honeywell
- Echelon
- IBM
- Novell
- Microsoft
- NCR (Knowledge Lab)

© Intelligent Agents Group, University of Essex