MiRTLE

University of Essex

Intelligent Environments Group

ePod

Buzz

Buzz-Boarding

(Practical Support for teaching Computing Based on the Internet-of-Things)

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http://dces.essex.ac.uk/staff/vic/vic.html

School of Computer Science & Electronic Engineering

Essex University

Structure of Presentation

- About Me
- Deconstruction as Learning
- Buzz-Boards
- Creative Science
- Faculty Cooperatives
- Summary

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

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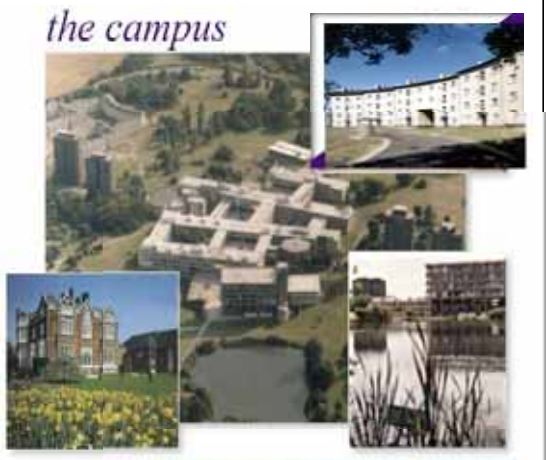
About Me

- Professor of Computer Science at Essex University
- Head of Intelligent Environments Group and director of Digital Lifestyles Centre
- Expert in robotics and artificial intelligence (founded Robotics at Essex)

- Current research focused on Intelligent Environments (using AI to support people in their everyday tasks).
- Part of organizational team for numerous conferences, workshops, journals
- Work with Intel on Product Innovation



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

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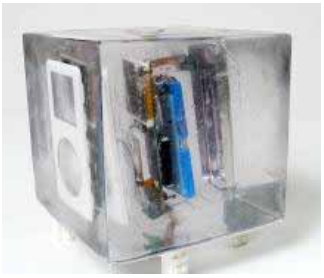
About Me – deconstruction as learning

- My childhood was littered with radio's, TVs and machines pulled apart in an attempt to understand how they work (poor parents)



http://www.billychasen.com/

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Essex Research – Virtual Appliances

Coordinating Functions

J. Chin, V. Callaghan, G. Clarke, "Soft-appliances: A vision for user created networked appliances in digital homes". In Journal of Ambient Intelligence and Smart Environments, IOS Press, Netherlands, 2009.

- The "*Internet-of-Things*" (IoT) **refers to uniquely identifiable computer-network connected "*things*" (phrase coined in 1999 by British born** technology pioneer **Kevin Ashton).**
- **DTI PHEN & EU eGadgets projects explored how these "*things*"** could be decomposed into more 'atomic' network services (eg a TV broken into a display, audio transducer, media stream processor, controller etc)
- **Includes a tool (PiP) to allow ordinary people (non-technologists) to recombine these** in novel combinations (with rules), forming personalised '*virtual-appliances*'.
- Forms the basis of **a type of *constructionalist and experimentalist learning*.**

Constructionalist Pedagogy
(Reconstruction as Learning)

- Learn how things work by reconstructing systems in same or different ways

- Components can be physical or abstract
- Ideally, the construction could be facilitated in a flexible, experimentalist way

The Challenge of Learning IoT Technologies

- The basic "building blocks" of IoT technology is embedded computers
- For most people, even software developers being confronted with such a "raw" computer would be somewhat of a shock
- Simple questions are where is the keyboard, where is the screen, what sort development software does it contain and how can you power it up?

The mbed is a tool for Rapid Prototyping with Microcontrollers

The **mBed** is based on the ARM Cortex-M3 Core running at 96MHz, with 512KB FLASH, 64KB RAM and various interfaces including Ethernet, USB Device, CAN, SPI, I2C

http://mbed.org

A Computer Science Student's Viewpoint

- Embedded-computers, as supplied from manufactures, are incomplete systems, and require extra hardware and software to make them do anything useful or interesting (which takes more time than typical university lab sessions allow.
- Computer science students have little or no electronic design expertise required to design and build various kinds of hardware input-output schemes and peripherals.
- Once students have constructed hardware, the system has relatively fixed functionality that is difficult to alter, making it difficult for students to get experience of programming a wide variety of systems.

A Lecturer's Viewpoint

- Doing things from the bottom up is time consuming and, within the limits of typical lab sessions, limits the complexity of the systems that students can build.
- System level solutions for embedded-computing education tend to either be single appliance oriented (eg a robot), or too simple to give realistic product development experience.
- The software tools are sometimes overly complex, taking a lot of learning and distorting the focus of the underlying computing principles being taught.

Constructionist Learning

Some Buzz Board modules

Examples: robot & Internet Radio

"Teaching Next Generation Computing Skills; The Challenge of Embedded Computing", Intelligent Campus 2011 (iC'11)

Buzz Boards

- Modular "embedded computing" 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*

Base-Board

- Base-board accepts accepts other vendors modules & processors (eg mbed, RPi, Arduino)
- Contains:
  - 8 General purpose push buttons with interrupt output
  - 8 tri-colour LED's
  - temperature sensor
  - light sensor (with a spectral response that matches the human eye)
  - audio sounder (that can also be used as a microphone),
  - high-resolution full colour OLED display
  - Both external DC and USB power operation
  - 2 bus ports that have I2C, SPI, and general purpose IO
  - 3-Axis accelerometer (optional)

Buzz Boards

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Buzz-Board Hardware Modules

1. Mezzanine ARM
2. Mezzanine RPi
3. Processor Base *Buzz Board*
4. Audio-SD *Buzz Board*
5. Manual Control *Buzz Board*
6. Environmental Sensing *Buzz Board*
7. Navigation *Buzz Board*.
8. Inter-board Extension *Buzz Board*
9. Inter-board Right Angled *Buzz Board*
10. 3 Way Inter-board *Buzz Board*
11. Development *Buzz Board*
12. Prototyping *Buzz Board*
13. Keypad *Buzz Board*
14. LED Display *Buzz Board*

Buzz Boards

1. Medical *Buzz Board*
2. MIDI *Buzz Board*
3. Network/232 *Buzz Board*
4. Quantum *Buzz Board*
4. RFID *Buzz Board*
5. Robot *Buzz Board*
6. Robot-Lite *Buzz Board*
7. Bluetooth *Buzz Board*
8. GPRS *Buzz Board*
9. WiFi *Buzz Board*
10. Range Finder *Buzz Board*
11. Aux Range Finder *Buzz Board*
12. Infrared Beacon *Buzz*
13. Battery *Buzz Board*
14. Test Point *Buzz Board*

www.fortito.com

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Some Contemporary Approaches

- LEGO MindStorms *
  - Mix of Lego bricks to build simple machines such as robots (based on ARM processor core)
  - Computer hardware restricted to the use of proprietary modules.

- Arduino *
  - Based on AVR processor
  - Uses dated 5v devices (difficult to use with modern 3.3v hardware)
  - Expansion system based on modules called 'Shields' (some incompatibilities do to diverse developers).

- Mbed *
  - ARM & Philips partnership (uses Philips NXP LPC1768 Cortex-M3 MCU)
  - takes form of mezzanine carrier for the processor
  - online development tools online

- Raspberry Pi *
  - credit-card sized computer that plugs into TV & keyboard (uses Broadcom BCM2835 SoC based on an ARM1176JZFS core)
  - Fame derived from cost of $25 for cheapest version

* Buzz-Boards work with all of these

The Intel Challange

- Intel integrated circuits (chips) take about 7-10 years from concept to production !
- Chips are designed for applications (eg computers, IoT devices) three or more generations out!
- How do employees (mostly science and engineering graduates) get skills to design 10-20 years out for products or applications that do not yet exist?
- Needs science and engineering students to have **creative minds** and skills; what are they and where do they come from?

The ingredients of a creative mind

Joy of discovery

Sense of challenge

Willingness to experiment

Imagination

Wonder

Inquisitiveness

Playfulness

Curiosity

Desire to learn

Positive discontent

Desire to interrelate

Tolerance of ambiguity

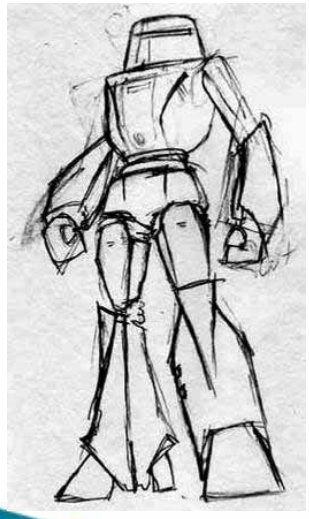
Willingness to take risks

Desire to see things differently

Questioning

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

Imagination: the magic ingredient?



- To think of future possibilities / needs, requires the present (current science, current context) to be extrapolated forward; but how?
- How does Intel specify a future that doesn't exits yet?
- There are many approaches but one used by Intel harnesses people's imagination and uses a methodology based on fictional stories that transport professionals to a future time by means of fictional stories – scenario based design, design fiction or Science Fiction Prototypes.

Science Fiction Prototyping

- Core methodology is the use of science fiction to motivate and direct research into science via science fiction prototypes (*imaginative stories*)
- SF-Prototypes grounded in existing research, and written for explicit purpose of acting as prototypes for people to explore a wide variety of futures.
- SF-Prototypes can be created by scientists to stretch their work or by, for example, writers, school children and members of the public to influence the work of researchers and companies.
- Outcomes of SFPs are used to create or technological products (and even new business models!).

From Imagination to Products – an example

- At CS'10 one SFP called "Tales from a Pod" was a speculative look at how artificial intelligence and virtual environments might change the nature of education in 2050.
- At its root, it imagined a future time when
  - Interactive computer games have merged with the world of cinema to provide "*immersive movies*" (audience were no longer passive observers - unless they wished to be), offering highly personalised experiences in the form of isolated high-tech-environments called '*educational pods*' (ePods).
  - the *technological singularity* had been reached, and machine intelligence and interaction is equal or surpasses that of people.
- Imagines this super-intelligence creates an "intelligent teacher avatar" that "lives" in the virtual reality pod.

http://dces.essex.ac.uk/Research/iieg/papers/TalesFromAPod(Paper).pdf

An Example–Exploring AI & The Future of Learning

From "Creative-Science 2010"

iPods were effectively small cocoons; something like a comfortable armchair enclosed within a sound-proof egg-like structure packed with sophisticated but largely invisible technology that included immersive mixed reality and sophisticated AI. When participating in a movie (the industry had long dropped the word "watching" which describing these new immersive movies) the immersive reality technology aimed to make the participant feel as though they were truly part of a fictional physical world.

Intel Creative Science Foundation – Promoting Technology Innovation through Science Fiction Prototyping

Additive Technology ePod-4

In this increasingly competitive world, where knowledge determines success, your child deserves the very best education available and that is Addictive Technology's **ePod-4**

Pioneering research by Benjamin S. Bloom in the 1980s (and supported by all work since) proved that students who receive one-on-one tuition learn at least an order of magnitude better than grouped students. If you want to give your child the best one-to-one education in the world, give them an Addictive Technology's **ePod-4**

Education:

- Super-Intelligent Artificial Teachers
- Personalised one-to-one tuition (the gold standard)
- Teacher's avatar has visualisation powers that don't exist in physical space
- Available 24 hours a day, 365 days a year
- Learning environment (avatar, surroundings, lessons) can be tailored for each student
- Unwavering attention and happy disposition
- Compelling content combined with contextual delivery
- Teachers available in different cultures, ages, sexes and form

Technology

- Free-Will 3 © - Quantum processor (upgradable)
- My-Mind 1.2 © - Evolving Persona Engine (customizable)
- Flame 5 © - EmotionWare
- Get Real 8.2 © - Mixed Reality Cocoon
- Real-Touch © iSkin & Haptics
- Ghost 4.1 © – 3D Imaging & Audio
- SentiNet © - Knowledge Engine

Addictive Technology, Zizhu Science Park, No. 880 Zi Xing Road, Minhang, Shanghai 200241, China

[Callaghan V, (2010). *Tales From a Pod*. In Creative-Science 2010 (CS'10). Kuala Lumpur, Malaysia: IOS Press, pp. 1-10.

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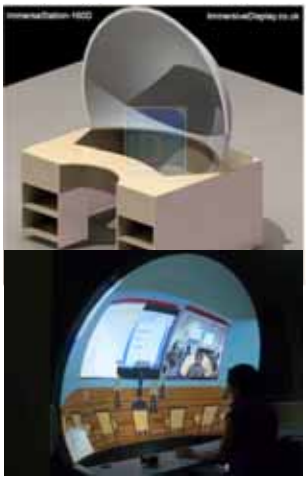
Essex Research Platforms – Immersive Reality Desk



The 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

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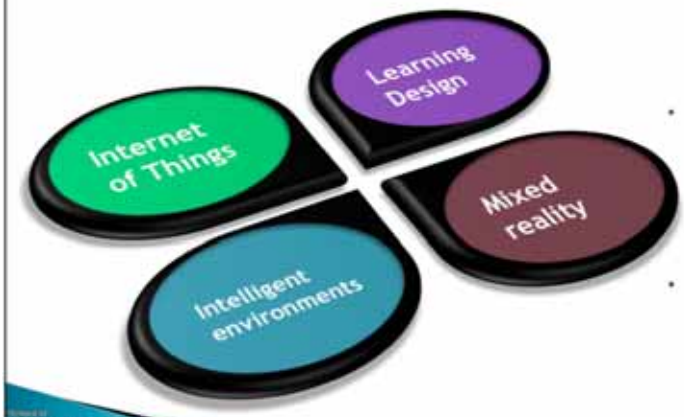
The 'eDesk' Project

Combine all these elements to create an futuristic intelligent learning environment



Working with:

- **San Diego State University (Educational technology Department)**
  Wang, Minjuan; Xiao, Jun; Chen; Callaghan, Victor; "*Message Design for Mobile Learning: Learning Theories, Human Cognition, and Design Principles*", British Journal of Educational Technology (BJET), 2011
- **Shanghai Jiao Tong University (eLearning Lab)**
  Tonghen Zhang, Vic Callaghan, Ruimin Shen and Marc Davies "*Virtual Classrooms: Making the Invisible, Visible*" (Presentation), Intelligent Campus 2011 (iC'11), Nottingham 26th July 2011
- **King Abdulaziz University, KSA (Computer Science Department)**
  Anasol Peña-Ríos, Vic Callaghan, Michael Gardner, Mohammed J. Alhaddad "*Towards the Next Generation Learning Environments: An InterReality Learning Portal and Model*", Intelligent Environments 2012, , Guanajuato, México, 26-29 June 2012

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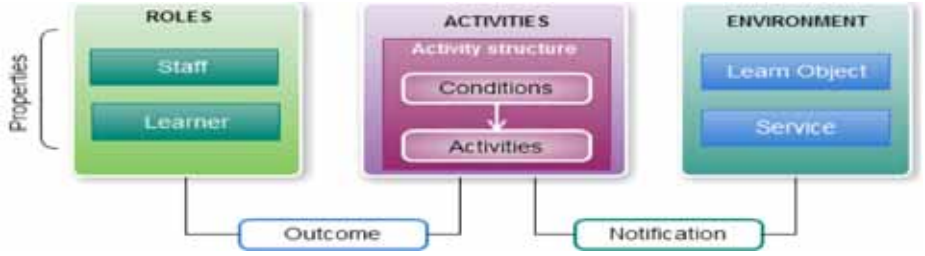
Learning Design



- Uses IMS (Instructional Management Systems) Global Learning Consortium specification for the creation and planning of the activities to be performed by the students during a teaching session to achieve some goals regardless of the pedagogical methods utilised.
- Structured sequences of activities known as Units of Learning (UoL) & benefit of this specification is the portability and reusability of the learning units

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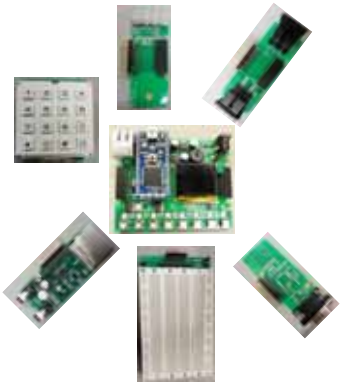
Academic Participation



- **Organised as a Faculty Cooperative**
  - Aims to allow academics to have a stronger stake-holding in the companies that provide educational technology
  - Owned by the academic community
  - Influenced by academic community
  - Open system approach
  - www.facultycooperative.org

Some Related Activities I Organise

ICST* Transactions on Future Intelligent Educational Environments

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

EAI European Alliance for Innovation

ICST.ORG

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

Exploring Future Business Visions Using Creative Fictional Prototypes

Special Issue of FUTURES, published by Elsevier, Amsterdam (http://www.sciencedirect.com/science/journal/00163287)

The 8th International Conference on Intelligent Environments

IE'12

www.intenv.org

Guanajuato, México.

26-29 of june 2012, (workshops on 26-27 of june 2012)

3rd International Conference

Creative Science (CS'11) - Science Fiction Prototyping for Technology Innovation

London – UK. November, 2012

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

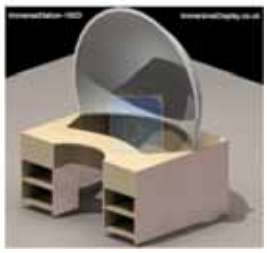
The Singularity – a point where AI transcends the limitations of peoples brains

International IC'11 Workshop on *The Intelligent Campus* - iCampus -

CSf Creative Science Foundation

intel

Summary



- Emerging technologies such as the "Internet-of-Things" are creating new challenges to educators as to how to teach the skills involved (which differ significantly from desktop computing).
- Companies such as Intel have identified a need for scientists and engineers to have more creative skills. (see *www.creative-science.org*)
- A combination of SFP, modularised computing (Buzz-Boards & Blocks) allows the application of a *constructionist / experimentalist pedagogical approach to lab based teaching of Internet-of-Things engineering in an motivating and effective way (see www.FortiTo.com*
- A "Faculty Cooperative" approach would allow the academic community at large to be involved (see *www.facultycooperative.org*)

University of Essex

Intelligent Environments Group

Any Questions?

More information can be found on:

http://ieg.essex.ac.uk

http://dces.essex.ac.uk/staff/vic/vic.html

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