**April 2012**

# Links between STEM academia in Scotland and the Creative Industries

## Context and introduction

At a meeting in November 2010, the Cabinet Secretary for Education & Lifelong Learning, Mike Russell, asked the Deans' Group if they might review the links between STEM academia in Scotland and the Creative Industries. At their spring meeting in 2011 the Deans agreed to invite members to provide information on relevant activities within their own organisations. Responses were received from 11 universities.

The returns reveal an astonishingly rich and diverse range of interactions. They do not represent a comprehensive catalogue, but they do confirm that very many opportunities have been taken to interact with creative industries, on many different fronts.

This Report is being sent to the Cabinet Secretary as a response to his initial request. The exercise has also served to raise awareness within our member institutions of the scope of these activities, and of the range of contexts in which they apply. It is possible that new collaborative links may be made on the basis of this interchange of information.

The Report below begins with a short overview commentary, prepared for the Deans by Prof Doug Greenhalgh of Glasgow Caledonian University. This highlights in particular the scope, depth and fundamental importance of core engineering and technology to the creative industries sector.

There follow two appendices. The first of these provides an extract from the Scottish Government's 2009 Key Sector Report on the creative industries. This was provided to members as defining guidance of the context within which relevant responses might fit. Appendix 2 represents a collation of responses received. No attempt has been made to order these in any particular way. Responses vary in terms of approach and detail, but they provide ample evidence of a very rich range of individual initiatives. Academic energy and imagination are clearly in evidence.

## An overview commentary: Engineering and technology interfaces

Creative industries are those that have their origin in individual creativity, skill and talent. They also include industries that have the potential to create wealth and job creation through the development, production or exploitation of intellectual property. They have a growing importance in engineering since they are closely associated with the human experience of using technology and this is, arguably exemplified by products such as smart phones (e.g. iPhone, Androids etc.). In these examples both the physical package and the design and functionality of the software and applications (apps.) have to be right. Thus we now live in a world where engineers are being stretched to deliver comprehensive solutions and creative talents are engaging with new technologies.

The purpose of this report is to identify the breadth and depth of HE engagement in the sector with engineering within Scotland.

The importance of the creative sector to Scotland is very strongly established since in contributes £2.4 billion[1] of gross value added on a turnover of approximately £5.2 billion[1]. The sector involves more than 60,000 people in over 8,000 business and is estimated to have grown by 27% in the past decade[1]. The sector is both underpinned by and driven through the output of

[1] Source: http://www.sdi.co.uk/sectors/creative-industries/key-facts.aspx

its long established institutions who are directly engaged in this sector including: Glasgow School of Art, the Royal Conservatoire of Scotland as well as numerous constituent parts of the Universities such as Gray's School of Art (Robert Gordon), Duncan of Jordanstone College of Art and Design (Dundee), The Studio Art School (UHI), Edinburgh College of Art (UoE) and the School of Textiles and Design (HW), the Institute of Arts, Media and Computer Games (Abertay) and Caledonian Creates (GCU). There is also a large involvement from more traditional engineering and technology schools and departments across the HE sector and this is covered in more detail in Appendix A.

What is perhaps less apparent to the casual observer is the scope of the links and the crucial importance of Engineering and Technology to this sector and thus the implications for HE activities.

The first point to make is that design is now an integral part of engineering. Any successful product has to be fit for purpose, be attractive to its customer and, now because the computer and microprocessor are ubiquitous, incorporate software that delivers an intuitive and efficient experience at the human interface.

The second point to make is that designers are now substantially embracing technology and this is driving a strong response from the ICT sector to support this. One prime example of this is gaming which has become a major industry exploiting talents of designers, engineers and technologists in equal measure. The importance of this is readily illustrated by the success of one product "Grand Theft Auto" which is produced by Rockstart North in Edinburgh. It is important to note that Abertay pioneered the world's first undergraduate degree course in Computer Games Technology and Glasgow Caledonian University has had post graduate courses in this area since the late 90's.

The third point to make is that ICT visualisation technologies are at a critical tipping point in their development where affordable and realistic 3D visualisation technologies are now rapidly emerging into the market place. This will create new paradigms for designers and substantive technology challenges to support them.

To illustrate the current status an appendix to this report is attached which details a large number of the activities that interface between the creative technologies and engineering and design. The breath and the scope are truly substantial and they directly impact industry, business, health-care, the natural environment and the third sector.

Therefore a fourth point to make is that the design and technologies gleaned from gaming are now set to feed into the design of games and software for education, rehabilitation of patients, and improved interfaces to complex technological products.

The interface between design and technology in Scotland is currently served by the established institutions of the creative sector, by the engineering and technology sectors and by specialised courses in such as gaming technology and engineering design. The sector will and should remain flexible in its approach, there is a need for engineering and technology specialist activities to increase their cognisance of this area, there is likewise a need for creative activities to become more technology aware. There is also a need for specialist activities which combine aspects of both creativity and technology and this is a slowly growing but important sector. The importance of this interface has been recognised by one leading learned body namely the Institute of Engineering and Technology, IET[2].

We recommend that this area is fostered and recognised both within traditional areas and the emerging interface areas. It is a major opportunity to support one of Scotland's most vibrant economic sectors through cutting-edge work.

[2] Source: http://www.theiet.org/sectors/design-production/index.cfm

## Appendix 1: Extract from the Scottish Government's Key Sector Report

The following briefing information was extracted from the 2009 Report on the Creative Indistries.

### 1 Description of the Sector

Creative industries are those that have their origin in individual creativity, skill and talent. They also include industries that have the potential to create wealth and job creation through the development, production or exploitation of intellectual property. The sector is made up of13 distinct industries:

- advertising
- architecture
- arts and antiques
- crafts
- design
- designer fashion
- film
- interactive leisure software
- music
- performing arts
- publishing
- software and computer services
- TV and radio

### 2 Scope and Performance of the Sector

| Employment (2007) | GVA (2007) | GVA per employee (2007) | Turnover (2007) |
|---|---|---|---|
| 60,700 | £2.4b | £41,600 | £5.2b |

The sector is characterised by Scottish owned, small businesses. In 2008, 97% of enterprises were small (0-49 employees). Splitting this category further shows that 60% of creative industries registered enterprises had zero employees whilst 37% of all creative industries registered enterprises had 1-49 employees. The majority of enterprises in the sector are Scottish-owned (97%), accounting for 69% of employment. Self employment of 24% in 2007 is double the Scottish average. Annex A gives a fuller statistical description of the sector.

Turnover varies considerably across the sector, with computer games and software (£1.7b in 2007), architecture (£1.5b in 2007) and publishing (£0.8b in 2007) – these three sectors accounted for over 75% of the sectors total turnover in 2007.

Employment in the sector increased by 3% between 2006 and 2007, while the estimated number of enterprises registered in the sector increased at a faster rate than the average of the Scottish economy over the last decade.

Recent GDP data show that output in the creative industries sector fell during the first quarter of 2009, down 0.9%. However, this fall was of much smaller magnitude than that measured across the Scottish economy as a whole, which fell 2.4%. However, the creative industries sector maintained positive growth in year on year terms at 3.0%, compared to a 1.2% fall in the economy as a whole.

## Appendix 2: A compilation of the responses received from members

### 1 University of Dundee

The 'creative industries' in the University of Dundee are in Duncan of Jordanston College of Art and Design, which is part of the College of Art, Science and Engineering, i.e. the 'design' part fits well with the engineering side of STEM. There is a broader discussion taking place about making learning accessible across the University, which for my Life Science students, might include taking courses in the College. Such cross-subject courses would then hopefully enhance the possibility that innovative links would build in the general economy.

### 2 Glasgow Caledonian University

The interplay between science, engineering and technology with the creative industries is an area of exceptional importance. It can be argued that the extraordinary growth in personal computing and hand held systems (e.g. iPhone, iPad, BB, Symbian, Android etc.) directly results from a direct interplay between these areas and it is only in hindsight that many are realising the importance of this. Gaming and sensing the world through complex audio and visual means (e.g. 3D) will undoubtedly lie at the heart of much that we do in the next ten years. New technologies that draw advantageously from creative design will be pervasive in our lives both for leisure as well as health care and smart control of energy and resources. It is therefore vital that these agenda are embedded in both our research and our teaching if we are to meet industries and societies needs.

At Glasgow Caledonian we have a long tradition of embedding engineering and technology alongside creative activities in design, visualisation and audio and we believe we are very strongly placed to play a leading role in the future of this area.

Along with the positive technologies, at GCU we are also working with Network and System securities which is an area destined to be more of a factor in all our lives and likely within the creative sector too, hence this recognises another important interface with technology.

Key data for GCU Research and Knowledge Transfer:

- Core funded projects =£1,465k
- Related funded projects = £2,116k
- Total funded projects (C & R) = £3,581k

Additional Comments

- One team from the Scottish Games Jam, run in January 2012 (and hosted at GCU), has been selected for the Scottish BAFTA New Talent, this team includes a GCU student.
- 2 Staff are presenting at “Games for Health” conference in Boston, June 2012, a cross institutional initiative, most influential conference in the field.
- KTP future programme has indicated an increased focus on Technological Innovation.
- (Reuters) - European policy makers have identified a large shortfall in computing and IT skills among young people that threatens to dent Europe's ability to compete and could exacerbate youth unemployment in the coming decade.

**3 University of Edinburgh**

There is key partnering between the School of Design in Edinburgh College of Art (http://www.eca.ac.uk/1108/) and the School of Informatics. This core pairing also pulls in other Schools (e.g. Arts Culture & Environment on the design side; Engineering on the STEM side) and will be enhanced by the integration of ECA into the University in August 2011.

The long-term vision is to develop a new approach to the design of informatics "products" that harness the ubiquity and data capacity of modern information systems (at individual to social scales) by developing the kinds of designers who understand how to build and adapt these systems. This sits alongside our existing entrepreneurial efforts (ProspeKT, etc) where we already have a track record of spinning out "smart" companies

As a focus for the effort we will set up a Design-Informatics Centre. This will differ from comparator efforts, such a Design London by being

- focused on informatics-related design (rather than design in general)
- international in its outlook (rather than focused on London and the UK)

We are linking the Centre to several other efforts including the Creative Industries KTN (the Director John Cass and deputy director Jeremy Davenport are already engaged with us). We were invited onto the round table for the recent Creative Industries consultation for the TICs. We link to the SICSA pool.

We will also develop a programme of teaching at UG and PG levels, starting with a joint Honours. This requires surprisingly little change to the teaching modules on offer but a major change in the way we view a degree - which must be deeply portfolio based rather than based on incremental testing (as is common for most STEM subjects).

There are also links between the **School of Engineering** and the Creative industries. Dr Andrea Hamilton is supervising a PhD student in ECA and has been involved in the submission of a grant application with Architecture. She is also studying part time for a BA degree through their night school!.

Alistair Elfick is working with Daisy Ginsberg on an NSF/EPSRC and RAEng project "Synthetic Aesthetics and Art-full Engagement". He is also applying with her to the Welcome Trust for funds to run a workshop to train artists in synthetic biology. He has expressed enthusiasm for continuing and enhancing his links

There are probably other joint activities which are falling beneath the radar at present, and many colleagues have expressed enthusiasm for involvement in the art/design/engineering interface!

**Collaborations with Edinburgh College of Art**

1. Scottish Funding Press Release on Design-Informatics - 25/11/2011

> "The Scottish Funding Council (SFC) is to invest £1 million into a new centre combining design expertise with world-leading computer science research.
>
> The Design Informatics Centre at the University of Edinburgh will allow the University's School of Informatics to work with The School of Design at Edinburgh College of Art to integrate product design with ideas from informatics.

Designers will work alongside informatics entrepreneurs to help build new products and services, including the next generation of social media tools. The centre aims to create a new kind of graduate who can talk the language of technology and designers but also has business and entrepreneurship skills.

The funding will support a new Masters degree which will be delivered jointly by the Informatics school and the College of Art, which will feature resident entrepreneurs and industry placements."

2. Design Informatics

Informatics is about structure, behaviour, and interactions. It's about natural and engineered information processors. Design is about the generation, development and testing of concepts. It's about the creation of physical objects, capabilities or services.

Design Informatics focuses on designing with data. We can harness massive connectivity, analytic power and industrial-strength simulation to design tangible products and intangible services to transform the ways we work, live at home, care for each other, and play. The Centre for Design Informatics is for the agents of change who want to make a difference through computational thinking and design, to make things better, bit by bit.

Our vision is that Scotland can take a lead in designing with data, combining informatics and design, to support the augmented society; just as virtual reality is blending into augmented reality, the digital economy and the information society will evolve into the augmented society. Already, social media tools are increasing the social and economic value that can be generated by extremely varied collections of people. As the products of informatics further augment our society, natural human intelligence will intertwine with vast data-processing power.

These emerging products are revolutionising the means by which social and economic value can be generated. Old divisions and distinctions are shifting and dissolving: designers and users, producers and consumers are working together in new ways to create new value. Design is embracing adaptive devices and services that both learn and teach. At the same time, the fields of design and informatics are being enriched through research by design.

The merger between the University of Edinburgh and the Edinburgh College of Art creates a unique opportunity for Scotland and the UK to realise Design Informatics. The Schools of Informatics and Design have formed the Centre to inspire, equip and nurture a new generation of design-informatics researchers, practitioners and entrepreneurs.

The Centre weaves together four threads from each school, with machine learning an overarching theme. For design: product, media, fashion and architecture. For informatics: vision and robotics, interaction, sensor networks, and synthetic biology. The academic year 2011/12 sees the Centre growing its activity in research, entrepreneurship, teaching and outreach.

Entrepreneurship

Resident entrepreneurs are joining the Centre to help take their own informatics products to market, designing with data, to build innovative prototypes and transform them into viable products. The Centre can support up to half a dozen residencies at a time, housed in Evolution House, with access to entrepreneurial education, and support for starting up. The Centre's Community of Interest is being developed to help forge the links between academics and local

and global companies and organisations, both large and small. These links will underpin the placements being established for future students.

Teaching

Courses are being designed for students who want to build their skills in design informatics. There will be a degree programme for informatics-based students, and another for design-based students. Both involve the deepening of technical skills, as well as broadening out to enable interactions across discipline boundaries. The courses have a focus on practicals and products, and work is in hand to scope out summer placements on challenging projects.

Research

Students, staff and entrepreneurs are exploring the possibilities which are generated by crossing ideas from design and informatics. For instance, what can computer vision do for animation? Can synthetic biology and fashion find common ground? Every student or staff research project has to address a practical challenge. Can we improve the ways we work, especially creatively - or the ways we care, for vulnerable members of the community - or the ways we play, on the sports-field, or on holiday?

3. Tales of Things (TOTeM)

Chris Speed is the PI for a large RCUK Digital Economy project (£1.4mill) entitled TOTeM that began in August 2009 and runs for three years to explore social memory within the Internet of Things. The projects public facing website www.talesofthings.com has received international recognition for developing a simple way for people to attach memories to physical artefacts through the use of barcodes. The project team (Edinburgh, UCL, Brunel, Dundee and Salford) have been working with many communities to explore how the association of memories to artefacts can reinforce intergenerational ties, extend cultural understandings and challenge the 'value' of things as they accrue immaterial data. The project has worked with specific communities to identify how artefacts and memories are linked: various ethnic communities in the Greenwich area during Black History month, ex-World War Two communities and members of the public through Science Week at the National Museum of Scotland. As part of the same project, Chris developed extended the technology to a site specific installation at an Oxfam shop in Manchester during which visitors to the shop who dropped items off were asked to tell a story about their relationship with the artefact. A week later, the objects became stock items in store and tags allowed shoppers to listen to the stories. The success of the project propelled the project in to the international press with articles on the BBC, in the Guardian, WIRED and New York Times. Even Oxfam realised the benefit for themselves and their broader community as profits shot up by 52% during the 'show'. As a consequence of the work Chris and his team are now in conversation with Oxfam to explore a role out of the technology across its UK stores.

4. Sixth Sense Transport

Chris Speed is also a Co-I on the RCUK Digital Economy funded Sixth Sense Transport research project (£900k), which explores the capacity of new mobile technologies to mediate the coordination of activities, is altering social and spatial practices and challenging our understanding of the transport network. Led by Southampton, with Edinburgh, Salford, Bournemouth and Lancaster, the Sixth Sense Transport project sets out to experiment with a transformation of the transport timetable that has governed the way we organize travel for over

100 years. For example, despite representing an extraordinary number of nodes within a system, of the 31,035,791 registered cars on UK roads, very few are actually represented in digital networks. In direct contrast is the precedent of 50 million users of mobile social networking worldwide. Not only does this build and reinforce social ties distributed over time and space, it also permits real-time data streams to inform network participants of new recommendations and the scope to establish new network nodes. The project aims to develop platforms across the design / informatics interface that explore how this might serve to anticipate opportunities for connections that are otherwise invisible to current users (e.g. a tangible 'Internet of cars'). This offers users the potential to re-distribute decision-making processes about travel and offers a critical socio/technical substrate around which new transport habits may emerge. The researchers suggest that by providing people with a way to visualise and augment the state of the 'transport network', then we might be able to realise more opportunistic and collaborative uses for transport resources and reduce carbon emissions. (http://www.sixthsensetransport.com)

5. Walking Through Time

A relatively small JISC grant provided the funding for design and production of the Walking Through Time iPhone application that was co-developed with partners at the College of Art and University. By making available historical UK maps, users are able to scroll through time and navigate places using maps that are hundreds of years old. Receiving over 8000 downloads during last year's festival, Chris has worked with museum and historical communities to explore how new technologies can provide new insights into history whilst standing on the spot! (http://www.walkingthroughtime.co.uk)

6. Comob Net

Working with colleagues in the school of architecture, geography, informatics and the artist Jen Southern, a small ECA research fund project has lead to the very popular iPhone application Comob Net that is free to download on the Apple App store. Comob Net offers users across the world a unique social attribute to GPS software – the ability to link friends with lines across a Google map in real-time. A small intervention that has proved to be very popular indeed allowing lovers, skateboard groups and just friends to build links and stay connected across digital media. The software has been specifically used with communities through workshops in Edinburgh, Dundee, Belfast and Manchester (http://www.comob.org.uk) .

7. Community Hacking

'Community Web2.0: creative control through hacking project' is a £40K AHRC funded Connected Communities project that explores the extent to which parallels between virtual society (Internet) and actual society (communities) may be extended in such a way that helps make sense of both the opportunities and risks of the Big Society for communities. As PI for the project Chris is working closely with the Wester Hailes community to explore how local 'memory poles' with digital codes upon them may support bridging opportunities for locals, as well as providing a platform for reminiscence and the collection of stories and photographs (http://www.communityhacking.org).

8. Scottish Academy of Fashion

SAF is an inter-institutional network that aims to establish Scotland as a 'global centre for excellence in fashion related learning and commercially relevant research'.
SAF is building on Scotland's educational and industrial strengths in innovative design, technical and scientific research to deliver collaborative industry activity, develop the requirement in industry for high level skills and expertise, and develop innovative processes and products that have the potential to make step changes in industry. Meeting, and creating industry demand,

combined with the potential to attract the best student and research talent, allows Scotland the opportunity to be world leading in this field.

Partner Institutions

The Scottish Academy of Fashion partners include:

- Edinburgh College of Art at the University of Edinburgh (ECA)
- The School of Textiles & Design at Heriot Watt University (HWU)
- Gray's School of Art at Robert Gordon University (RGU)

Based on the premise that Scotland has the potential to have a globally marketable commodity in fashion related learning and research, SAF received £220,000 from SFC to fund a 'Pre-Implementation' phase, completed in November 2011, to establish demand and the capability of partner institutions.

The results achieved in SAF's 'Pre-Implementation' phase were significant, including:

- Demonstrating demand: a proactive approach has resulted in a significant level of project activity and new engagement between industry and academia. Prior to SAF this engagement was extremely limited.
- Establishing capability: forming a mechanism for establishing new cross-disciplinary, industrial focused research activity and articulating the opportunity for a global centre of excellence. Prior to SAF this activity did not exist.
- Built a hub of knowledge and contacts, complementing existing initiatives, and bringing a new, internationally credible, focus.

Early stage outputs generated a significant return on investment and established a strong basis for developing the opportunity. SAF will make a direct contribution towards addressing the 'innovation deficit' in Scotland, and via a robust, proactive approach, develop a global opportunity for Scotland. SAF complements and augments existing initiatives, including Interface, and the work on skills development of the Scottish Textile Academic Group.

## 4 Edinburgh Napier University

At Edinburgh Napier, the School of Arts and Creative Industries sits in the same Faculty (Engineering, Computing and Creative Industries) as the School of Engineering and Built Environment and the School of Computing. Moreover industries from the creative industry sector can be found in each school, for example interactive leisure software and software & computer services in Computing and architecture (technology) in Engineering and Built Environment as well as a wider range in Arts and Creative Industries itself. All three Schools work together with modules shared across programmes and schools, notably in the areas of digital media and product design & engineering.

Edinburgh Napier recently established nine Institutes for research and innovation. This new Institute structure and the Scottish Government SEEKIT / ERDF grant-funded Business Innovation Exchange will enable collaboration and cross-referral of SME innovation engagement through Institute Business Development Executives / Innovation Managers mapped on STEM-related industry sectors and the Creative Industries sector working together not just within Edinburgh Napier but across partnership with St Andrews University and Queen Margaret University.

Links between the STEM subjects and the creative industries have been encouraged through internal strategic investments including:

- development of undergraduate and postgraduate programmes in Interactive Entertainment;
- development of an Interactive Collaborative Environment to support cross-disciplinary research as part of a 'Future Living, Future Life' project. In addition one of our Professors has been give the remit of encouraging cross-disciplinary/inter-disciplinary research;
- interdisciplinary innovation projects engaging Creative industries SMEs e.g. a City of Literature Iphone app (a collaboration between the Faculty's Institute for Creative Industries and the Institute for Informatics & Digital Innovation)
- running mobile apps and games development modules and having designed creative internships as a way of engaging local businesses with students to increase mobile and games technology capabilities in industry;
- visual effects (VFX) modules being aligned to Skillset accreditation to ensure standardisation of expectation amongst local employers.
- using support from industry the Faculty has games development and interaction design research studentships and an infrastructure to encourage entrepreneurship in games and mobile apps.

**5 University of Glasgow**

Current engagement with industry

- iPhone game apps - we are currently negotiating a licence with a major US media network. The licence will assist the network with the animation of cartoon characters for output aimed at young adults.
- 3D for media applications - Funding Council / EPSRC supported research into 3D imaging for biomechanics, in conjunction with Edinburgh University, has now been developed and licensed in a non exclusive agreement and is used as a 3D capture tool for Hollywood movies and special effects.
- mobile devices and human machine interactions – we have a number of ongoing relationships with multinational companies involved in creative industries.
- Media Training – we work with media training organisations extending research findings into training for professionals on self presentation and first impressions.
- Mechanisms associated with movement relating to animation - we have extended our research in this area and currently work with an international media organisation on its further development.

Opportunities

Centre for Music Technology (http://cmt.gla.ac.uk/)

- The aim of the centre is to provide a framework in support of a rich interaction between artists, engineers and scientists, university external and internal organisations and individuals, in order to collaborate on activities within music technology. Research areas include: Information Management, Music Information Retrieval and Representation, Standards, Creative Productions, creative pull applications, creativity and technology, Music Education, Web-based and On-line Music Education and Systems for Music and time-based Media

Other related activities with potential links in the college

Voices

- Voices and colours – the extension of research into Synesthesia a neurologically-based condition in which stimulation of one sensory or cognitive pathway leads to automatic, involuntary experiences in a second sensory or cognitive pathway.
- Voices and visual information, social interactions, non-speech information.
- Characterisation of voices and voice recognition.

Lighting & displays

- Work with industrial partners and associates in museums and art galleries on the science and art of light and lighting, colour and vision, photobiology and image technology.

## 6 University of Highlands and Islands

As far as UHI is concerned STEM subjects appear to have very few links within our 'creative industries' network.

I've discussed this with a few 'creative industries' staff at UHI and they can see potential benefits of the computing side working more closely with themselves. Computer games and other 'apps' sit in both camps (computing and creative industries) and there are obvious synergies between them.

From an engineering point of view we include 'creativity' in some of our programmes, but it is mostly about using techniques to stimulate creativity and ways of removing 'creative blocks'. The more engineering design oriented programmes will be more creative in nature but UHI do very few of these at the moment.

## 7 University of Aberdeen

The University of Aberdeen has many example of where STEM interfaces with industry in both teaching, research and knowledge exchange activities, some of which are highlighted below;

Teaching

MSc Programmes including (e-commerce, Artificial Intelligence and Advanced Information Systems) prepare students for careers in advanced software development, technology management and commercial and academic research. The programmes include teaching in areas such as user modelling, information filtering, personalisation, adaptive hypermedia, data mining and visualisation. The programmes also balance the technical with the business and finance issues of e-commerce, leveraging our experience in the area and provides in-depth knowledge and skills of leading edge technologies, such as cloud computing, mobile computing, data mining and visualisation (for example of geographical and healthcare data), semantic web, natural language processing, and agent-based and peer-to-peer computing.

The Medi-Cal unit within the University has been providing web based learning tools for medical students for many years. They have recently been awarded for a collaboration with a medical student to deliver an innovative web based tool using video, audio and simple visualisation to deliver teaching tools (http://www.abdn.ac.uk/medical/meducation2011/anaemia/).

Research

Dr Wamberto Vasconcelos from Computing Science is involved in a grant application with colleagues in Brazil (University of Sao Paulo), looking into recommendations and requirements

for assisted living spaces (rooms, kitchens, bedrooms, hallways, etc) ensuring that light is ideal, that the field of vision (or sensor range) is the best for applications, etc. We also look into achieving compromises between aesthetical aspects (e.g. colour of walls to ensure best contrast, but adopting people's preferences). The team involved includes architects, psychologists, and computer scientists.

Within Transport research, Dr Jillian Anable is involved in an on-going collaboration with an organization called 'Julies Bicycle' which is working to make sustainability a core part of the arts and creative industries. http://www.juliesbicycle.com/ Her work has been to help them scope out their research on the transport impacts – mainly in relation to the music and theatre sectors

Knowledge Exchange

Prof Ehud Reiter is one of the founders of the spin-out company Data2Text . This is founded on research and commercial links with the media sector (details are confidential), generating automated reports and other text (and voice-based) outputs from large automated data sets. Applications are also in healthcare, education, logistics and engineering and other operational activities.

RCUK funded dot.rural project provides many examples of where STEM interfaces with creative industries as the latter is one of the four themes of the programmes (
Prof Tim Norman from Computing Science is involved with the ASSURE (Agent and Semantic Support for Rural Enterprise) project as part of dot.rural, working with a variety of businesses and entrepreneurs in rural areas (including those involved in the creative industries such as design and crafts) to investigate how next generation business networking systems can help to support and develop rural enterprise.

Prof Chris Mellish is involved with the CURIOS project as part of dot.rural, working with community groups to develop cultural repositories of linked information that can be accessed by different user groups in an "intelligent" way. At present this is looking at material collected by historical societies about their own communities, but it will also be extended to other kinds of historical and cultural material that is collated and catalogued in different forms."

Within Geography, Dr David Green undertakes research in the application of Spatial Geographic Information and Geographic Information Systems
- Information or knowledge management: creation of data model - INSPIRE compliant data models for sharing of data and information amongst user groups.

- Data capture, retrieval and representation: mobile data collection for display with online website/WebGIS

- large scale data collection for online website and web-based WebGIS

- creation of online videos and GIS tutorials for public information system and online WebGIS, as well as creation of educational websites, leaflets and flyers for school and public groups on the use and applications of Geographic Information Systems

- GIS simulation of sea level rise and coastal flooding for use in public awareness raising and education and online website and WebGIS

- Film: creation of short film for public awareness raising and education (IMCORE and LNS)

Dr Mark Reed of geography is involved in two projects:
Sustainable Uplands project is funded by UK government agencies and has commissioned the following work from the creative industries:

- A professional storyteller and an illustrator to produce a children's book about our research
- A song by a singer-songwriter and a production team to communicate aspects of our research
- A music video about the song from 20:20 Vision, a collective of professional photographers
- Film-makers to make two documentaries about our research and films summarising scenarios generated through our research
- Website developers to create an interactive website for members of the public to express what the uplands mean to them
- Research proposal submitted with three visual artists to the Insight Institute, and a Leverhulme Artist in Residence proposal being developed

The Aberdeen Centre for Environmental Sustainability was awarded a Creative Scotland grant for four artists in residence, culminating in their work being shown at the ACES2011 conference in August 2011. See an article about the work with links to each of the artists here:
http://www.aces.ac.uk/news/729/
Professor Bill Neill has recently shared a platform with the film director Tino Buchholz at the University of Kassel. His contribution was to discuss creative planning in the context of design , architecture , heritage and memory in the city. See"Creativity and the Capitalist City" by Tino Buchholz: http://www.creativecapitalistcity.org/
The University of Aberdeen was awarded a place on the Design Council university programme ",Innovate for Universities" which provided a number of projects with toolkits and allowed design to be embedded within the commercialisation process. These case studies can be found on the design council web site:
http://www.designcouncil.org.uk/our-work/support/Innovate-for-Universities/Case-studies/

The Rowett Institute for Health and Nutrition use creative tools for their Knowledge Exchange programme in particular as part of the work aimed at the community and schools, these can be found at the following link:
http://www.abdn.ac.uk/rowett/knowledge-exchange/community-and-schools/

**Aberdeen Business School**

The Department of Communication, Marketing and Media, sits within the Aberdeen Business School and delivers creative education within a business management context, with links to the Faculty of Design and Technology. There are approximately 1,100 undergraduate and postgraduate students in the Department, and subject delivery includes the creative and cultural industry areas of advertising, fashion management, media, journalism, communication, events, tourism and digital media. The role of technology plays a very significant role within the Department and this is reflected in subject design, content and delivery, thus ensuring graduates are creative practitioners with an understanding of the growth and significance of the digital economy.

**8 University of St Andrews**

St Andrews has a Masters in Museum and Galleries studies (run through the School of Art History) and these students work with scientists to produce exhibitions for the public (e.g. history of photography, centenary of Chemistry, the life of D'arcy Thompson). We also have artists working within the natural history museum here- perhaps less obviously a STEM project though.

**9 University of Abertay, Dundee**

One of UAD's biggest contributions to the creative industries is the value added graduates that emerges from our industry focused programmes at undergraduate and postgraduate level. In 2010/11 there were 330 FTE UG students and 85 FTE PG students studying in the area of the creative industries of which 41% UG students were studying for a BSc award and 42% of PG students studying for a MSc. 49% of post graduate student were enrolled on MProf in Games Development which has significant involvement from the games industry. These programmes deliver core skills in mathematics and computing as well as the creative element which is required to work in this field and as such one of the supports for the creative industries within Abertay by the STEM subjects is in terms of teaching provision to these programmes.

The University runs the £5 million Prototype Fund which is financially backed by three partners: the European Regional Development Fund, the UK Government (administered by the Department for Business, Innovation and Skills and the Department of Culture Media and Sport), and Abertay University. This fund supports young computer games companies with high growth potential as well as running events such as the £100,000 TIGA Games Contest which again aims to provide support for games developers to build a prototype and use it to secure further development funding.

In terms of the wider impact of the creative industries at Abertay, for the last 5 years there has been an emphasis on exploiting games technology and techniques in a number of scientific projects ranging from sustainable planning for the built and natural environments, 3D visualisation of agent based models and soil science. The main motive is the development of interactive digital media for interdisciplinary communication and as a platform for stakeholder engagement primarily for decision-making and understanding complex systems. These approaches have been applied to 3 main areas:

Urban Sustainability
We have developed an innovative interactive visualization and modelling tool to support stakeholder engagement in sustainable urban planning decision-making. This approach also has applications in areas such as sustainable water management where technical information from the study of sustainable water management, is manipulated so that it is possible to o compare the impact of different decisions.

3D Visualisation of Agent Based Models
Communicating and understanding the output of Agent Based Models can be enhanced using games techniques. These techniques permit remarkable levels of detail visually and can be interactive in real-time. In the Lunan landscape visualisation we aim to develop an interface to understand and communicate the link between farmer's decision-making (how this is influenced by social and economic drivers) and biodiversity (skylark health). Gaming techniques used in the project include hardware instancing of growing crops and skylark populations as well as level of detail techniques.

Soil
A step towards understanding the Carbon dynamics of soil is to integrate the physical environment of soil, quantified using Computer Aided Tomography (CT), with descriptive models of fluid flow and microbial dynamics as affected by Carbon distribution. The generation of large 3D time series data from simulations of water and microbial distributions at the pore scale may be integrated with the soil structural properties and analysed. Coupling visualization

techniques to quantitative measures and simulation output can provide an insightful and intuitive technique to understanding soil processes such as the effect of pore scale structure on dynamics of water flow and microbial species and more importantly how these are interrelated.

## 10 Robert Gordon University

At the Robert Gordon University, creative industries primarily sits within the Faculty of Design and Technology, encompassing Gray's School of Art, Scott Sutherland School of Architecture, the School of Computing, and the School of Engineering.

### Gray's School of Art

Gray's has circa 750 undergraduate and postgraduate students, and over 400 more studying on short courses. Within Gray's the subject portfolio consists of Painting, Contemporary Art Practice, Fashion & Textiles Design, Communications Design, 3 Dimensional Design, and Product Design. Many of the design subject disciplines have focused on STEM issues throughout their recent history, predominantly through themes such as health, transport, energy, and environment, and with particular prevalence in Product Design and Communications.

STEM issues also drive a number of research agendas within design at Gray's and other schools within RGU, with examples being the use of technology in Fashion and Textiles Design, and the integration of innovative technology solutions within Product Design.

### School of Computing

The School of Computing offers a broad portfolio of courses in the discipline of Computing at both undergraduate (UG) and postgraduate (PG) levels, with approximately 500 students. Both programmes are geared to produce graduates who can fulfil a professional practitioner's role in industry or drive research and development in an academic or commercial context. The ubiquitous nature of Computing and its broad area of application continue to influence the shape of the School's undergraduate portfolio. Consequently a number of routes have a distinct multidisciplinary character that extends beyond core computing to the boundaries with: Engineering; Art; and Business. This currently includes aspects of digital media, graphics and animation. Students often apply these skills in the oil and gas sector.

The Faculty is moving towards the consolidation of a Digital Media portfolio, which will engage all four schools in the use of smart technologies, computer science, design, media and modelling skills in the exploitation of visualisation, content development and knowledge/data management in mobile and web applications, and energy, health, architecture and engineering contexts.

The Faculty is home to the IDEAS Research Institute (Innovation, Design and Sustainability), which is a new multi-disciplinary research centre encompassing the disciplines of Engineering, Computing, Architecture & Built Environment, and Art & Design. It builds on acknowledged international research excellence, exploiting the rich potential of the interfaces between these diverse disciplines, and exploiting synergy from these research strengths and fostering collaboration through a multidisciplinary research context encompassing key themes of Creativity, Design & Innovation, Digital Technologies, Energy, Environment & Sustainability across a range of applications and sectors.

The Faculty is also home to C4Di, the Centre for Design and Innovation Management, which is a project established in 2008, designed to provide support to SMEs in design and innovation management, with clients in the health, energy and food & drink sectors.

**11 Heriot-Watt University**

At HWU we are trying to restore the missing DŠ and create a D-STEM model, that fully recognises the value of design to STEM and business. As Sir George Cox stated in The Cox Review of Creativity in Business, "we need business people who understand creativity, who know when and how to use the specialist, and who can manage innovation; creative specialists who understand the environment in which their talents will be used and who can talk the same language as their clients and business colleagues; and engineers and technologists who understand the design process and can talk the language of the business."

Recent multi-disciplinary initiatives such the Creativity, Design and Innovation research theme, the Scottish Academy of Fashion and a new proposed MBA with a specialism in Design for the Creative Industries demonstrates how HWU is aware of the vital role of design in innovation, and how design, science, technology, engineering and enterprise work together to create products, solutions and applications greater than the sum of their parts.

Through new initiatives such as ŒInterior Design¹ between the School of Textiles and Design and The School of the Built Environment, we are developing a greater integration of design and Œdesign thinking¹ methods with STEM and business curricula. Our portfolio of disciplines across our academic schools provides a great opportunity to fully embed design tools, techniques and capabilities into teaching and research.

We regularly engage the public in our design/technology research through inclusive design methods, and disseminate our research through creative exhibitions at venues including Dovecot Edinburgh, The Lighthouse  Scotland¹s Centre for Architecture and Design and the Milan Design Festival.

Our teaching and research can play an important role in Scotland's socio-economic recovery through developing a new generation of scientists, engineers, designers and technologists to create products and services around the needs of customers and our society.

The Creative Industries have flourished over the last decade. According to the latest data, 64,660 people were employed in the creative industries in Scotland - an increase of 11% on 2003. Total turnover in the sector in 2007 was £5.2 billion, with gross value added (GVA) around £2.4 billion, and Scotland¹s creative industries exports increased by 36%, in real terms, between 2002 and 2007 to a total value in excess of £3 billion (source ŒScotland¹s Creative Economy, Universities Scotland/Universities UK). Recent data suggests that the Creative Industries are surviving the downturn better than other industry sectors and can play a vital role in helping stimulate science, technology and manufacturing.

HWU actively aims to connect STEM with the Creative Industries, forging multi-disciplinary collaborations that can address the complex challenges of today, and build an integrated business model for the 21st century.