
IMMERSIVE EDUCATION INITIATIVE
iED 2012
BOSTON
June 14 - 16
BOSTON COLLEGE
summit.ImmersiveEducation.org
VIRTUAL WORLDS LEARNING GAMES SIMULATORS
AUGMENTED & MIXED REALITY FULL IMMERSION


MiRTLE
University of Essex
Intelligent Environments Group
ePod
Buzz
Towards Mixed-Reality Co-Creative Learning Environments
Prof Victor Callaghan
Essex University
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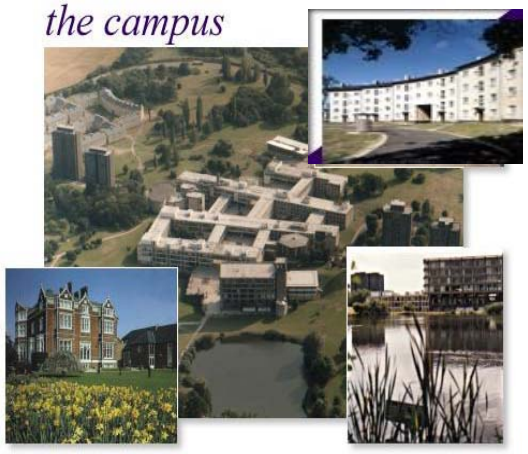
http://dces.essex.ac.uk/staff/vic/
School of Computer Science & Electronic Engineering
Essex University

About Me

- Professor of Computer Science at Essex University
- Leader of Intelligent Environments Group
- Main expertise in robotics and intelligent environments (founded Robotics & Intelligent Environments at Essex)

- Current research focused on Intelligent & Immersive Mixed-Reality Environments.
- Founder and part of organizational team for numerous conferences, workshops, journals
- Work with Intel on Product Innovation (which have rise to research I will introduce)



•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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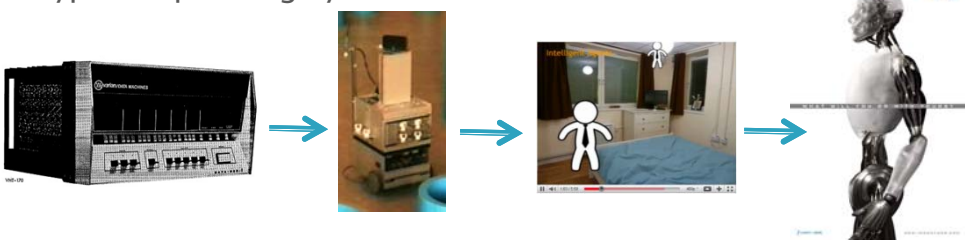
In the beginning .....

- My PhD was in software engineering and I was working on "*computer operating systems*" (one called *Vamp3*, like an early Windows etc)
- Was struck by comparison with how our brains do a similar job with managing our bodies and wondered "is a brain a type of operating system"



- This analogy got me into Artificial Intelligence (intelligent agents, intelligent machines, robotics etc) .....

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Some Current 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/

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)

Exploring Future Business Visions Using Creative Fictional Prototypes

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

CSI intel Creative Science Foundation

Creative Science (CS'13

SciFi Prototyping for Research Innovation

London, UK. February, 2013

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

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

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Structure of Presentation

- Essex Facilities (Living Labs)
- Motivation (Creative Science – Tales from a Pod)
- Constructionist Ideas (the project components)
  - Deconstruction & Virtual Appliances
  - Internet-of-Things (Buzz-Boards)
  - Adjustable Autonomy (metered tutoring)
- The Project
  - The Immersive Environment (ImmersaStation)
  - Learning Design
  - Work Activities
  - The Community (EduNet)
- Intel "Nebulous Worlds" (online experiment)
- Summary

The **Robot Building** (Sathorn business district, Bangkok, Thailand) was designed for the Bank of Asia by Sumet Jumsai to reflect the computerization of banking & was completed in 1986.

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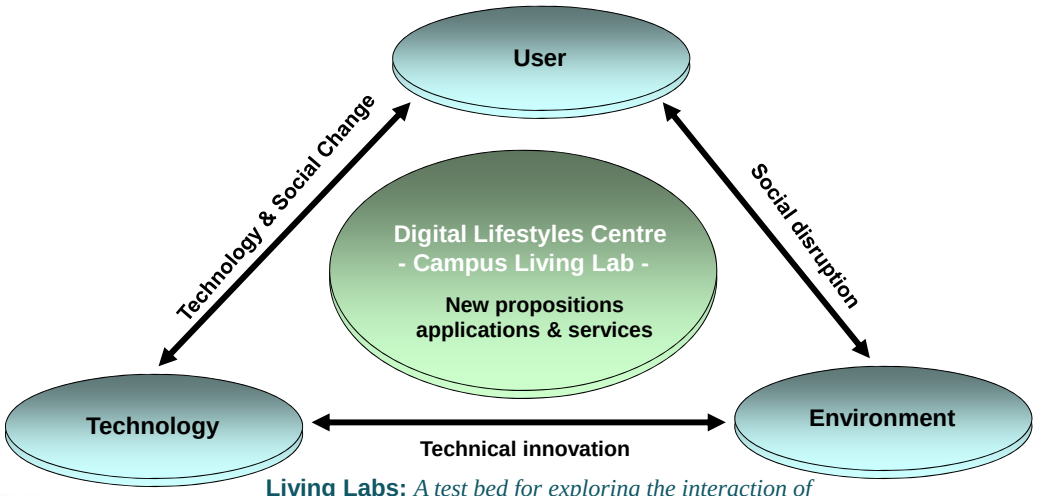
Essex University Living Labs



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

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Essex 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

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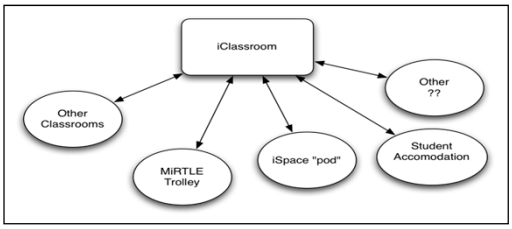
Essex Research Platforms 2 – iClassroom

- 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



iCampus (intelligent cities)

Exploring a networked society (campus universities are akin to mini-cities)

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

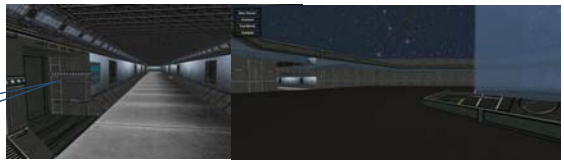
iWorld

- The iWorld is a **Mixed-Reality** simulating people & buildings outfitted with real devices (in the iSpace), and virtual objects (in the iWorld).
- 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.

Originally based on a collaboration with EA

The iSpace

The iWorld



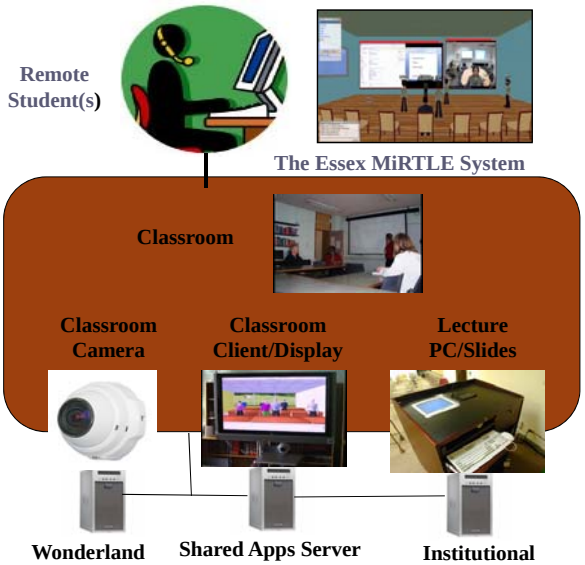
Intel's Nebulous Worlds (based on the Unity platform)

Essex Research Facilities 5- Immersive Mixed Reality

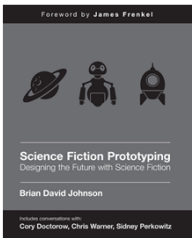
- Teaching using mixed Reality
- Students & teachers both real and avatars is mixed reality space
- Materialises abstract concepts

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



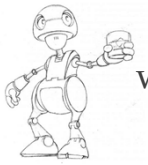
SF-Prototyping & Creative Science



- **Science Fiction Prototyping**
- Created by Intel's Futurist (Brian Johnson)
- Based on getting engineers extrapolating their work forward by them writing fictional (but grounded) stories.
- Aimed at helping with problem Intel had in anticipating market for their chips 3 generations of application away
- Applicable to any discipline (**could be used for iED**)

Creative Science Foundation

- Started by Intel but they aim to get other large multi-national companies on board.
- Will eventually fund all activities related to creative science methodology
- This will take time to be establishe



CSf Creative Science Foundation

www.creative-science.org

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Motivation – SFP – "Tales from a Pod"

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

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[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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Constructionist Ideas–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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Constructionist Ideas–Reconstruction as Learning

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

- Components can be physical or abstract

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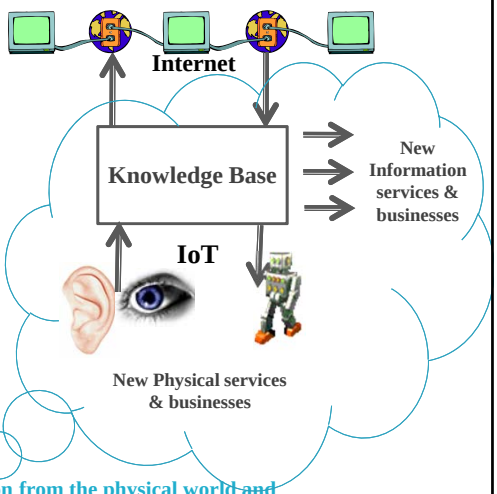
Constructionist Ideas – Internet-of-Things (IoT)

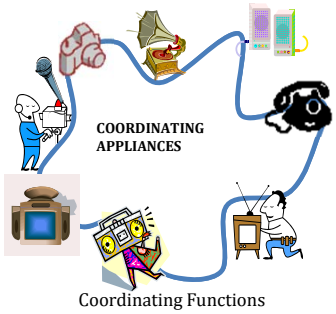
- Environments "where (networked) devices, services and applications work together seamlessly supporting even richer, more engaging and deeply connected (user) experiences" (Bill Gates, 2006)
- Estimate for the IoT in 2020 suggest the market could be between 22 billion and 50 billion dollars made up of some 16 billion connected devices



Based on collecting information from the physical world and enabling new & disruptive social and business services.

Constructionist Ideas– Virtual Appliances

Next Wave Technologies and Markets Programme



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.

- DTI PHEN & EU eGadgets projects explored how everyday "*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 *constructionist and experimentalist learning*.

Constructionist Ideas – Buzz Boards

www.FortiTo.com

- Network aware computer architecture building Blocks
- Spin-Off from Essex University

- Over 30 different modules
- Processor agnostic (supports ARM, mbed, Pic, RPi, Arduino)

Buzz Boards

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Constructionist Ideas – Buzz Boards

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

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

Buzz Boards

www.FortiTo.com

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Constructionist Ideas – Buzz Boards

www.FortiTo.com

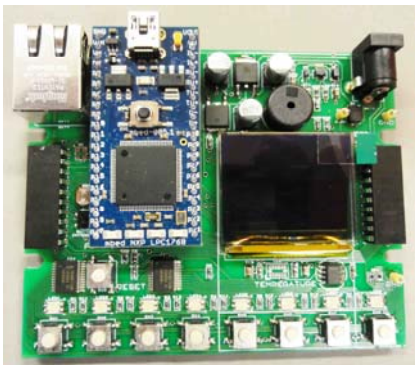
Software Development

- *Because Buzz Boards* are carriers 3rd party boards, they work with the third parties development system tools
- Generally (eg mbed), development software is based on a simple 'drag & drop'. Processor Base Board connected to a PC via USB which behaves like a USB pen drive allows drag and drop of compiled program device – press the 'reset' button to execute it.
- Variety of software demos and assignment templates provided (including software source code and assignment text)

Buzz Boards

Constructionist Ideas – Buzz Boards

www.FortiTo.com



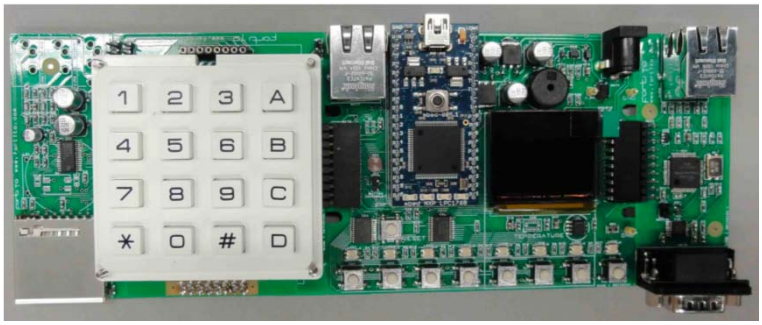
Buzz Boards

Processor Baseboard – accepts mezzanine based processor

- 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)

Constructionist Ideas – Buzz Boards

Internet Radio www.FortiTo.com



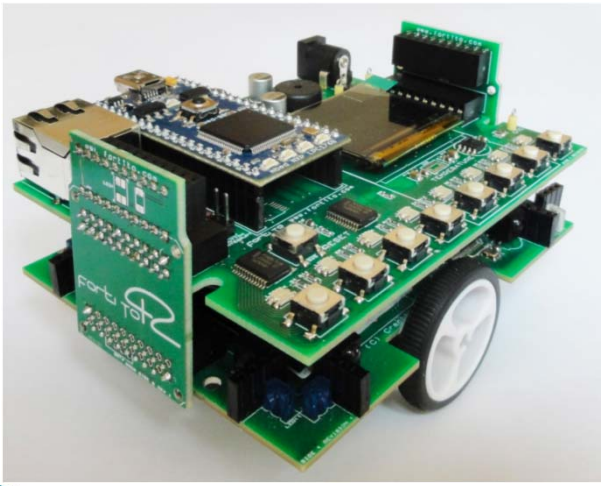
(from left to right) an audio, keypad, base & network *Buzz Boards*

- Internet radio assembled by plugging together
  - ARM-Cortex mBed mezzanine,
  - processor base board, network
  - keypad (optional)
  - audio *Buzz Boards*

Buzz Boards

Constructionist Ideas – Buzz Boards

Desktop Mobile Robot www.FortiTo.com

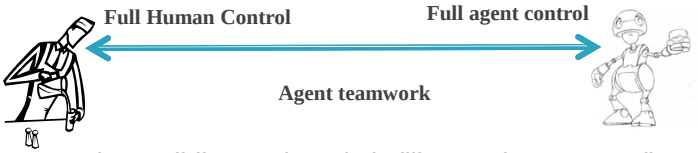


- Desktop robot assembled using
- ARM-Cortex mBed mezzanine,
- Processor base board
- Robot chassis (with IR proximity sensors and batteries)
- Two three-way inter board connectors

Buzz Boards

Constructionist Ideas – Adjustable Autonomy

- The Autonomy (Intelligence) continuum



- 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 intelligent systems.
- In Education, if we made an intelligent tutor it would be possible to use this methodology to adjust the amount of help provided to the student (to find a sweet spot between too much and insufficient help)

Matthew Ball, Vic Callaghan "Managing Control, Convenience and Autonomy", Journal of Ambient Intelligence and Smart Environments, IOS Press, Vol 12, 2012, *ISBN 978-1-61499-049-9*

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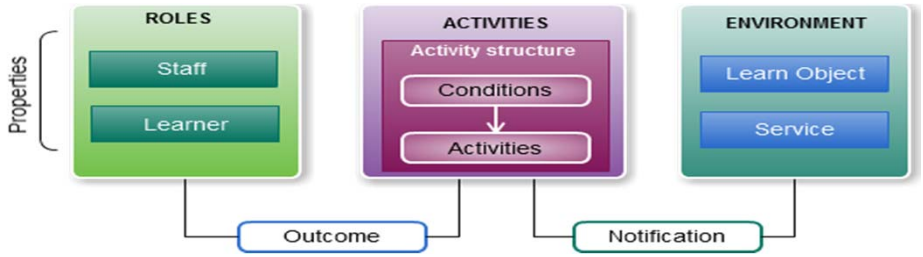
Learning Design



- 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

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

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The Project (Mixed-reality Co-creative Learning)

Combine all these elements to create Mixed-reality Co-creative Learning Environment

Anasol Peña-Ríos, Vic Callaghan, Michael Gardner, Mohammed J. Alhaddad "*Towards the Next Generation Learning Environments: An InterReality Learning Portal and Model", IE'12, Guanajuato, Mexico, 26-29 June 2012*

Anasol Peña-Ríos, Vic Callaghan, Michael Gardner, Mohammed J. Alhaddad, "The InterReality Portal: A Mixed Reality Co-creative Intelligent Learning Environment", WOFIEE'12, *Guanajuato, Mexico, 26 June 2012*

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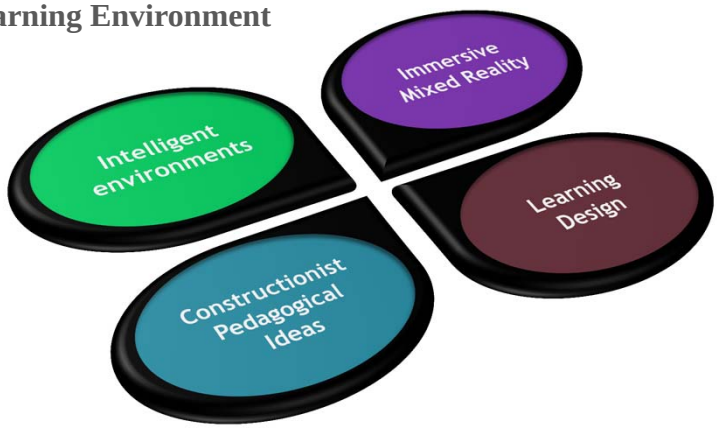

Involves partners in America, Europe, the Middle and Far East (we welcome more!)

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The Project- Immersive Reality Desk

The Essex-ID Immersive reality

- 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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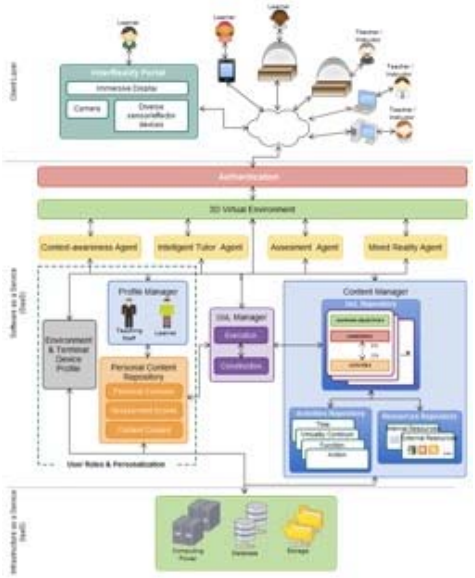
Mixed Reality Co-creative Architecture

- Described in more detail in:
- *"Anasol Peña-Ríos, Vic Callaghan, Michael Gardner, Mohammed J. Alhaddad "Towards the Next Generation Learning Environments: An InterReality Learning Portal and Model", IE'12, Guanajuato, Mexico, 26-29 June 2012"*
- *"Anasol Peña-Ríos, Vic Callaghan, Michael Gardner, Mohammed J. Alhaddad, "The InterReality Portal: A Mixed Reality Co-creative Intelligent Learning Environment", WOFIEE'12, Guanajuato, Mexico, 26 June 2012"*



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The Project – Current activities

- Construct and deploy a number of physical prototypes in UAE (EBTIC), Saudi Arabia (KAU), Indonesia (UGM), UK (Essex)
  – first version built and installed at Essex
- Build the Mixed-Reality assignment hardware and software
  - hardware built, software simulations being created at Essex
- Create a multiplicity of agent to support learning content agents (San Diego), tutor avatars (Shanghai), environment control agents (Essex)
  - work in progress at Shanghai and Essex
- Devise pedagogical tools based around learning design (San-Diego), adjustable autonomy (Essex) and embedded computing (Essex) and learning content (KAU, Kalifa)
  - work in progress at San-Diego and Essex
- Produce learning material and conduct evaluations
  - in work queue

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EduNet – A Research and Teaching Collaborative Network

- UK
- KSA
- Kuwait
- UAE
- China
- Indonesia
- Taiwan
- ?

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

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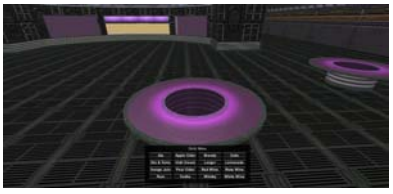
Nebulous Worlds – Intel Competition

- Online competition to stimulate creative science thinking
- Takes the theme of asking what is "free will" and can machines ever attain this.
- Invites science students to write program to feign free will.
- Scope for other activities and prizes (something business related?)



Simon EGERTON, Marc DAVIES, Brian JOHNSON, Victor CALLAGHAN, "Jimmy: Searching for Free-Will", Creative Science 2011, Nottingham, 26th July 2011

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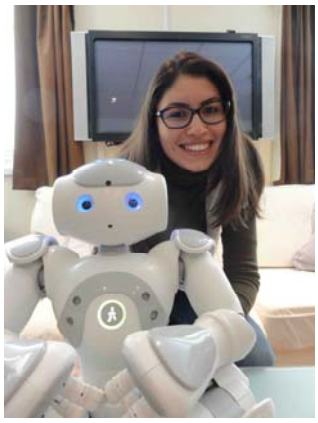
Summary



- Mixed Reality & Intelligent Interactive systems has a lot of potential immersive educational environments.
- Creative Science is a useful tool for creating visions and "stretching" research (think about writing a SFP for CS'13 or joining CSf).
- Our work is really only at a beginning and we would welcome feedback
- Difficult problems = Research Opportunities

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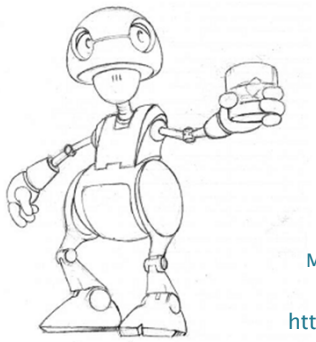
University of Essex

Intelligent Environments Group

Any Questions?



vic@essex.ac.uk

More information can be found on:
http://ieg.essex.ac.uk
http://dces.essex.ac.uk/staff/vic/

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