Managing Intelligent Environments; people versus agents?

Prof Victor Callaghan
(vic@essex.ac.uk)
Essex University

http://victor.callaghan.info

School of
Computer Science &
Electronic Engineering
Essex University

Drawing by Paul Rumsey
(www.paulrumsey.co.uk/)

About Me

- Professor of Computer Science at Essex University
- Head of Intelligent Environments Group and director of Digital Lifestyles Centre
- Worked in avionics (aircraft) before joining university system
- Specialist in robotics and artificial intelligence (founded Robotics at Essex in late 80's, IE in late 90's)

- Current research focused on Embedded-Agents, End-User Programming, Affective Computing & Mixed Reality.
- Part of organizational team for numerous conferences, workshops, journals

- ***parkland of 200 acres***
- ***Royal Charter in 1965***
- ***9,162 students***
- ***30 % post graduates***
- ***38 % overseas (130 countries)***
- ***Ranked 9th in UK for research***

Some Publishing Activities

Future Intelligent Educational Environments)

Shanghai, China. 7-9th July 2012

ICST* Transactions on Future Intelligent Educational Environments

*Institute for Computer Sciences, Social Informatics and Telecommunications Engineering (ICST)

EAI European Alliance for Innovation

http://icst.org/future-intelligent-educational-environments/

ICST.ORG

The Singularity Hypothesis (Volume 2): A Pragmatic Approach. Springer edited volume in The Frontiers Collection.

The Singularity – Point where AI transcends the limitations of peoples brains

Intel Labs Pittsburgh

CREATIVE SCIENCE FOUNDATION

www.creative-science.org

Exploring Future Business Visions Using Creative Fictional Prototypes

Special Issue of FUTURES, published by Elsevier, Amsterdam

(www.sciencedirect.com/science/journal/00163287)

Special Issue on Creative science prototyping and the future consumer technology landscape

School of Computer Science & Electronic Engineering

Essex University

Structure of Presentation

- About Me
- Part 1 – Overview of Essex Research Facilities
- Part 2 – Discussion on role of autonomy in Intelligent Environments.
- Summary

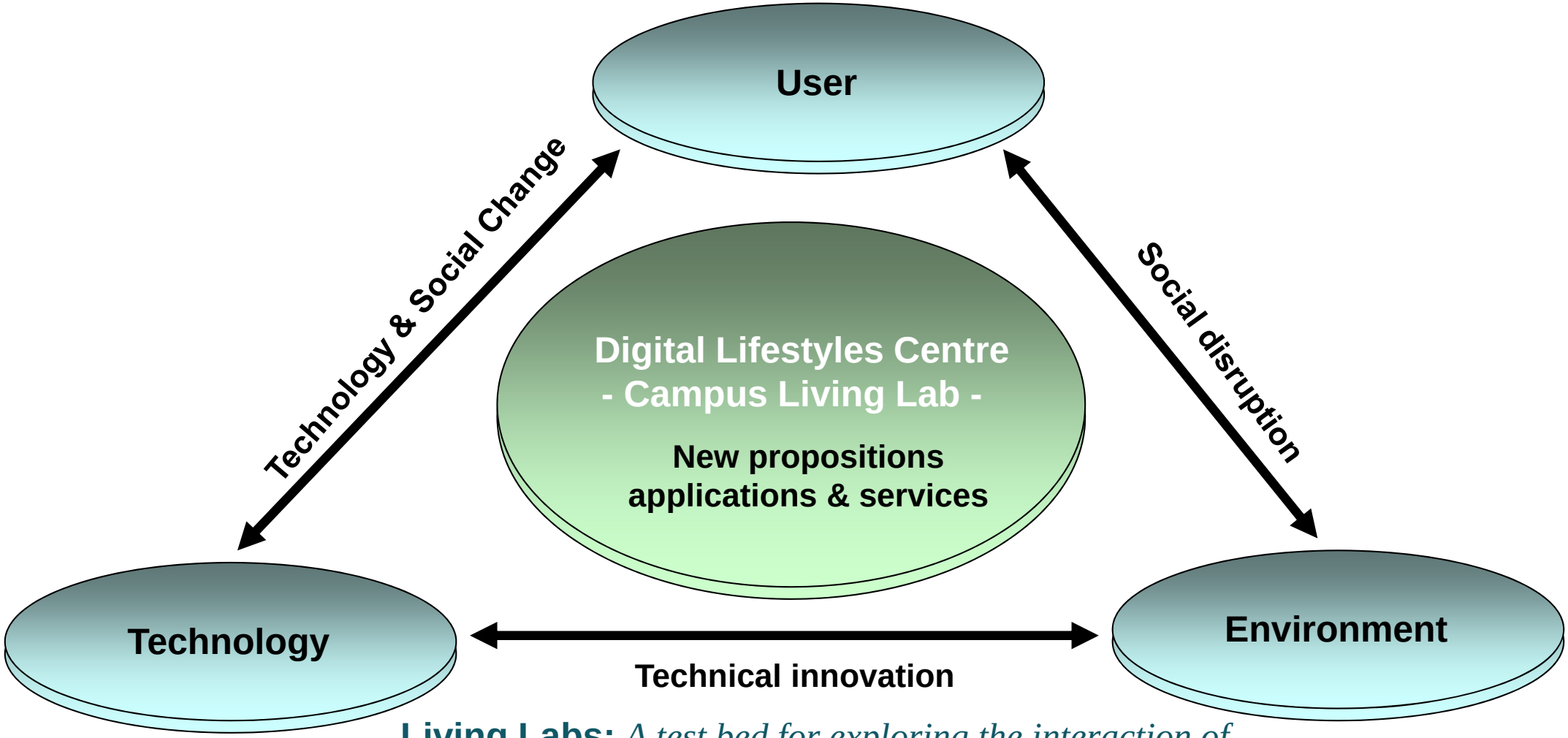
YouTube videos on IEG work:
http://www.youtube.com/user/vcallghan?feature=watch

Drawing by Paul Rumsey
(www.paulrumsey.co.uk/)

Part 1

Essex University
Intelligent Environments
Facilities

Essex University Living Labs



Living Labs: *A test bed for exploring the interaction of users and technology in our everyday life.*

Our Research Facilities 1

iSpace (evaluation environment)

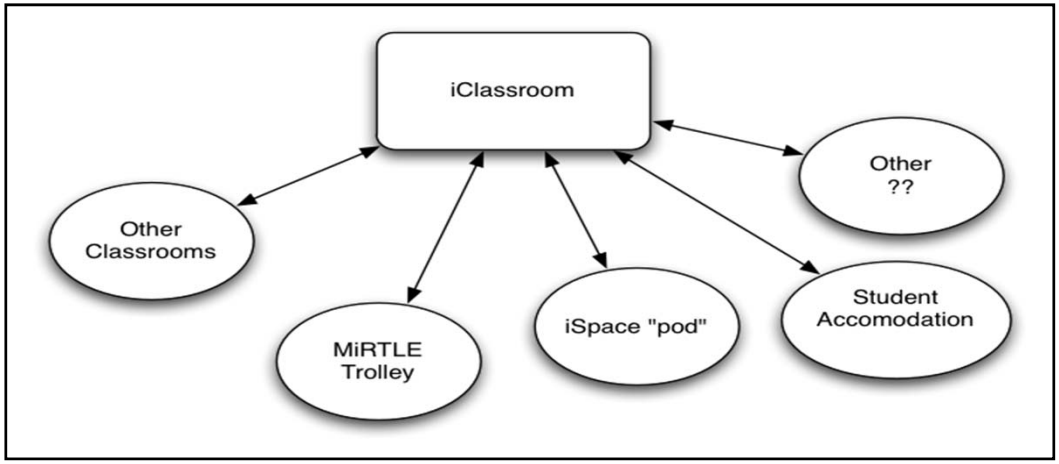
- Test-bed for ambient intelligent and pervasive computing in a domestic setting (Full sized 2 bedroom apartment)
- Sensor, actuator, computer and network rich environment to enable open-ended R&D
- Capable of supporting evaluations with long-term occupants



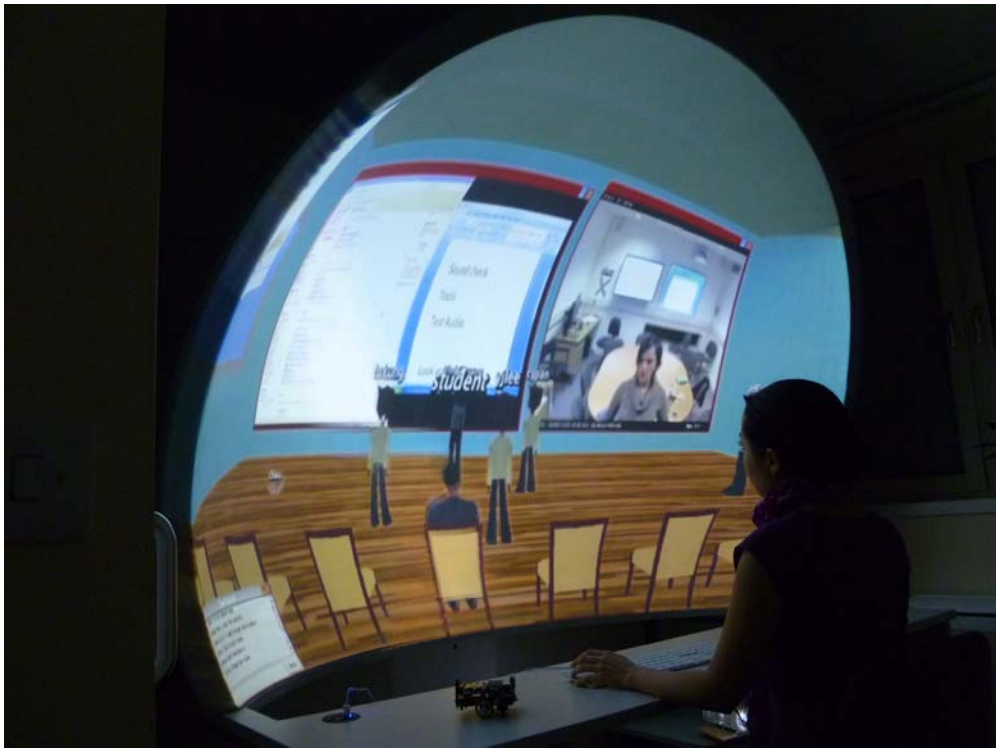


Essex Research Platforms 2 – iClassroom

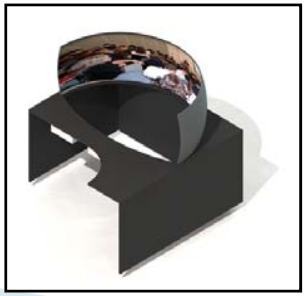
- An experimental high tech pervasive networking classroom
- Designed to make maximum use of intelligent agents to support all aspects of the teaching environment (environment, administration, learning) and give the illusion that geographically dispersed spaces are part of a single continuous entity



Essex Research Platforms 3 – Immersive Reality Desk



The Essex-ID Immersive reality Desk



- Based on "*Tales From A Pod*" vision
- Student feels immersed in real teaching environment
- Mix of real video and avatars (eg AI tutor)
- Mechanical and Optical structure produced by Immersive Displays Ltd (Essex based company)
- Intelligent and Interactive Environment being developed by Essex University

http://www.immersivedisplay.co.uk/immersastation.php

EduNet – A Research and Teaching Collaborative Network

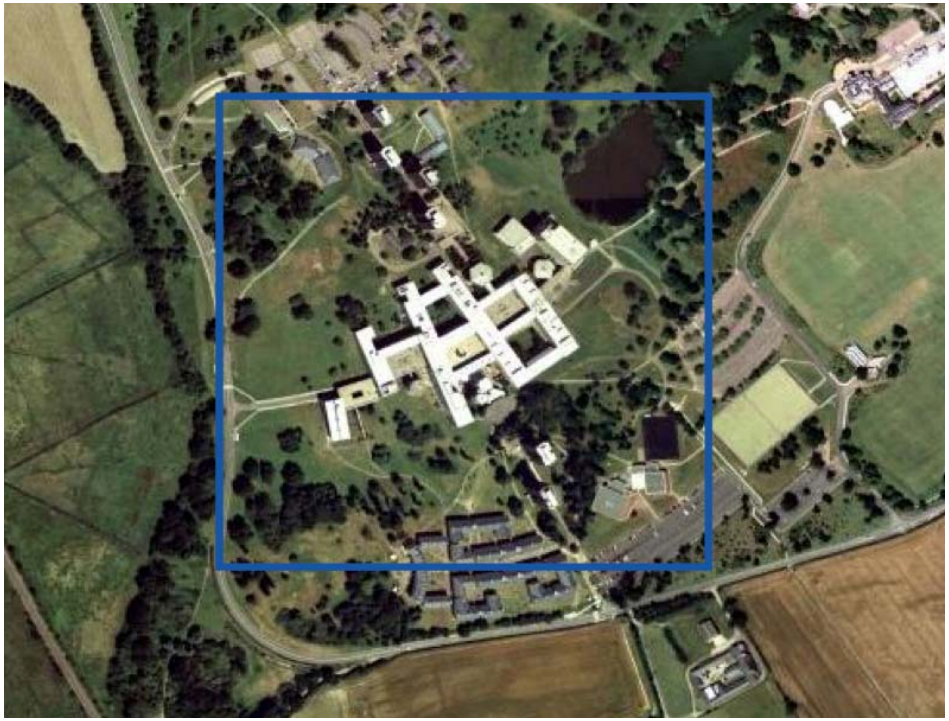
- UK
- USA
- KSA
- UAE
- China
- Indonesia
- Taiwan
- Other?

EduNet is an international collaboration focused on the creation of geographical distributed (but connected) Intelligent Learning Environments that act both as a vehicle for **collaboration** around both **teaching** and ***research*** into intelligent environments. If you want to join us in this "*academic adventure*" then please contact us – vic@essex.ac.uk

Our Research Facilities 4 – iCampus

HIPNet Project *"Validation and Modelling of Next Generation Networks"*

Campus Coverage **(via WiMax Testbed)** **Suburb Coverage (5km radius)**

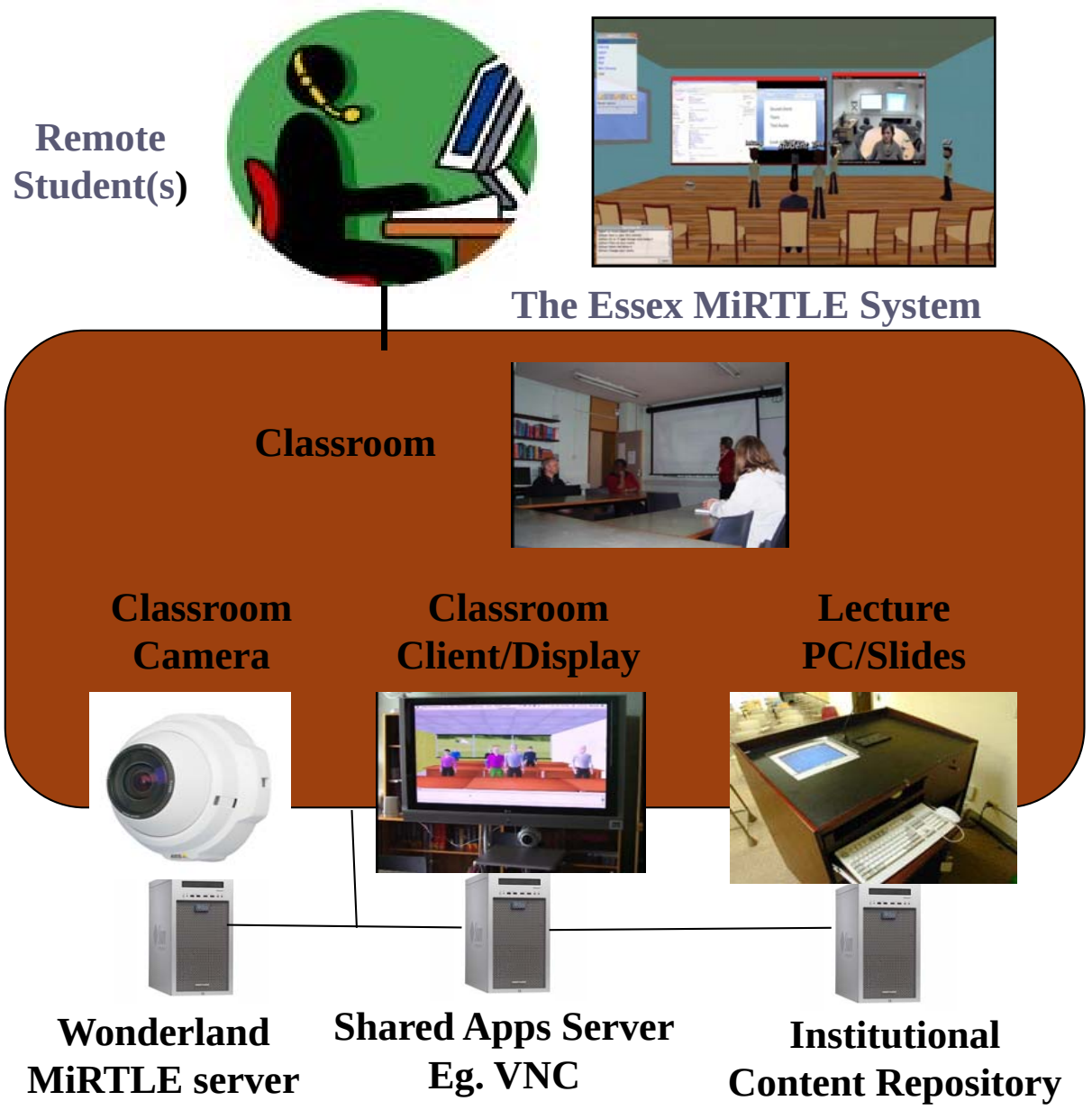


Our Research Facilities 4 – iWorld

- The iWorld is a Mixed-Reality simulating multiple buildings outfitted with real devices in the iSpace, and virtual objects in the iWorld.
- Based on Unity 3D and RealXtend (a derivative of Second Life). At the core is a simulation of Essex iSpace
- Changes made to devices in one world are immediately reflected in the other world (via shared middleware)
- One reality may be supplemented by devices in the alternative reality.

Essex Research Facilities 5– Immersive Mixed Reality

- Teaching using mixed Reality
- Students & teachers both real and avatars is mixed reality space
- Materialises abstract concepts



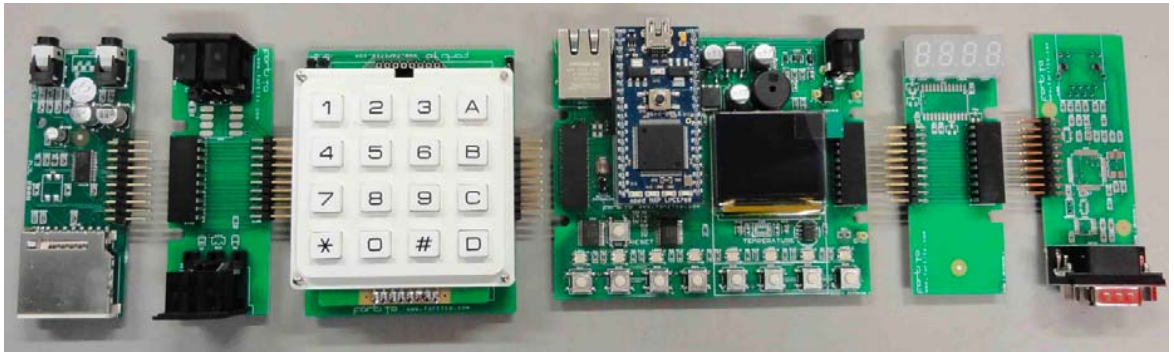
Davies M, Callaghan V, Gardner M, "Towards A Mixed Reality Intelligent Campus" IET International Conference on Intelligent Environments 2008, Seattle, 21-22 July 2008

Tongzhen Zhang, Vic Callaghan, Ruimin Shen ,and Marc Davies "Virtual Classrooms: Making the Invisible, Visible", Intelligent Campus 2011 (iC'11), Nottingham 26th July 2011

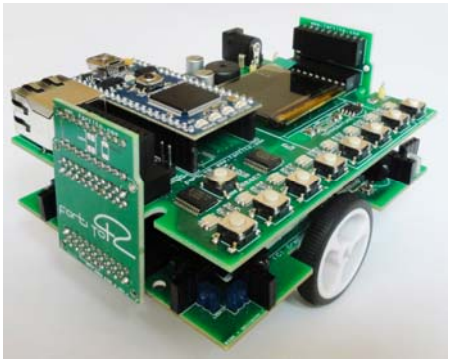
Essex Research Facilities 6 – Internet-of-Things

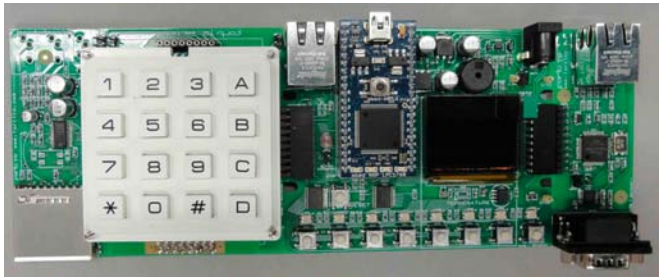
"the world of choice is the world of creative possibilities"

Buzz Boards



Some Buzz Board modules





Examples: robot & Internet Radio

- Essex based modular "embedded computing" (eg "*Internet of Things*") teaching system (deconstruction/reconstruction)
- Desktop robot assembled using
  - ARM-Cortex mBed mezzanine,
  - Processor base board
  - Robot chassis (with IR proximity sensors and batteries)
- Internet radio assembled by plugging together
  - ARM-Cortex mBed mezzanine,
  - processor base board, network
  - keypad (optional)
  - audio *Buzz Boards*

Minjuan WANG, Victor CALLAGHAN, Malcolm LEAR, Martin COLLEY "Teaching Next Generation Computing Skills; The Challenge of Embedded Computing", Intelligent Campus 2011 (iC'11)

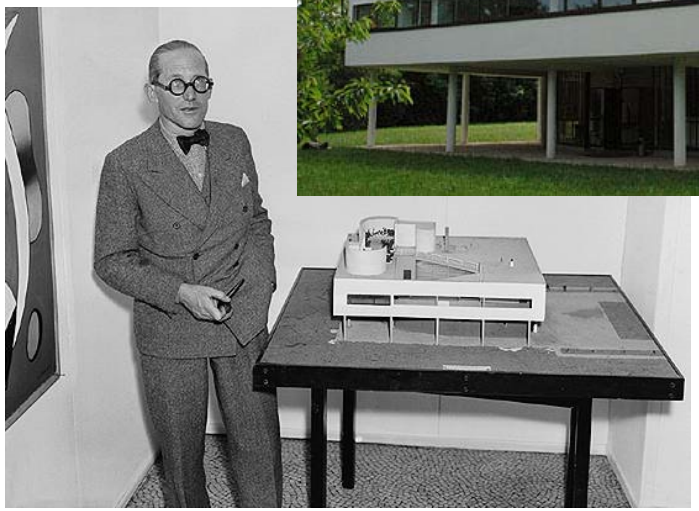
Part 2

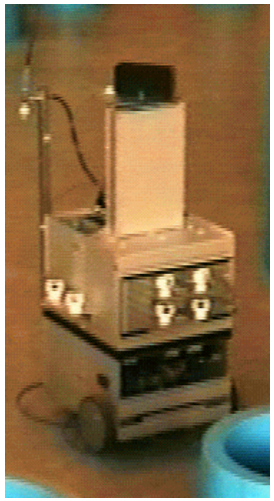
Autonomy & Intelligent Environments

Living inside Machines

Le Corbusier, Villa Savoye, Poissy, 1928-31.

- Le Corbusier (1887–1965) famously remarked that, "*A house is a machine for living in".*

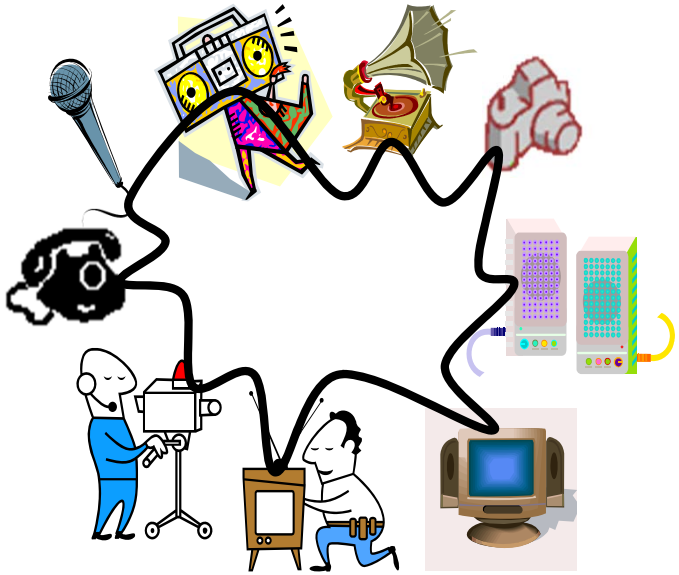


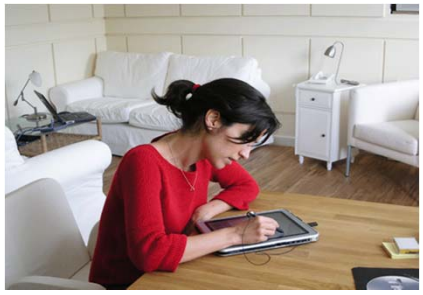


- "*A building is a robot we live inside" (Callaghan 2000)*

Machines Get Bigger – Ami Environments?

- They are: environments "where (**networked**) devices, services and applications work together seamlessly supporting even richer, more engaging and deeply connected (user) experiences" (Bill Gates, 2006)
  - Applications aim to design living environments that are more comfortable, usable, productive, secure, caring (medical), social, entertaining or energy efficient





- its **people** based and, to some extent, about **choice** (either unconscious or conscious) and **personalisation.**

• and is tied to nebulous concepts of social values and lifestyle

Better Intelligent Environments

- To a large degree, **people** are the "customers" of Intelligent environments
- So, to some extent, the judgment of better Intelligent Environment is the **judgment of people**, or users.
- What are **users views**, what are they bothered about?

What Are People's Views

- **Venkatesh** (2001) University of California - *attitudes to smart home technologies*
- **Chung** (2003) Samsung Corp, American Institute for Research - *smart home requirements in USA & South Korea*
- **Barkhuus and Dey** (2003) University of Copenhagen - *is context-awareness taking control away*
- **Röcker** (2004) Fraunhofer Institute, Philips Research and France Telecom - *cross cultural expectations of to smart homes in multiple European countries*
- **Mäyrä** (2006) Tampere University Hypermedia laboratory - *expectations of digital homes*
- **Montano** (2006) Goteborg University – *attitudes to smart homes*
- **Davidoff** (2006) Carnegie-Mellon University - *type of control of digital homes*
- **Rukzio** (2006) University of Munich - *interaction with technology in digital homes*
- **Chin** (2008) University of Essex - *study of user control issues in smart home*
- **Ball** (2011) University of Essex - *study on perceptions of agent autonomy in Intelligent Environments*

- A commonality found in all these studies is that **maintaining control** is a **paramount concern** for potential users of Intelligent environments.
- Additionally, issues concern adaptability, customisability and transparency of the system, as well as privacy of personal information and trust.
- The studies also found that people can balance concerns against potential benefits (eg mobile phones, energy conservation etc).

Matthew Ball, Vic Callaghan, *"Perceptions of Autonomy: A Survey of Users' Opinions Towards Autonomy in Intelligent Environments", Intelligent Environments 2011 (IE'11), Nottingham 27-29th July 2011*

Agents – A Question of Control?

"The dream of technology is the dream of control…control is an illusion; absolute control, even if it were possible, would be disaster." William Byers, Concordia University (author of 'The Blind Spot')

- *"we have adopted an optimal control framework in which failing to satisfy each objective has an associated cost. A **discomfort cost** is incurred if inhabitant preferences are not met … An **energy cost** is incurred based on the use of electricity … discomfort is indicated by overriding the choices of <the controller> and this relative discomfort is translated to a dollar amount by means of a **misery-to-dollars conversion fact**or"* (Mozer 98)

- *"a contrasting paradigm is to see the **'user as king/queen'** and create agents that '**particularise'** (rather than generalise) to a specific user's needs, and respond immediately to whatever the end user demands (providing it does not violate any safety constraints)"* (Callaghan 04)

- "Some lay people **distrust autonomous agents** and prefer to exercise **direct control** over what is being learnt and when … or use their **creative** talents … to become designers of their own systems" (Chin 09)

Control– Who Is The User (individuals or groups)?

- In communal spaces, who chooses the shared settings

- Inspiration from companies

Groups = “collective individual”

Callaghan V, Colley M, Clarke G, Hagras H, "A Soft-Computing based Distributed Artificial Intelligence Architecture for Intelligent Buildings", In book entitled “Soft Computing agents: New Trends for Designing Autonomous Systems”, International Series "Studies in Fuzziness and Soft Computing“, (Eds: V. Loia, S.Sessa), Springer-Verlag, Volume 75, pp. 117-145, 2002

Artificial agents versus Human Agents – A Question of Balance?

- If Technology Plays a hand in control of our environments then:
  - What is the balance between machine versus user control
  - How is that achieved?
- What do people mean by control
  - The freedom to make choices for themselves – **autonomy?**

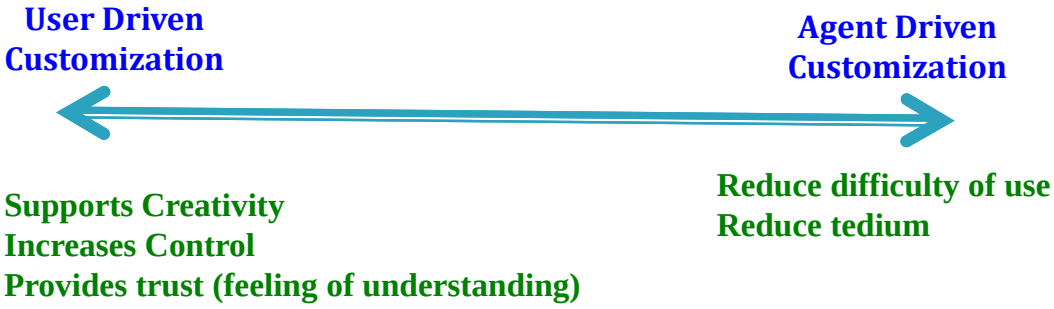
Autonomy

- ## Human View
  - Involves ideas like freedom to make choices, terms like "*free will*" (try typing "*the free will illusion*" into Google)
- ## A Machine View

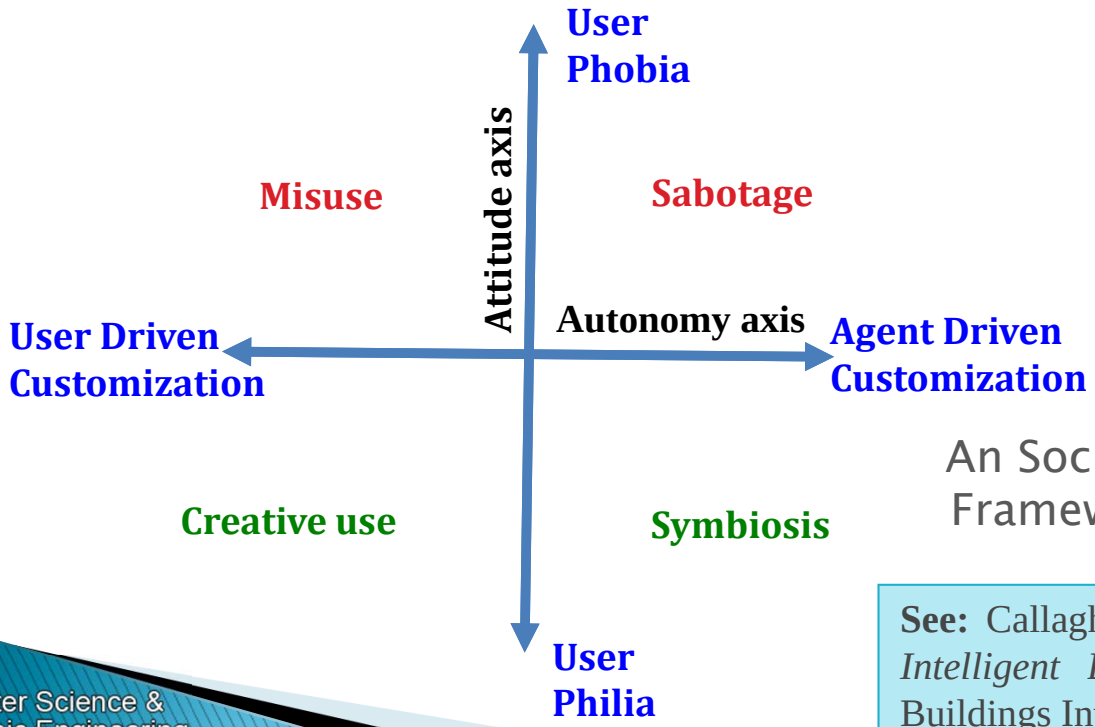
no (or little) assistance from people !

  - So reducing autonomy is akin to getting more assistance from people – teamwork or more commonly, Agent Teamwork

Attitudes to Autonomy



A general assumption underpinning this model is the view that the less understanding of, and control over, their technological environment that people have, the more resistant or fearful they will be of it (and vice versa).

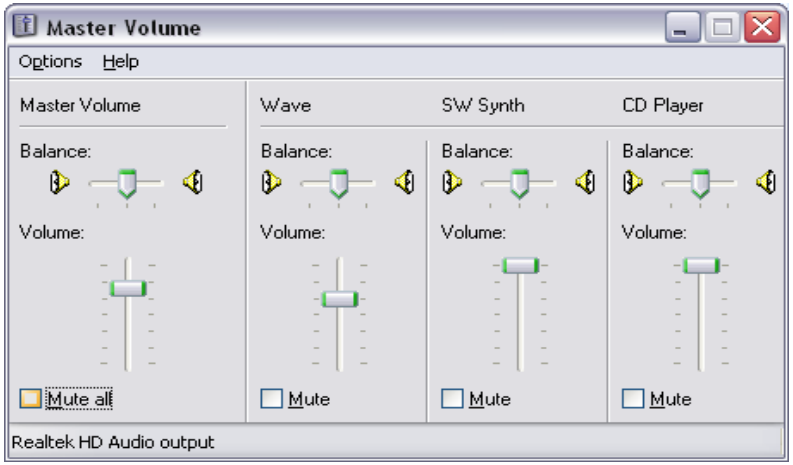


An Socio-Agent Autonomy Framework for AmI Research

See: Callaghan V, Clarke G, Chin J "*Some Socio-Technical Aspects Of Intelligent Buildings and Pervasive Computing Research*", Intelligent Buildings International Journal, Vol 1 No 1, 2008

Adjusting Autonomy

- Imagine a sliding scale switch (like a volume control) for each system in the environment.
  - So we have a theoretical mixing-desk for autonomy in the system.

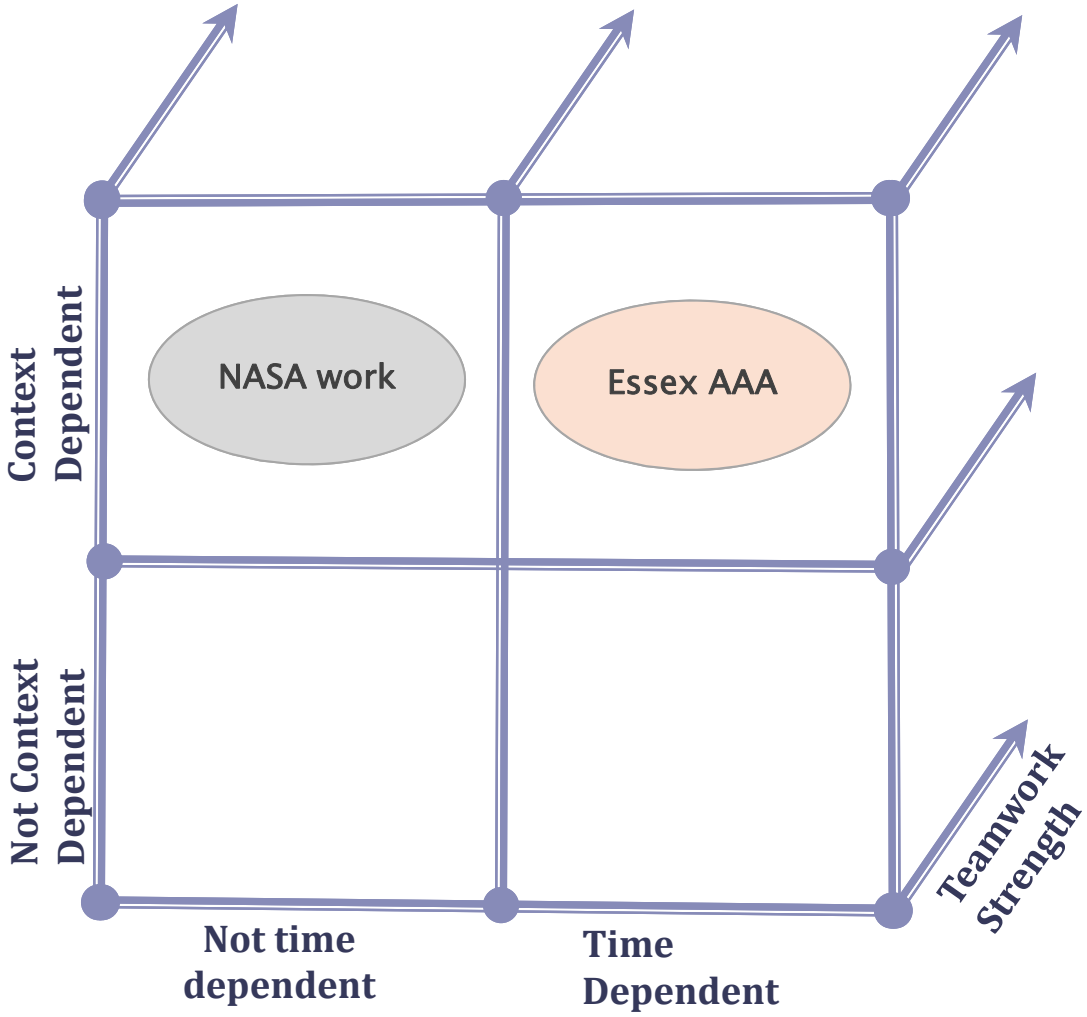


- The autonomy scale – how much control do people have?
  - 2 extremes

User Driven Configuration ⟷ Agent Driven Configuration

- End-user programming approaches
  - Empowers the user
  - Well suited to creatively minded users
  - What if user isn't able or willing to use the system?
- Autonomous-agent programming approaches
  - Reduce cognitive load placed on the user
  - Works by guessing users intentions, so prone to making wrong
  - Lack of transparency can cause distrust

Adjusting Autonomy



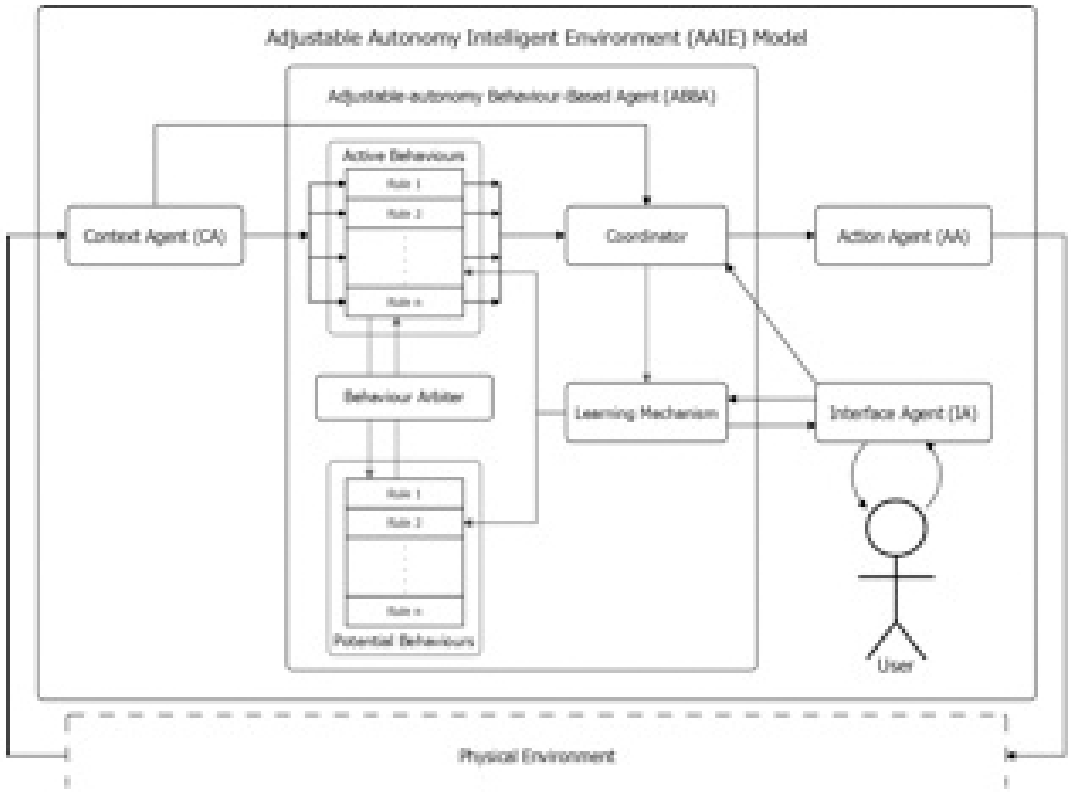
Essex AAA Discrete Modes

- Full autonomy: agent learns from the user's behaviour, automatically creates/maintains rules as the agent deems it necessary.
- High autonomy: agent learns rules from the user's behaviour which can only become active when confirmed by the user (agent teamwork).
- Low autonomy: user creates/maintains rules assisted by the agent presenting suggestions (agent teamwork)
- No autonomy: the user creates/maintains rules with no assistance from the agent.

An Adjustable Autonomy Agent

Essex Continuous AAA Mode

- Based BBA & ISL
- 2 sets of behaviour (active & potential)
- Each rule has a 'usefulness' parameter (how frequent & accurate rule has proved)
- Variable autonomy achieved through varying usefulness threshold (a differential of standard learning inertia).

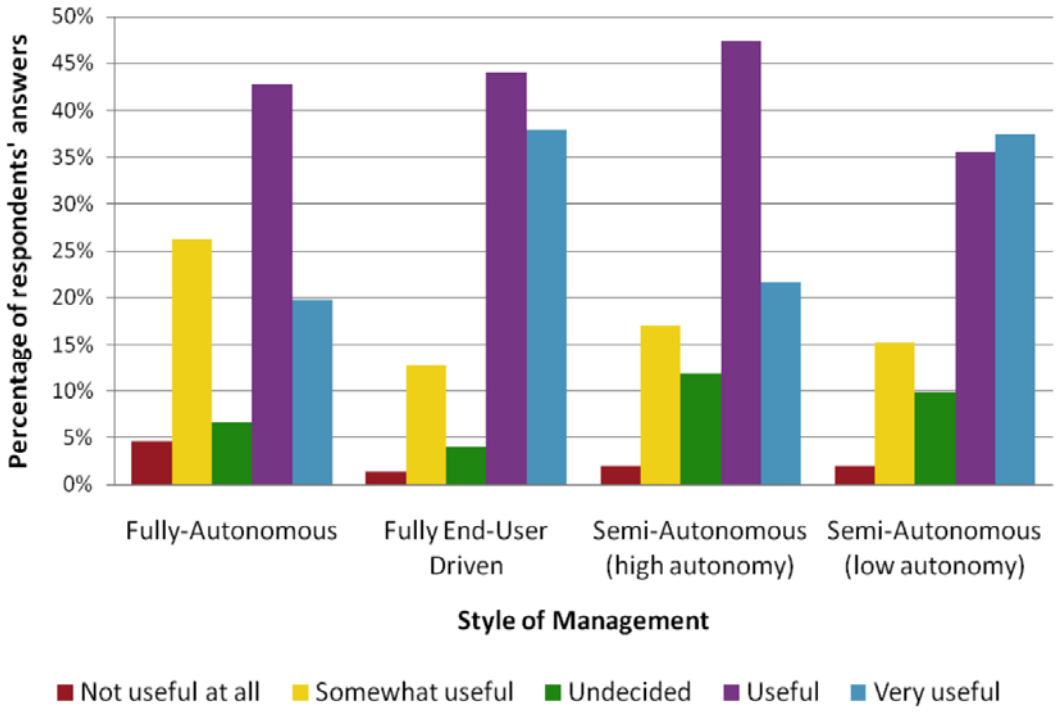


Ball et-al "*An Adjustable Autonomy Agent for AmI*", IE2010, Malaysia

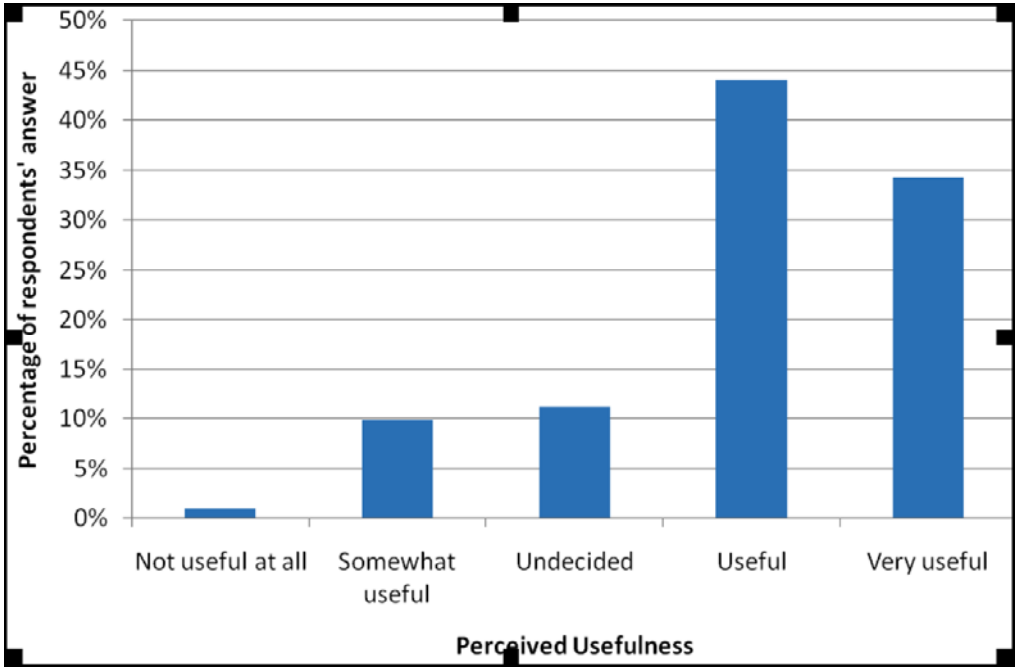
"*governing a system at a sweet spot between convenience (delegating every bit of work) and comfort (delegating only what agent can be trusted to perform)*" (Bradshaw 04) ie adjustable autonomy allows agent to 'back-off' certain tasks and let user take control whenever user so wishes.

Findings – 1

How useful users perceived the different styles of management to be



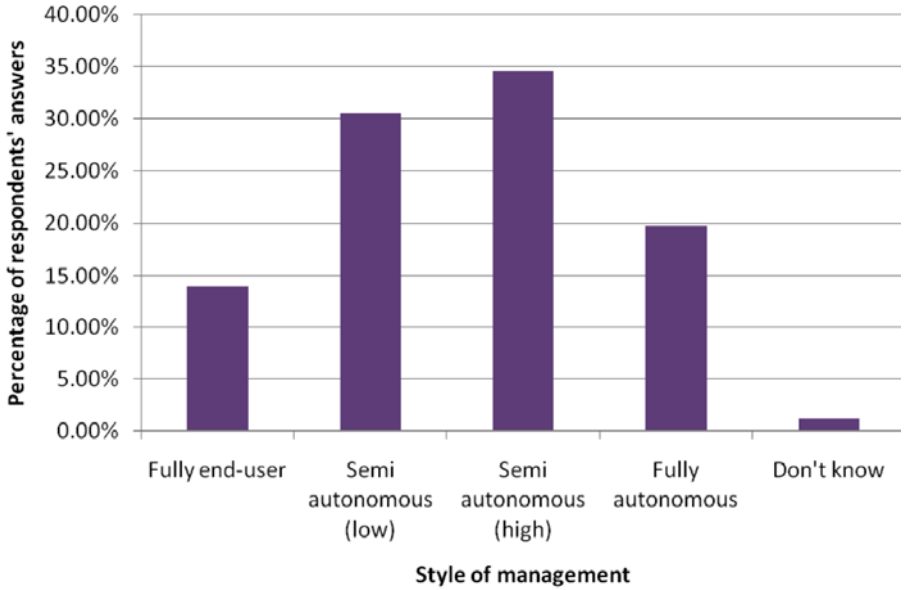
How useful users found the ability to change between the different styles of management?



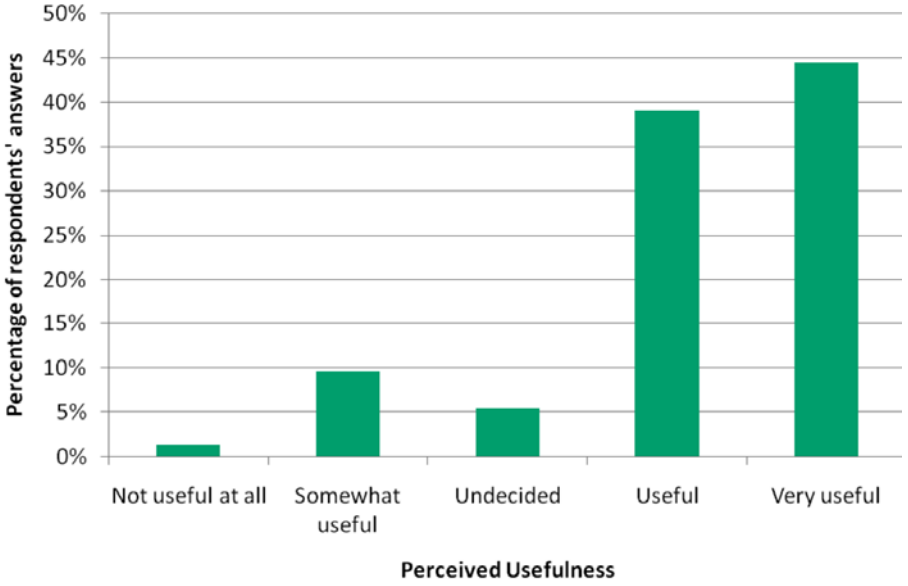
Findings – 2

Sub-system	Answer / Percentage of respondents answers				
	Fully end-user	*Semi-autonomous (low)*	*Semi-autonomous (high)*	*Fully-autonomous*	*Don't know*
Lighting	12.50%	28.95%	36.18%	20.39%	1.97%
Heating	13.16%	29.61%	39.47%	16.45%	1.32%
Entertainment	27.63%	36.84%	25.00%	10.53%	0.00%
Security	13.16%	28.95%	32.89%	23.68%	1.32%

How useful users found choosing the style of management for individual parts of the system



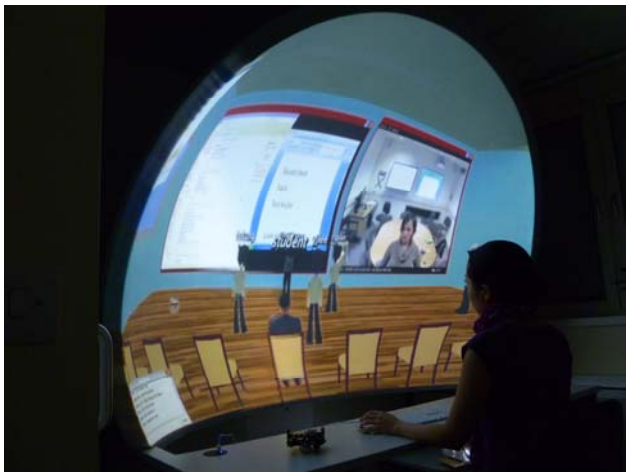
Overall popularity of the different management styles



Overall view of usefulness of being able to choose the style of management for individual parts of the system

3 Applications of Adjustable Autonomy

The iSpace – An AmI Environment



The Immersive reality Desk

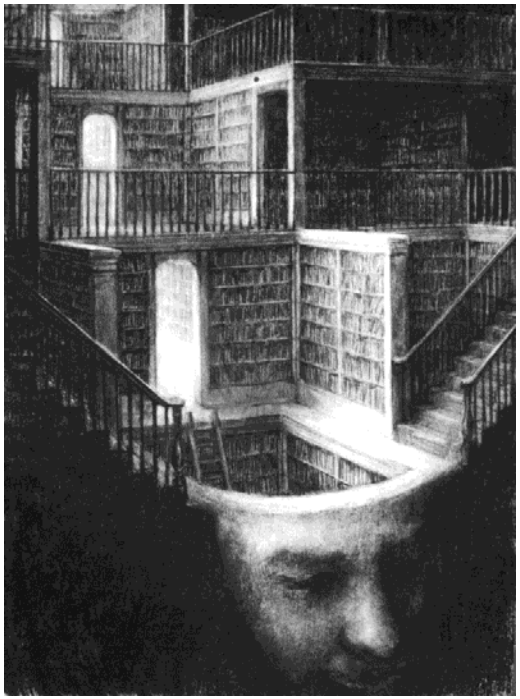
- **Sociology Research** – Work started by exploring 'user concerns' for BT (initial output of project)
- **High-Tech Products & Environments** – During research became obvious users liked adjusting level of autonomy, so developed as end-user tool
- **Education** – teachers can be viewed as variable autonomy agents, providing variable amount of assistance, so investigating applying it to immersive education.

http://www.immersivedisplay.co.uk/immersastation.php

University of Essex

Summary

- Introduced the Essex University Intelligent Environments research facilities (iSpace, iClassroom, iDesk, iCampus & iWorld).
- Discussed the role of '**Agent Autonomy**' in Intelligent Environments
- Finally, we are always interesting in forming new research partnerships; if you can see ways of working with us participating in our events, please contact us (vic@essex.ac.uk).



Any Questions?

A copy of this presentation can be found on:
http://victor.callaghan.info/publications/2013_MiddlesexWorkshop(Managing Intelligent Environments).pdf

PDFs of relevant papers can be found on:

http://victor.callaghan.info

Drawing by Paul Rumsey
(www.paulrumsey.co.uk/)