NESTA Making Innovation Flourish

Next Gen.

Transforming the UK into the world's leading talent hub for the video games and visual effects industries

A Review by Ian Livingstone and Alex Hope

Little Big Planet 2

All the images in this report are taken from games and visual effects that were made in the UK

Ian Livingstone OBE

Ian Livingstone is Life President of Eidos and one of the UK's founding fathers of interactive entertainment.

In 1975 he co-founded Games Workshop and launched *Dungeons & Dragons* in Europe. In 1977 he published *White Dwarf*, the UK's first interactive games magazine and was its editor for five years.

In 1982 he co-wrote *The Warlock of Firetop Mountain* with Steve Jackson, the first Fighting Fantasy interactive gamebook. The series sold in excess of 16 million copies in 25 languages. He wrote many of the international best-sellers including *Deathtrap Dungeon*. In 1984 he invested in Domark, one of the first UK computer games publishers, designing the company's first game *Eureka*. He joined the board in 1992 and helped merge the company with Eidos Technologies. Following a full listing on the London Stock Exchange in 1995, he served as Executive Chairman of Eidos plc until 2002, and subsequently as Creative Director. At Eidos he helped to secure many of the company's major franchises including *Tomb Raider* and *Hitman*.

He is a Non-Executive Director of SocialGO plc, Non-Executive Director of UKIE, Chair of Skillset's Computer Games Skills Council, Vice Chair of the BAFTA Games Committee and an advisor to the British Council.

He was awarded an OBE, a BAFTA Special Award, a British Inspiration Award and an Honorary Doctorate of Technology by the University of Abertay, Dundee for his contribution to the UK computer and video games industry.

Alex Hope

Alex Hope is Managing Director and Co-founder of Double Negative Ltd, the UK's largest film-only VFX company.

He started his career at The Moving Picture Company and was a Board Director from 1996-1998. In 1998 he left to work with VFX Supervisor Peter Chiang as VFX Producer on *Pitch Black* and, in the same year, helped to found Double Negative. Alex then spent four years both helping to run Double Negative and as a VFX Producer on a number of productions including *Enemy at the Gates*, *Johnny English* and *Cold Mountain*. In 2002, as the company expanded, he took on the full-time role of Managing Director. Double Negative has grown from a team of 30 people in 1998, to 900 people in London today, and it has a Singapore office that opened in 2009. Double Negative VFX Supervisors have been nominated for two films for the 2011 VFX Oscar – *Inception* and *Iron Man II*.

Alex is also currently a Board Director of the UK Screen Association, the trade body that represents and promotes over 140 service companies working in film, commercials and television in the UK.

Foreword.

In July 2010, Ed Vaizey, the Minister for Culture, Communications and the Creative Industries asked us to undertake a Review of the skills needs of the UK's video games and visual effects industries and to make practical recommendations for how these needs can be met. Being passionate believers in the cultural and economic contributions our two industries make to the UK, and having managed skills gaps and shortages at the coalface ourselves, we both leapt at the opportunity. Six months later, after an intensive period consulting our fellow practitioners, school teachers and university lecturers and conducting a comprehensive programme of data gathering and original research, we are presenting **Next Gen:Transforming the UK into the world's leading talent hub for the video games and visual effects industries**.

Though there are important differences between our industries, we recognised that many of the skills we draw on are similar. They both combine art and digital technology, and rely on a highly specialist, yet flexible, workforce that can adapt to furious rates of technological change. We felt that the education system was not meeting the needs of our industries.

But during the course of the Review we learned that a lot more than the future of our two industries rests on addressing the challenges we have identified in this report. That if the UK is to retain its global strengths in the high-tech creative and digital industries more generally it must urgently address the need for more rigorous teaching of computing in schools. That government and industry have a shared responsibility for supporting excellent university courses that teach industry-essential skills but which would struggle in a completely free market. That the changes in the education system that are needed to support the fusion of art and technology skills – the defining feature of our two industries – are essential for the future of all of the UK's creative and digital industries.

We would like to thank the many thousands of individuals who contributed ideas and opinions for this Review, either through our surveys and interviews or at our consultation meetings and workshops. We have highlighted key contributors in the acknowledgements section that follows the Executive Summary and in the list of individuals we thank at the end of the report. We'd like to pay particular thanks to Hasan Bakhshi and Juan Mateos-Garcia for their tireless efforts in researching and drafting this report. They made incredible contributions to all aspects of the Review.

In this report we detail a set of 20 recommendations for government, educators and industry, identifying clearly in each case where we see lead responsibility lying. We have set out a blueprint for change, and look forward to working with government, educators and industry to make it happen.

Ian Livingstone and Alex Hope
February 2011

The Chronicles of Narnia: Voyage of the Dawn Treader Image Courtesy of Twentieth Century Fox/Walden/MPC

Executive summary.

The video games and visual effects industries play to the UK's twin strengths in creativity and technology. British ingenuity has given us a headstart in two sectors that have rapidly become ubiquitous in our lives, from mobile phone games to 3D film blockbusters. At over £2 billion in global sales, the UK's video games sector is bigger than either its film or music industries, and visual effects, the fastest growing component of the UK's film industry, grew at an explosive 16.8 per cent between 2006 and 2008. High-tech, knowledge-intensive sectors and, in the case of video games, major generators of intellectual property, these industries have all the attributes the UK needs to succeed in the 21st century.

£2 billion

The global sales of the UK video games industry in 2008

A skills problem...
Yet, the sad truth is that we are already starting to lose our cutting edge: in just two years, it seems the UK's video games industry has dipped from third to sixth place in the global development rankings. Meanwhile, the visual effects industry, though still enjoying very rapid growth, is having to source talent from overseas because of skills shortages at home. That is mainly a failing of our education system – from schools to universities – and it needs to be tackled urgently if we are to remain globally competitive.

...that starts with schools
The industries suffer from an education system that doesn't understand their needs. This is reinforced by a school curriculum that focuses in ICT on office skills rather than the more rigorous computer science and programming skills which high-tech industries like video games and visual effects need. As the curriculum is overhauled and syllabuses are brought into line with the most challenging in the developed world, we need to look to places like Singapore and Finland so that the computing and artistic skills that are vital to high-tech, creative industries are given the impetus they need.

At the same time, young people and their teachers need a greater awareness of the job prospects in these industries and the qualifications that can take them there. STEM subjects – the sciences, technology, engineering and maths – and art are key to success. Raised awareness of this will alone make these subjects more attractive to young people. But video games and visual effects have a much more direct role to play in addressing the UK's STEM needs: increasing numbers of schools are recognising that games can be used to improve maths, physics and computer science outcomes in the classroom itself.

...and is compounded by poor university courses
The video games and visual effects industries can do a lot more to encourage those with excellent science, technology and art degrees to consider them as career options. But they also need job-ready graduates with more specialist technical skills who can start with a good understanding of production processes and the programming languages and software applications the industries use. There are already many university courses purporting to provide specialist training for video games and visual effects. But most of these courses are flawed, leaving those graduating from them with poor job prospects. There are some important exceptions, and a strengthened accreditation system for such courses would highlight their industry relevance and guide would-be students to those courses that will properly equip them for a career in these industries.

These are fast-changing sectors. Innovations in technology can transform media in months, as is happening now with emerging games platforms such as smartphones, social networks and 3D. So, those working in the industry need the opportunity regularly to refresh their technical and business skills.

A private market in supplying Continuous Professional Development (CPD) to these industries has emerged to meet these needs, but many employers cannot afford to use them. Universities and colleges could offer high-quality lower-cost options, but they currently are not seen as a source of training for these sectors. Stronger partnerships are needed to ensure that effective CPD can be accessed in further and higher education to keep our high-tech, creative industries at the top of the game.

Our findings: there are severe misalignments between the education system and what the UK video games and visual effects industries need
Underpinning our Review has been what is, by some way, the largest ever data collection and research study of the skills needs of the video games and visual effects industries. We have surveyed parents, young

people and teachers to gauge their views on the skills and subjects required to work in the video games and visual effects industries. We have found a worrying lack of understanding of the importance of maths, physics and art.

We have interviewed university course assessors and uncovered real concerns about the quality of STEM skills (in particular maths and programming) and soft skills such as team-working of young people emerging from school.

We have collected data from over 1,800 individuals either employed in, or who have sought employment in, the video games and visual effects industries, and found a disconnect between what they learned at university and what they needed to know when they started work.

And we have undertaken in-depth interviews with over half of the UK's video games and video effects employers, who reveal a real dissatisfaction with the talent pool available in the UK, which means that many have to recruit overseas instead.

Our skills audit of specialist universities courses feeding talent into these industries has revealed an oversupply of graduates from these courses for the number of available jobs, and large numbers enrolled on specialist courses in further education colleges, even though we show that very few of these go straight into industry jobs.

The stakes: the UK's high-tech creative industries

As the Review progressed, it became quickly apparent that the stakes were higher than the future of two industries. The deficiencies we were uncovering in the education system needed urgent action for the future of the UK's high-tech creative and digital industries more generally.

The essential processes of video games and visual effects are the creation of digital assets, their animation or manipulation to create content, and ultimately their commercial exploitation. These processes are in fact common right across the high-tech creative industries. And the tools that are created in the visual effects and video games industries for optimising the quality of the images produced and the processing performance of the hardware they run on, migrate into the rest of the high-tech creative industries.

Our actions: equipping young people with the right knowledge and skills for these industries…

We need to make radical changes and have made a series of recommendations that we believe can transform the prospects of the UK's high-tech creative industries like video games and visual effects. Our main recommendations are highlighted here in bold and italics. The full set of 20 recommendations are listed in the box on page 7.

Computer science should be on the national curriculum alongside maths and physics, with new qualifications that give young people the technical computing knowledge they can go on to develop in higher education, for the benefit of video games and visual effects companies and those in many other digital sectors. We need more specialist teachers, and more effective use of video games and visual effects in STEM lessons.

A GCSE in computer science should be introduced in all schools and recognised, alongside art, within the new English Baccalaureate. Young people should have access to video games and visual effects clubs that give them the experience of cross-curricular working.

The industries need to be more strategic in the way they engage with schools, providing better resources for teachers and career advisers, giving young people exposure to industry role models and developing a new national schools competition. Colleges and universities also have an important role to play in supporting these initiatives.

…and ensuring a steady flow of high-quality graduates from universities and colleges

Strengthened accreditation of university and FE courses, building on Skillset's existing scheme, is essential if young people are to make informed decisions on what is the right pathway into the industries. ***These industry-accredited courses should receive targeted funding from HEFCE as 'Strategically Important and Vulnerable' subjects when the Government's reforms to university education funding are implemented***. Industry in turn must demonstrate its own commitment to these courses by introducing new industrial scholarships and supporting CPD for lecturers.

STEM graduates and students should be made more aware of opportunities in the industries. A new University Technical College for the high-tech creative industries should be developed. Improved CPD provision should be offered by industries at universities and FE colleges so that employers have access to a broader range of affordable training options for both technical and business skills. And firms must continue to be able to recruit the best international talent.

Pulling together to win

Unless we act quickly, we are in danger of losing out in globally competitive markets that are only set to grow quickly in the years ahead. Our proposals below call for a redirection of existing government resources, not for new ones. Nor do they require significant funds from industry or educators. But they do require a real drive and shared sense of purpose from all three if we are to re-invigorate a British success story with the talent it needs to thrive.

Twenty recommendations across the talent pipeline

Schools

Recommendation 1. Bring computer science into the National Curriculum as an essential discipline.

Recommendation 2. Sign up the best teachers to teach computer science through Initial Teacher Training bursaries and 'Golden Hellos'.

Recommendation 3. Use video games and visual effects at school to draw greater numbers of young people into STEM and computer science.

Recommendation 4. Set up a one-stop online repository and community site for teachers for video games and visual effects educational resources.

Recommendation 5. Include art and computer science in the English Baccalaureate.

Recommendation 6. Encourage art-tech crossover and work-based learning through school clubs.

Recommendation 7. Build a network of STEMNET and Teach First video games and visual effects Ambassadors.

Recommendation 8. Introduce a new National Video Games Development and Animation Schools Competition.

Recommendation 9. Design and implement a Next Generation of Video Games and Visual Effects Talent Careers Strategy.

Recommendation 10. Provide online careers-related resources for teachers, careers advisers and young people.

Universities, Colleges and Vocational education

Recommendation 11. Develop kitemarking schemes, building on Skillset accreditation, which allow the best specialist HE courses to differentiate themselves from less industry-relevant courses.

Recommendation 12. HEFCE should include industry-accredited specialist courses in their list of 'Strategically Important and Vulnerable' subjects that merit targeted funding. Industry commits to these courses through industrial scholarships and support for CPD for lecturers.

Recommendation 13. Raise awareness of the video games and visual effects industries in the eyes of STEM and arts graduates.

Recommendation 14. Give prospective university applicants access to meaningful information about employment prospects for different courses.

Recommendation 15. Develop a template for introducing workplace simulation into industry-accredited video games and visual effects courses, based on Abertay University's Dare to be Digital competition.

Recommendation 16. Leading universities and FE colleges sponsor a high-tech creative industries University Technical College (UTC), with clear progression routes into HE.

Recommendation 17. Kitemark FE courses that offer students the best foundation in skills and knowledge to progress into Higher Education.

Training and continuous professional development

Recommendation 18. Skillset Creative Media Academies and e-skills UK's National Skills Academy for IT to work with industry to develop specialist CPD training for video games and visual effects industries.

Recommendation 19. Support better research-oriented university-industry collaborations in video games and visual effects.

Recommendation 20. Continue to treat the 18 visual effects occupations on the Government's shortages list as shortage occupations.

Acknowledgements.

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Contents.

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Part I. About this Review

In this Part we present the rationale for this Review. We describe the seven discrete research strands through which we have identified bottlenecks in the talent pipeline for the video games and visual effects industries.

"Creative computing gave rise to a new UK entertainment industry in the 1980s. The market for computer games boomed and UK designers and programmers were revered at home and abroad. Original and innovative PC titles like ***Elite****,* ***Jetpac****,* ***Populous****,* ***Lemmings****,* ***Sensible Soccer*** *and* ***Worms*** *became hugely popular. They were followed in the late 1990s by international blockbusters such as* ***Tomb Raider*** *and* ***Grand Theft Auto*** *and in the 2000s by titles such as* ***Fable*** *and* ***RuneScape****. Today, some 70 per cent of the UK population enjoys playing games. Indeed, hundreds of millions of people are enjoying playing games the world over. Global revenues from software sales are reportedly $50 billion per annum and are expected to rise to $87 billion by 2014. It is the largest entertainment industry in the world and continues to grow.*

The games industry is highly competitive and the industry needs the best talent with hard skills: world-class computer scientists and artists. Quite simply, there are not enough of them in the UK. In recent years the UK has slipped from 3rd to 6th in the world development league. The education system is failing to produce the talent of the calibre required. There is a generation of young people who are passionate about playing games, yet they don't know that a development industry is well established in the UK, or which subjects they need to pursue a career in the industry. Now is the time to invest in talent by equipping them with skills for the digital age. This is not about additional funding. It's about re-directing existing resource to have the right mix of subjects to prepare our children for a digital world and its creative and commercial opportunities."

Ian Livingstone

"A review of the 20 biggest films of all time shows that seventeen of those are visual effects (VFX)-heavy blockbusters and the other three are CG-animated films utilising very similar technology. Computer-based effects have transformed the way high-end films are made. In the last 20 years, the proportion of the budget of these types of films that is spent on VFX has grown from around 10 per cent to anywhere between 20 per cent and 50 per cent. The great news is that, over that same period, the UK has been transformed into a global centre for VFX, taking market share from the rest of the world. Between 1997 and 2004, employment and turnover of the four largest VFX companies in the industry increased in real terms by 444 per cent and 540 per cent respectively and, as we'll show in this report, growth has continued. A look at the films nominated for the best VFX Oscar reveals that at least one British company has been represented in five of the last six, with one win (for films including ***The Golden Compass****,* ***The Dark Knight****,* ***The Lion, the Witch and the Wardrobe****). The UK's VFX capabilities are now a major draw to big budget US films coming to the UK. And they have helped drive inward investment from film to $920 million in 2010.*

But British VFX success is not limited to film. The UK has long been a global post-production centre for commercials. Commercials that are filmed both in the UK and around the world and then transformed into slick films in British VFX studios. VFX is playing a larger and larger part of the programmes we watch on TV, from ***Dr Who*** *to* ***Walking with Dinosaurs****. This is a young industry that will play an ever-increasing role in film, TV, broadcast and the web. Its technologies will become standard tools for any image-based content creation business. If you're creating content, you are using computers, and the skills needed are common to both VFX and games.*

This is all great news. But it could be even better. UK VFX companies are turning away millions of pounds of work every year for one reason: they can't find the skilled people they need. This means job opportunities and potential tax revenues are being lost. The Migration Advisory Committee recognises this and has placed 18 VFX roles on their shortage occupations list.

Through this Review I want to raise awareness of our industry and its potential as a great place to work in. I want to highlight why currently the education system is largely failing it. There are a few great examples of what does work in education, and we need to make these the norm. Industry, educators, and government must all play their part in transforming the education system at every level to ensure that the UK stays at the centre of one of the industries of the future, rather than being left behind."

Alex Hope

3

The number of films nominated for this year's Oscar for Achievement in Visual Effects that were entirely or significantly created by UK visual effects companies

a. This Review is about two of the most high-tech and fast-growing creative industries in the UK

Video games and visual effects are two of the fastest growing creative industries in the world. High-tech, knowledge-intensive and, in the case of video games, generators of valuable intellectual property, these industries have all the attributes the UK needs to succeed in the 21st century. The global market for video games is projected to grow at an annual rate of 10.6 per cent over the coming years to reach $86.7 billion in 2014.[1] In many markets, video games have gone from a product to service with spectacular success: hundreds of millions of people are playing video games over an increasing range of devices and online via dedicated games portals and social networks. New console motion controllers are redefining the way users interact with video games. In film, 3D spectaculars such as *Avatar* have lured global audiences back to cinemas. Film ticket sales worldwide grew 7.9 per cent between 2008 and 2009, and eight of the ten top grossing films in 2009 had a strong visual effects component.[2]

The UK is in an excellent position to reap the benefits of this explosive growth in the market for video games and visual effects. As recently as 2008, its video games development sector was the third largest in the world after the USA and Japan, generating £2 billion in global sales, contributing £1 billion to GDP and employing 10,000 people.[3] Meanwhile, Soho is widely acknowledged as the most important hub for visual effects production after Hollywood, and houses four of the world's largest visual effects companies. Between 2006 and 2008, the UK visual effects industry grew by almost 17 per cent, employing 5,000 people.[4]

Landmark video games including *Elite*, *Tomb Raider*, *Grand Theft Auto*, *Fable*, *RuneScape* and *Little Big Planet* are the brainchildren of UK developers, and leading companies in Soho are behind the visual effects for blockbuster film franchises such as *Harry Potter* and *Batman*.

…where technological ingenuity meets creative prowess

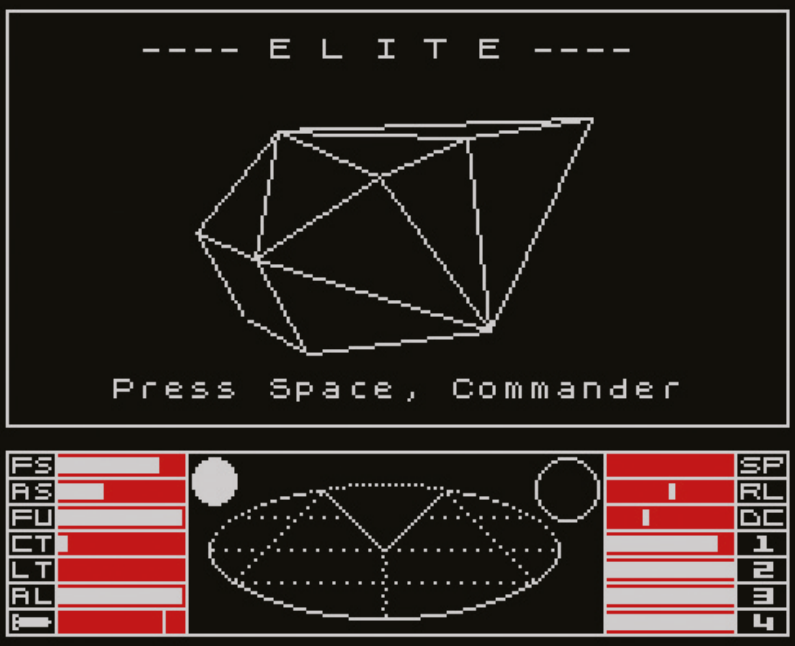
Of course, the UK has long been a world leader in technological innovation. Britain had the world's first Industrial Revolution. Its code breakers at Bletchley Park helped win the Second World War and created the first computer. Their inventiveness is echoed in the multitude of innovative high-tech start-ups peppering the country today. This technological ingenuity is matched only by our creative flair: the UK's creative industries, from the arts to television broadcasting and from music to digital media and design are, on some measures, proportionately the largest in the world.[5]

We shouldn't be surprised, then, to find the UK at the global forefront of video games and visual effects, two industries that combine the twin British traditions of technological and creative excellence. In these industries, research and development meets content development, and scientists and software engineers work hand-in-hand with artists and designers to produce interactive and audio-visual content that is consumed the world over.

b. Resolving the skills challenge for the UK video games and visual effects industries

The UK video games and visual effects industries face fierce competition in rapidly changing markets

Other countries are seeking to attract these two high-tech, high-growth industries to their shores. In Canada, several provinces lavish video games development with



Elite copyright Acornsoft

generous tax breaks and subsidies, and invest heavily in their universities to produce a specialised talent pool.[6] Access to finance and a skilled workforce are joined at the hip in attracting video games companies. Canada again, and New Zealand and Australia have targeted tax credits specifically at visual effects production. Eastern European and Asian countries with cheaper labour costs are increasingly able to tackle top-of-the-range video games and visual

Box 1. The UK's video games and visual effects industries: creative and commercial powerhouses

Video games: The UK has long excelled in producing innovative – often genre-defining – video games that enjoy resounding commercial success. In recent years, British studios have been behind some of the most popular video games titles in the world. *Grand Theft Auto IV,* produced by Edinburgh's Rockstar North, broke all entertainment records in 2008, selling 3.6 million units and earning $310 million in sales in its first 24 hours. Other award-winning, top-selling titles of recent years include *Little Big Planet*, *Fable*, *Batman: Arkham Asylum*, *Lego Star Wars* and *SingStar*, respectively developed by Media Molecule, Lionhead, Rocksteady, Traveller's Tales and Sony Computer Entertainment London. UK studios such as Frontier and Rare are, with *Kinectimals* and *Kinect Sports*, also at the forefront of innovation with new motion controllers in consoles.

Some UK video games companies have taken a lead in online markets. Cambridge-based Jagex is behind *RuneScape*, the most popular free-to-play multiplayer online game in the world, while Hand Circus caused a splash in the App Store with its iPhone game *Rolando*. Playfish, which makes social network games, now owned by Electronic Arts, has just hit a user base of 55 million and more than 90 million virtual items are transacted daily in Playfish games.

Visual effects: *Batman Begins*, *The Dark Knight*, *Bourne Ultimatum*, *Prince Caspian*, *The Voyage of the Dawn Treader*, *Avatar*, *Clash of the Titans*, *Prince of Persia*, *The Sorcerer's Apprentice*, *The Da Vinci Code* and many more. It is hard to think of a Hollywood blockbuster over the last five years which has not benefited from the creative expertise of talent working in Soho's visual effects hub. Double Negative, Framestore, MPC and Cinesite – four of the largest visual effects companies in the world – have all been involved in these films. Alongside these films they have also helped bring J.K. Rowling's *Harry Potter* books to the screen, which between them have earned $6 billion at the box office. This franchise has been fundamental to the growth of the UK visual effects industry which now is helping set the standard for quality globally. This year three of the five films nominated for the Oscar for Achievement in Visual Effects were entirely or significantly created by these companies. Double Negative visual effects supervisors are nominated for *Inception* and *Iron Man II*, and Framestore and MPC Supervisors for *Harry Potter and the Deathly Hallows Part 1*. Framestore is a past Oscar winner (2008). The Mill heralded the arrival of the UK on the visual effects map with its Oscar win in 2001. As the industry has grown, so it has enabled numerous new companies to set up work on these high-end effects films. The UK is also a global centre for visual effects work in commercials, with The Mill, Framestore and MPC attracting work from all over the world. The UK also boasts some of the world-leading companies producing technology and tools for the visual effects industry. The Foundry, for instance, has developed Nuke, the industry standard for compositing.

Little Big Planet 2
copyright Sony Computer Entertainment

effects projects, directly competing with leading UK companies. While all of this happens, both industries are experiencing disruption as a consequence of technological progress and market changes (such as the move to online and mobile in video games, and the spread of 3D in film). What worked in the past will not be enough to succeed in the future.

If the UK is to tackle these challenges, and realise the economic benefits of rapid growth in video games and visual effects markets, it is crucial that both industries have access to the right kind of talent. However, the UK's education system is not producing enough people with the right skills.

The education system is failing to produce talent of the calibre that these industries now need

Previous evidence suggests that difficulties filling vacancies are having a real impact on video games and visual effects companies' growth prospects.[7] They are forcing some companies to recruit from abroad, turn down lucrative work and in some cases move their operations overseas. Skills shortages have led the government to include 18 specialist visual effects occupations in its shortage occupation list for Tier 2 of the points-based system. This situation is not sustainable. The education system needs to adapt to ensure that the UK keeps up with other countries that are actively promoting their own video games and visual effects industries.

This Review seeks to transform the UK into the best source of video games and visual effects talent in the world

In July 2010, Ed Vaizey, the Minister for Culture, Communications and Creative Industries asked Ian Livingstone, Life President of Eidos, and Alex Hope, Managing Director of Double Negative, the largest film-specialist visual effects company in Europe, to lead this independent Review of skills for the video games and visual effects industries. Undertaken by NESTA with support from Skillset and e-skills UK (the respective Sector Skill Councils for Creative Media and Business and Information Technology), its purpose was to identify the bottlenecks in the flow of talent from education into the video games and visual effects industries, and to put forward a programme of practical actions to remove them.

Ultimately, the Review seeks to transform the UK into the best source of talent in the world for these two sectors, ensuring that UK video games and visual effects companies have access to the skills they need to stay ahead of their overseas competitors. As well as supporting indigenous video games and visual effects companies with the highest growth potential, this will also help attract inward investment from global companies, which are always on the lookout for top talent.[8]

If the UK's video games industry overcomes existing barriers to growth and keeps up with its global competitors, it stands to generate £1 billion more sales by 2014. And the UK's visual effects sector, if it continues to expand at the rates experienced in recent years, could reach £610 million in revenues by the same year.[9]

At the digital frontier, the skills needs of video games and visual effects businesses are bellwethers for the creative industries

Digital technological progress is disrupting all the creative industries. Music, publishing and advertising businesses have still fully to come to terms with online distribution, and even live performance arts organisations are experimenting with digital technologies to reach audiences in new ways.[10] The crossover between creativity and technology is examined in *The Fuse*, a recent report by the Council for Industry and Higher Education, which argues for the need to think about the creative, digital and

£102 billion

GVA of creative, digital and IT industries in the UK

information technology industries in an integrated way, acknowledging their strategic importance for the UK economy, and paying special attention to the multidisciplinary way in which they combine creativity and technology, which creates new demands from the education system.[11] *The Fuse* makes it clear that these sectors matter for the UK economy, employing over 2.5 million people, and contributing £102 billion in GVA.[12]

An implication is that other creative industries are already facing – or are bound to face imminently – similar skills shortages to those faced by the video games and visual effects industries.[13] This means that many of our recommendations will benefit those industries too, by addressing deficiencies in their own talent pipelines. Arguably, our actions aimed at raising awareness of the industries, ensuring that universities and colleges equip graduates with industry-relevant skills, and that they participate more actively in CPD for the video games and visual effects workforces, could serve as a template for action in other, increasingly high-tech, creative sectors.

c. Our approach

A talent pipeline…
During the Review, our consultations with industry have led us to adopt the metaphor of a 'talent pipeline' through which talent flows across different educational paths (including schools, colleges, universities and continuous professional development) and into video games and visual effects. We have worked with industry and educators to diagnose where the bottlenecks in this pipeline lie (Figure 1). And we have sought to answer one key question: what do the UK's video games and visual effects industries need from the education system?

- The video games and visual effects industries need a steady flow of young, high-calibre talent from the education system. This talent is first nurtured at school, from where it feeds into further education colleges and universities, and then into industry.

We have examined the barriers to achieving this, and have put forward recommendations to remove them, in schools, colleges and universities:

a. **Schools:** primary and secondary schools should provide young people with the knowledge that can be developed into industry-relevant skills later in life.[14] We must ensure that young people are taught the essential Science, Technology, Engineering and Mathematics (STEM) knowledge, including computer science, that they need to work in the high-tech industries of the 21st century including video games and visual effects. We need to set in motion a virtuous circle where video games and visual effects help draw young people into maths, physics and computer science, and improve their learning outcomes, in turn enlarging the talent pool for these industries in the future. Schools should do more to encourage cross-curricular learning. Careers guidance needs to reflect the growing employment opportunities in high-tech creative industries like video games and visual effects.

b. **Colleges and universities:** Colleges and universities should produce graduates with the right mix of deep academic knowledge, hands-on technology skills and awareness of what working in the industries involves. This requires both improving the quality of specialist courses and raising awareness of the video games and visual effects industries as excellent career destinations for the smartest graduates from

general STEM and arts degrees.[15]

- The video games and visual effects industries need access to affordable and high-quality training options to keep the technical and business skills of their workforces up to date. Training providers can also help individual employees to upgrade their skills in sync with changes in the labour market.

  We have examined how to achieve this in the third and last point of the talent pipeline:

  c. Continuous Professional Development including the provision of training services by FE colleges, universities and private training providers. We uncover the precise nature of skills shortages in the labour market, confirming that video games and visual effects companies rarely use FE colleges or universities for CPD and training, and we identify the barriers to upgrading the skills of the two industries.

…and a research programme

Given the lack of an existing robust evidence base, we have worked closely with industry and educators to design and implement an ambitious research programme comprising seven discrete data collection and analysis exercises:

1. **Surveys of young people and parents:** Surveys of 564 11-18 year olds and 918 parents/carers focused on their awareness of the UK video games and visual effects industries, their perceptions of careers in these industries and their knowledge of the skills required to succeed in them.

2. **Surveys of teachers:** Surveys of over 400 primary and secondary school teachers about their awareness of the UK video games and visual effects industries and the skills needed to work in them. The surveys also examined the use of technology in the classroom and teachers' own technology skills and media consumption habits.

3. **Interviews with university course assessors:** Interviews with course assessors at leading universities, teaching specialist video games and visual effects skills, and experts in overseas territories. The interviews explored the assessors' experience of course applicants, and what needs to be done at school to ensure that more young people can succeed in the most demanding and industry-relevant degrees.

4. **An audit of university and college skills supply:** A detailed audit of video games and visual effects specialist courses at universities and colleges, including course numbers, entry requirements, syllabus content and graduate employment destinations.

5. **A survey of employers:** The largest scale in-depth survey of video games and visual effects employers' skills needs ever conducted in the UK, involving 224 video games and 84 visual effects companies.

6. **An online survey of talent:** A survey of 910 people working or seeking work in the video games industry, and separately 936 people working or seeking work in visual effects.

7. **Interviews with recruitment agencies and headhunters:** Interviews with leading recruitment agencies and headhunters for the video games and visual effects industries. The interviews explored new trends in the labour market for these sectors, as well as emerging skills needs in the eyes of recruiters. The study also helped to triangulate the findings from the employer and talent surveys.

An appendix, which can be downloaded from NESTA's website, presents our methodology for data collection and findings of the different research strands in further detail.

In addition to our primary data collection, we have also drawn on relevant sectoral studies carried out by organisations in the UK like Skillset, e-skills UK, TIGA, UKIE and UK Screen Association, international bodies like the OECD and the International Association for the Evaluation of Educational Achievement, and academic studies (references are provided throughout in the endnotes).

We have carried out extensive rounds of consultations with industry experts, educators, professional bodies and policymakers

Between August and December 2010, we held five expert workshops, and separately consulted more than a hundred people in order to develop our research programme, validate its findings, and build our recommendations. In developing some of our recommendations we consulted learned bodies including the Institute of Physics, the British Computer Society's Academy of Computing and The Royal Society, and groups like Computing at School and STEMNET. Some of the individuals we consulted for the Review, including those at our workshops, are listed at the back of the report. We are indebted to them for their time and input.

A word on our recommendations

When developing our recommendations, we have been at pains to attribute funding responsibilities based on a careful assessment of the benefits and costs of each action. We call for public funding only where there is a

Clash of the Titans: Image Courtesy of Warner Bros Pictures/MPC

strong public value case for UK plc, for instance where our recommendations will impact on the numbers of young people choosing to do STEM subjects that are in high demand across the whole economy, or will improve learning outcomes in schools. Even here, wherever feasible, we seek co-funding from industry. Where we believe that the benefits from action will be largely limited to the video games and visual industries (say around raising levels of awareness), we call on them to take the lead, including in funding them.

Structure of the Report

In Part 2 of the Report we provide a brief overview of the video games and visual effects industries. We identify the essential skills that go into the production of video games and visual effects.

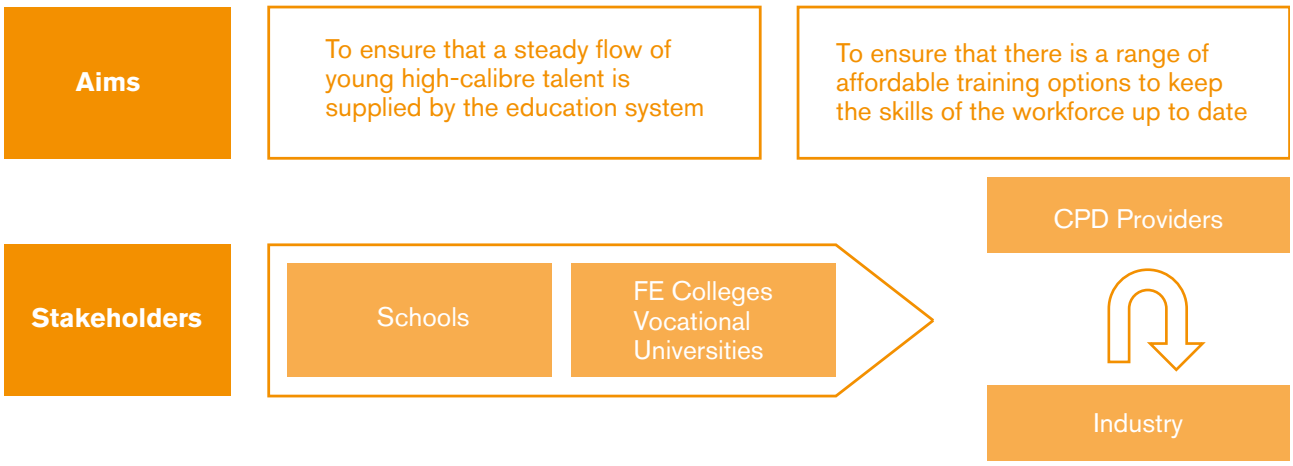
Part 3 presents our findings and policy recommendations in the schools area.

Part 4 focuses on higher education, further education and vocational training.

Part 5 examines the provision of training for continuous professional development.

Part 6 presents the conclusions of the Review and suggests lead responsibilities for implementing our recommendations.

Figure 1. The talent pipeline



KinectSports copyright
Microsoft Game Studios

Part 2. The video games and visual effects industries: where creativity meets high-tech

In this Part, we provide an overview of the video games and visual effects industries, and of their activities in the UK. Our discussion of their production processes and innovation activities, as well as the results from our own research, shows how these are quintessential high-tech creative industries that integrate creative content production and cutting-edge technology. This means that they depend on excellent STEM skills and artistic talent working together.[16]

"Video games are now accepted as a genuine art form, capable of evoking emotional responses from players. The industry was built on two of the core strengths of the UK – creativity and high technology. It was a marriage of art and science. Video games production ticks all the right boxes for the digital economy: creative, knowledge- and skills-based, IP-creating, high-tech, broadband-enabled, scalable and green. Developing games is not a simple matter.

Games were once a single-player experience, available as a product sold at retail to typically 'niche' gamers, usually male. Today's games have become social and have entered the living room. Men and women, young and old are playing games together, both off and online. There are many gaming platforms: PCs, TV-based consoles, handheld devices, smartphones and online portals, and social networks such as Facebook offering games as a service. At one end of the spectrum, small, agile teams are delivering innovative online interactive content and at the other, large 100+ person teams are developing intense, graphics-rich, cinematic single- and multi-player gaming experiences for high-end consoles played both off and online.

The skills needed to produce such varied content are, however, linked by the common denominators of computer science, maths, physics and art. The relatively low number of graduates leaving universities with these hard skills is a fundamental problem for the games industry. Unless this trend is reversed, production will move offshore leaving the UK to rue yet another wasted opportunity in an industry for which it has the innate fundamental abilities to be a world leader."

Ian Livingstone

*"VFX is about making the impossible possible on screen – if you can think it, we can create it (nearly! – and those things we can't do yet, we'll be able to do pretty soon). Whether it is the talking lion in **Narnia**, making Paris fold on top of itself in **Inception**, or crashing the Millennium Bridge into the Thames for **Harry Potter**, there is one common feature: the fusion of art and science.*

If you want to make computerised water believable, it needs to look and move right. Which means you need to understand: the science behind the way light behaves as it passes through water, partially reflected on the surface to give bright highlights but also passing through the surface to illuminate what lies beneath; and the computational fluid dynamics that physicists use to model how liquids move.

Once you have the science, you then need to take an artistic eye to it. While the equation borrowed from physics may accurately describe how the water moves, it is not perfect and needs a subjective and creative decision made about what 'feels' right. Once you've created the tool in the computer to light the water realistically, you still need the artistic flair of a cinematographer or a painter to make it look great. At every turn, the VFX artist is combining maths, physics, computer science and art to create. They do this as part of a team and with a pragmatism born of a need to work to a tight deadline."

Alex Hope

a. Video Games: the art of software

i. An overview of the video games industry

Interactive goes mainstream

The video games industry produces interactive content that is consumed across a wide range of devices, including games consoles (such as Microsoft's Xbox, Sony's PlayStation and Nintendo's Wii), personal computers, arcade machines, portable gaming devices (like the Nintendo DS), mobile phones and tablets. Video games markets have grown exponentially over the last decade, and are expected to continue doing so: according to the latest projections from PricewaterhouseCoopers, the sector will grow at an average annual rate of 10.6 per cent between 2010 and 2014 – faster than film, music and TV.

The latest report from the Interactive Software Federation of Europe (ISFE) shows the extent to which video games have come of age as a mainstream entertainment medium.[17] It shows that almost a third of all people older than 16 in the UK describe themselves as 'gamers' (with an almost even breakdown between men and women). The percentage goes up to 74 per cent for people between the ages of 16 and 19. In its most recent *Communication Markets Report*, Ofcom notes that one in every two UK houses owns a video games console. Playing video games is now the most popular form of online media consumption in the UK (39 per cent of internet users report doing so), ahead of music and film. 'Games' is the 7th most popular search term on Google.[18]

The video games value chain is being transformed by digital distribution and online gaming

In the early days of the video games industry in the late 1970s and early 1980s, all it took to produce a blockbuster title was one or two entrepreneurial individuals with a good idea and the right technical skills. Most video games projects took a few months to complete, and they were very often self-funded. As the scale of projects grew, driven by new and more powerful gaming devices, so did the levels of investment required for development. (Table 1 illustrates these changes with a comparison between *Elite* and *Grand Theft Auto IV*). This led to the emergence of large publishers financing development studios in exchange for ownership over the resulting Intellectual Property (IP).

The advent of digital distribution has transformed the video games value chain, enabling developers to reach their audiences directly, or through online stores such as Apple's AppStore, Valve's STEAM and Microsoft's Xbox Live. It has also made it possible to produce new kinds of video game that are played on the Internet or in social networks, with new business models that generate revenues through subscriptions, online advertising, and the sale of virtual goods and premium content. The online segment of the video games market is expected to grow at an annual rate of 21.3 per cent between 2010 and 2014, twice the average for the sector overall. Some industry insiders believe that revenues from online sales will surpass those from packaged goods this year.[19]

Console gaming is still dominated by large 'platform holders' such as Microsoft, Nintendo and Sony (who not only design and manufacture gaming consoles, but also publish video games developed by their 'in-house studios'), and large publishers such as Activision-Blizzard and Electronic Arts (who release video games developed by their in-house studios and 'third party' independents). Meanwhile, new giants are emerging in the online space – Google has made a large investment in Zynga, the US social gaming company

Table 1: Two UK video games blockbusters, 24 years apart

	Elite	*Grand Theft Auto IV*
Release date	September 1984	April 2008
Project team	2	150
Development time	2 years	4 years
Man-month equivalent	48	7,200
Memory requirements	22 Kilobytes	1.5 GB (PC version)
Units sold	600,000	17 million
Estimated gross revenue at 2009 prices	£21 million	£600 million

Sources: Spufford, F. (2003) 'Backroom Boys.' London: Faber & Faber; Barton, M. and Loguidice, B. (2009) 'The History of Elite: Space, the Endless Frontier.' Available at: http://www.gamasutra.com/view/feature/3983/the_history_of_elite_space_the_.php; EDGE (2009) 'The Making of Elite.' Available at: http://www.next-gen.biz/features/the-making-of-elite?page=0,0; Orry, J. (2010) 'GTA 4 Sales reach 17 million.' Available at: http://www.videogamer.com/news/gta_4_sales_reach_17_million.html. http://gamewiki.net/Grand_Theft_Auto_IV

21.3%

Projected annual growth rate of the online video games market between 2010 and 2014

behind Facebook video games titles such as *FarmVille* and *CityVille*, which has an estimated market value of $5.5 billion – larger than Electronic Arts.[20] Downloads from digital distribution platforms such as Steam and Apple's AppStore are also booming, and millions visit online gaming portals such as Miniclip and Kongregate every day.[21] Publishing is not dead, but it is certainly changing.

Independent studios are hired by publishers to produce video games. Increasing numbers 'self-publish' on the Internet. They vary in size depending on the platform they target: while video games for mobile phones can be developed by small teams, 'AAA' blockbusters for consoles and high-end PCs require investments of up to $100 million (before marketing costs) and hundreds of developers. The mainstream success of online and social network gaming has been associated with rapid growth in the size of some of the leading studios. Cambridge-based studio Jagex, responsible for RuneScape (which has 10 million regular users), is now one of the largest video games companies in the UK (and the 22nd fastest growing high-tech company in the country according to the *Sunday Times* Tech Track 100).[22]

Video games production also relies on support services provided by a rich ecosystem of companies – including 'middleware' (software tools for video games development), localisation, testing, outsourcing and motion capture.

Video games development is a multidisciplinary effort

The ideal of the lone coder toiling away at home remains alive thanks to the popularity of mobile phones where an individual can still produce a successful video game, as well as the PC. This is illustrated by the success of *Minecraft*, a million-selling indie game produced single-handedly by a Swedish programmer.[23] But the truth is that even in these markets most projects are carried out by multidisciplinary teams.[24]

These teams, which can number several hundred for larger scale console projects, include computer programmers who produce the software, artists, animators, designers in charge of the gameplay (the way in which the user interacts with the video game, which is key for immersion and engagement), scriptwriters and music composers. Like any software, video games require strenuous usability testing and quality assurance, as well as careful project management to ensure that all these components are integrated smoothly.

The increasing importance of digital distribution and self-publishing means that many studios can no longer leave the commercialisation of their video games to publishers. Instead, they are having to improve their business, sales and marketing skills to make the most of new online and social gaming markets where the business models of the 'bricks and mortar' age don't apply any more. Working with unproven technologies, as well as unpredictable audiences, video games developers face higher levels of commercial uncertainty than most creative businesses.[25] Projects often shift course significantly before completion, putting great stress on the problem-solving and improvisation abilities of the workforce.[26]

Changes in technology and markets keep impacting on the skills needs of the sector

Disruptive change seems to be the only constant in this industry: new platforms, peripherals and programming languages appear in the market at a relentless pace. 2010 alone saw the release of Microsoft Kinect and Sony's Move, smartphone and social network gaming became the hot thing for new consumers looking for 'bite-sized' gaming experiences, and 3D TVs started to gain mainstream traction. Cloud gaming and a new generation of video games consoles are coming soon. This dynamism helps to explain the

boom in gaming audiences over the last decade, but it also means that video games developers need to keep their skills constantly updated to stay ahead of the curve.[27]

Video games are at the cutting edge of many technology fields

Intense competition in entertainment markets has driven rapid technological change, putting video games companies at the forefront of many technology fields: studios adopt sophisticated optimisation techniques to exploit the graphical capabilities of hardware and save memory; they write complex artificial intelligence algorithms to make the behaviour of their video games more believable to players.The advent of new motion sensitive controllers and touch pads has put the sector at the forefront of innovation in user interfaces. Online video games companies constantly seek ingenious ways to reduce their bandwidth load and signal lag. They also collect and analyse user data rapidly to improve the quality of the user experience. Social network games companies launch new titles with minimum viable content and serve new metrics-driven content to consumers on a weekly or even daily basis.

In doing all this, video games companies often produce proprietary technologies and tools that allow them to stay ahead of their competitors, and which can be licensed to third parties: this is an important source of value for video games studios that have traditionally relinquished ownership over their IP to the publishers who fund their work. For example, Crytek, a leading German video games studio, is behind CryEngine, a state-of-the-art engine that can be licensed by other studios to produce their own video games (or even in some cases, high-spec military simulations).[28]

ii. The video games industry in the UK

A historical success story for the UK's creative economy

The UK video games development industry emerged over the 1980s and 1990s when a generation of bedroom coders who had learned programming on cheap and widely available computers graduated into professional video games production. This 'golden age' generated titles such as *Elite*, *Lemmings*, *Populous* and *Broken Sword*. The UK's creative and technical excellence attracted the attention of global publishers, many of which acquired independent studios and set up their European headquarters in the UK.

The UK remained at the forefront of video games development for many years. As recently as 2008, the UK's video games industry was the third largest development territory in the world after the USA and Japan. It generated £2 billion in turnover, contributed £1 billion to GDP and employed 10,000 people in development activities.[29] The UK still hosts some of the most prestigious video games development studios in the world (indeed, 25 out of the top 100 development studios selling their product in retail celebrated by Develop, a trade magazine, are based in the UK).[30] The creative outputs of the UK video games industry are heavily in demand throughout the world – according to a TIGA survey, 91 per cent of UK video games developers export their products overseas. On average, they generate 62 per cent of their turnover through sales in international markets.[31]

But the UK's position as a global video games development hub is under threat

Not all is well with the UK video games industry. Over the last few years, there have been increasing concerns about its decline in global market share. Mounting competition from countries with generous public subsidies, such as Canada and France, as well as those with booming online markets (including Germany and South Korea) together with cheaper studios in Eastern Europe and the Far East mean that the UK has fallen in the global development rankings. In 2010, Canada officially overtook the UK to become the third development territory in the world in terms of workforce[32] – according to industry insiders, the UK could have already dropped down to the 6th position globally, behind South Korea and China.[33] A recent study by TIGA reports that the UK video games industry has shed 900 jobs since 2008.[34] The UK video games industry has made vigorous calls for a tax credit for video games production similar to those already available in Canada and France.[35]

The lavish public support enjoyed by overseas competitors is not the only challenge facing UK video games companies. The sector has long had structural difficulties accessing finance for development and growth. This is one reason why no home-grown publisher has managed to reach the global scale of their US, Japanese and French competitors. The UK industry also faces barriers to benefiting from public schemes already in place to support investment and innovation.[36] Skills shortages and problems with the education system, with which this Review is concerned, also rank as one of the main barriers to making video games in the UK.[37]

A highly entrepreneurial development sector

Our employer survey targeted companies with UK offices involved in the production or commissioning of video games, and collected data for 224 businesses. Figure 2 shows that small companies dominate the sector (just under three-quarters have fewer than 25 permanent employees, and only 8 per cent have more than one hundred). That said, relatively few employers account for a significant proportion of the workforce, with the four largest companies employing a third of the overall workforce in our sample. Most businesses (145) responding to our survey define themselves as independent developers; a further 32 are studios owned by publishers; 83 describe themselves as

Batman: Arkham City
copyright Warner Bros. Interactive Entertainment.

having publishing functions, and 74 provide support services (these categories are not mutually-exclusive – for instance, many independent studios also publish their own video games).[38]

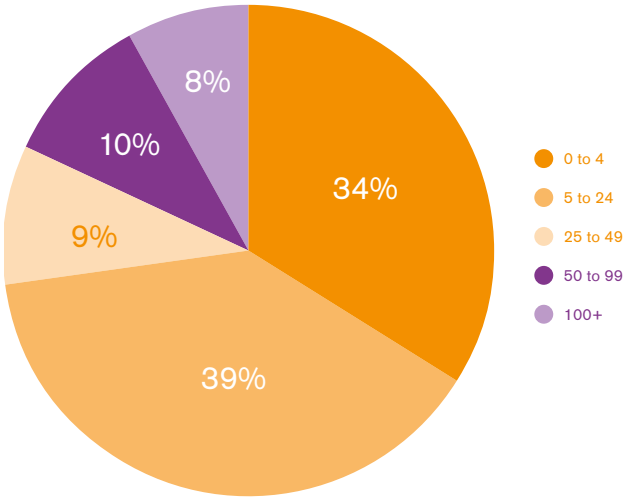
Console and PC are the dominant platform focus (over 61 per cent of our respondents have produced video games for each of these markets), followed by mobile (44 per cent) and other handheld devices (26 per cent). Only 1 per cent specialise in educational and training video games. Larger companies focus on console games, while smaller ones tend to specialise in the mobile and PC markets.

UK video games companies recruit highly qualified personnel, often with degrees in STEM subjects

Our video games talent survey shows the extent to which the UK video games industry integrates technology-intensive and creative tasks. Of 736 respondents currently employed in the sector, 30 per cent are in programming positions, 24 per cent are artists or designers and 10 per cent work in production positions (including producers and project managers). A further 9 per cent are involved in testing.

The sector recruits employees from many courses: 12 per cent of graduates who responded to the survey had studied video games programming courses, 29 per cent had degrees in computer science, 12 per cent in creative media, 7 per cent in animation, and 5 per cent in video games design. Our sample contained more mathematicians than people with general arts degrees (7 per cent compared with 2 per cent). Overall, 48 per cent of graduates working in the video games industry who completed our survey had studied STEM subjects (including maths, engineering, physics and computer science).[39]

Figure 2: Size distribution of video games employers in our sample



Source: Video games employer survey, 2010.

These results also illustrate the high levels of knowledge and skill that are required to work in the industry. Seventy-three per cent of respondents who were currently employed in the industry had an undergraduate degree; 25 per cent had a postgraduate qualification (including 3 per cent with PhDs). Twenty-nine per cent of those with degrees working in the industry had been awarded First Class Honours.

Consistent with this, we looked at the 640 respondents who provided their salary details to estimate their average annual gross salary, and compared it with other occupations from the 2010 Annual Survey of Hours and Earnings (ASHE). Our respondents' average salary, £36,211, compares favourably with the national average (£26,510), and is in line with other Professional, Scientific and Technical Activities (£36,732).

Of the 20 biggest films of all time, 17 made heavy use of visual effects and the other three were CG-animated films

The multidisciplinary aspects of video games development are also visible in our employer survey
The responses to our large-scale employer survey confirm the extent to which the video games industry draws on technical and artistic personnel who, crucially, are able to work closely with each other. When asked what were the top three qualities sought in newly qualified candidates, 71 per cent mention technical skills to plug into production from day one, 65 per cent identify the ability to work as part of a team and 51 per cent flag up artistic skills to make a difference creatively.

b. Visual Effects: high-tech dream factories

i. An overview of the visual effects industry

Visual effects have become a driving force in creative media
Rapid advances in software and hardware have made it possible for film-makers and TV production companies to create experiences that would have been inconceivable a few years ago, and worldwide audiences have flocked in droves to watch them. Amongst the top ten grossing films of all time were *Harry Potter and the Deathly Hallows Part 1, Harry Potter and the Sorcerer's Stone* and *Batman: The Dark Knight*, all with a strong visual effects component generating between them $2 billion at the box office. The bulk of their visual effects were provided by specialist companies based in Soho.[40]

Although visual effects are more prominent in science fiction, adventure and fantasy content (many of the characters and settings are wholly computer-generated in *Harry Potter* and *Lord of the Rings)*, they are becoming more important in other genres too. They help film-makers reduce the production costs of shooting outdoors scenes or recreating period settings – from the Second World War in *Atonement* to Victorian London in *Sherlock Holmes*.

They are most often provided by specialist companies
The audience's appetite for ever more absorbing and spectacular experiences has driven a technological race in visual effects production. But very few film or TV companies have the in-house levels of expertise required for the highest quality visual effects production. Visual effects are instead provided by specialist companies employing hundreds of animators, artists and programmers, such as those in Soho.

As visual effects become more important, so do the levels of collaboration between the companies producing them and their film, TV and advertising clients. Although visual effects companies are usually considered as part of the 'facilities' sector, providing post-production services to businesses in other parts of the value chain, they often participate in projects from their very inception. Many provide expert advice during the pre-production and production stages, after which they create and integrate visual effects with live footage. As with video games, visual effects companies draw on support services such as technology and tools developers.

What does a visual effects project look like?
Films are perhaps the most ambitious and demanding area of work for visual effects companies. Consider what a 'typical' visual effects project life cycle for a big-budget feature film looks like.

During pre-production, the phase before filming starts, the visual effects team will:

- Work with the director and other departments on the film to design shots and plan how to shoot them.
- In some projects create a CG-animated version of key sequences of the film, to assist in shot design and planning. This 'pre-visualisation' allows the director and other departments on the film to plan how they will shoot complex scenes.
- Create concept art, e.g. of creatures or landscapes.
- Begin building digital models that are required, informed by the pre-visualisation and concept art.
- Begin R&D on new software that may be needed to create groundbreaking effects.

During the production phase of the film:

- The visual effects team has crew on set to advise the director and ensure all the separate elements that may go into a finished shot are filmed correctly.
- The team undertake detailed surveys of the set (both photographic surveys and with laser-based scanners) to create digital models of the set.

During the post-production stage:

- The visual effects team is in full production mode. The director edits and decides which shots in the film will be given to the visual effects team to start work on.
- The visual effects processes at this stage include:
  - Tracking – that is, matching the virtual and physical camera using survey data gathered.
  - Adding digital models into shots, animating CG characters and animating effects such as water.
  - Matching the look and lighting to the real elements in the shot in 'lighting'.
  - Integrating ('compositing') all the filmed and computer generated elements together to create the finished shot.

The visual effects team will be dealing with very large numbers of digital models made up of multiple elements. They handle hundreds of shots which may, in turn, have hundreds of elements to them. All of these components need to be tracked, and their creation and treatment by artists needs to be scheduled. It is a very significant project management exercise to ensure it is done on time and budget.

Unlike film production, where most project teams come together for a film and disband afterwards,[41] the visual effects industry has a large permanent workforce, even if companies also draw on freelance – often international – expertise for specific projects.

Innovation gives visual effects companies their competitive edge

Many of the breakthroughs in computer graphics leading to the birth of the animation and visual effects industries as we know them were funded by the US National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA).[42] To this day, visual effects companies are bound up with breakthroughs in technology, enabling filmmakers to realise their vision, and generate more and more realistic, immersive and compelling experiences for their audiences. This is the source of their competitive advantage, and, in some cases, of valuable intellectual property (IP) too: as they resolve new and unexpected challenges, they accumulate expertise and develop proprietary technologies that they then exploit across projects. For instance, Soho's The Moving Picture Company (MPC) has produced an in-house suite of tools for 'crowd control', physics and the construction of digital sets. This technical IP can, at least in some cases, generate licensing revenues too – US animation giant Pixar is behind RenderMan, one of the leading solutions for the rendering of high-quality visual effects and animation.

ii. The visual effects industry in the UK

Leading the world from Soho

The UK has become a global hub for visual effects production over the last ten years. The industry has drawn on the UK's film production expertise, as well as on the world-renowned strength of its TV and advertising sectors to tackle Hollywood's most demanding projects. Over time, the strength of the UK's visual effects industry has become one of the driving factors that makes the UK an attractive location for film production, meaning that its indirect economic impacts on the wider film industry likely dwarf its already significant direct contributions to exports and value added.[43] The sector has experienced rapid growth over recent years. Between 2006 and 2008, it expanded its revenues by 16.8 per cent, and its workforce by 16.4 per cent (the fastest segment of the UK facilities sector).

The four largest UK visual effects companies (Double Negative, Framestore, Cinesite and MPC) are all based within ten minutes walk of each other in Soho.[44] One would be hard pressed to find a fantasy, science fiction or action blockbuster over the last five years – including the *Harry Potter* franchise, *The Chronicles of Narnia*, *Inception*, *Iron Man II*, *Batman: The Dark Knight*, *Hellboy II*, *Avatar*, or *Pirates of the Caribbean* – which has not depended on these companies' expertise.

What are the challenges for the UK visual effects industry?

As with video games, the UK visual effects industry is facing increasing competition from countries offering public subsidies specifically targeted at attracting post-production and visual effects companies to their shores (such as Canada or Australia),[45] as well as cheaper territories in Asia (such as India). There are also concerns about the relevance of existing public schemes, like the R&D tax credit, for the distinctive innovation activities of the sector.[46]

Nevertheless, skills shortages are a barrier to growth often mentioned by UK visual effects companies. They undertake significant recruitment overseas to fill gaps in the local talent base. Eighteen specialist visual effects occupations have been included in the Government's approved shortage occupation list for Tier 2 of the points-based migration system.[47]

There is a real risk that the migration caps on foreign workers will make it harder for UK visual effects companies to tap into international sources of talent. This is another reason why it is urgent to ensure that the UK education system produces people with the skills that high-tech creative industries like visual effects need. Mapping out the best way to do this is the purpose of the Review.

The UK visual effects industry is dominated by a small number of large companies

Our survey of 84 visual effects employers shows that, like video games, most companies in the sector are very small (almost 80 per cent have fewer than 25 employees) – Figure 3. The industry is, even more so than video games, dominated by a very small number of large companies: the largest four accounting for almost 60 per cent of the overall workforce in our sample. Our respondents work across a wide range of markets: 68 per cent work for TV companies, 58 per cent for advertising clients and 51 per cent on film projects. Fifty-one per cent of visual effects companies report that they are already producing 3D content.

They draw on the best talent, from the UK and overseas

Our visual effects talent survey shows how the industry brings together creative and technology specialists. 40.9 per cent of respondents currently working in the industry are CG artists (covering skills including Digital modeling, FX animation and lighting), 15 per cent are compositors, 10 per cent are involved in Research and Development, tool production, shader writing and programming, and 10 per cent are animators. A further 10 per cent are involved in production and project management.

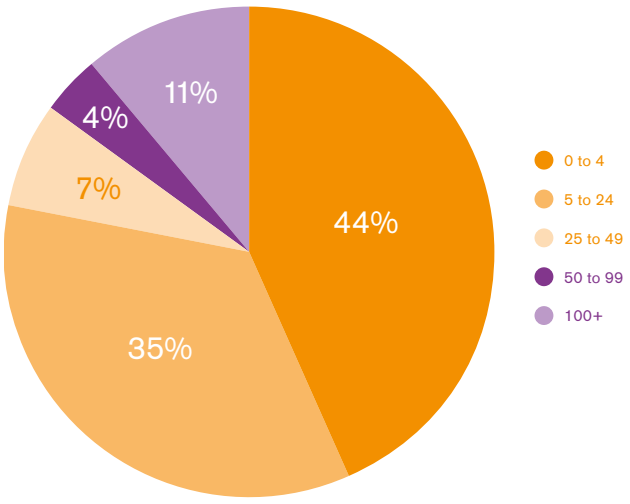
Twenty-seven per cent of those currently working in the industry studied animation degrees, while 24 per cent did their degree in a creative media subject. Ten per cent graduated from computer science courses and 9 per cent studied at art school. Seven per cent have degrees in visual effects production courses, and 6 per cent in film-related subjects. Overall, almost a quarter of those employed in the visual effects industry have a degree in a STEM subject (including maths, physics, engineering and computer science).

The qualifications of the workforce are impressive: 77 per cent of all respondents currently employed in the visual effects industry have at least a degree, and 33 per cent have a postgraduate qualification. Thirty-six per cent of graduates have degrees with First Class Honours.

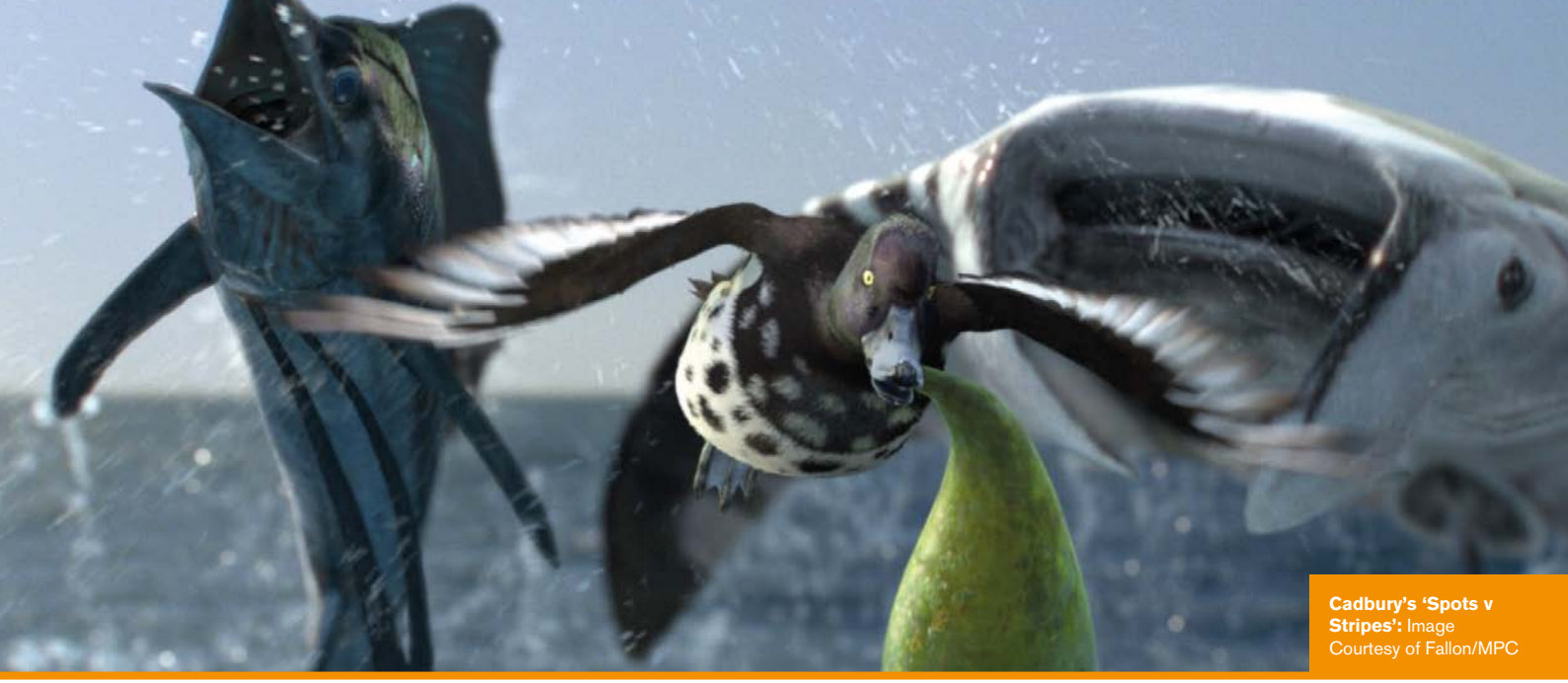
The workforce's high levels of qualifications, and employer competition for scarce talent, are reflected in high earnings. Based on the 627 individuals for which we have earnings data, annual gross earnings were just over £45,000, way above the average earnings for Information and Communication professionals (£39,742) according to the 2010 ASHE,[48] and almost a third higher than the average annual salaries within the 'motion picture, video and television programme production, sound recording and music publishing activities' category (£34,137).[49]

The UK visual effects workforce is highly internationalised and relies heavily on overseas recruitment in the absence of sufficiently skilled domestic graduates: according to our talent survey, 30 per cent of all graduates working in UK visual effects companies obtained their degrees from overseas institutions.

Figure 3: Size distribution of the visual effects employer sample



Source: Visual effects employer sample 2010



Cadbury's 'Spots v Stripes': Image Courtesy of Fallon/MPC

Visual effects companies rely on technical experts and creative talent working together as a team

Responses to our visual effects employer survey further illustrate the extent to which visual effects companies bring together technical and artistic skills. Three-quarters of all respondents highlight the ability to work as part of a team in the top three qualities sought from recruits straight from education (an even higher proportion than in video games), while 64 per cent flag up 'technical skills to plug into production from day one'; 61 per cent mention 'arts skills to make a difference creatively'.

c. Summary: STEM industries that are creative too

Video games and visual effects are high-tech industries that depend on people being able to develop complex technical systems, and maintain and optimise the efficiency of intricate production pipelines. Improvements in hardware processing power, graphical capabilities and features and expanding broadband speeds push them towards ever-greater technological feats. However, the technologies they develop are but a means to deliver the creative content that thrills and moves audiences. They need artists, animators, storytellers and designers as a result.

The crossover between high-tech and creativity in these industries is reflected in their output: on the one hand, amazing experiences and blockbuster franchises; on the other, cutting-edge technologies and tools that increase the UK's long-term competitiveness and produce revenues from licensing IP to third parties (and spillovers in other parts of the economy, as when architects use video games engines to visualise their buildings).

To stay at the top of the game in their fast-moving competitive markets, these industries need multidisciplinary teams combining the best of STEM and art skills.[50] Historically, this has played to the UK's strengths, but as the industries have grown, the scale of their demands for top-end skills – including business leadership – has increased. Important cracks have begun to appear across the talent pipeline. We now examine where these cracks are and why they have arisen, and put forward recommendations to ensure that the UK's video games and visual effects industries continue to grow in the future.

The Chemical Brothers 'Salmon Dance': Image courtesy of Factory Films/ Framestore

Part 3. The Talent Pipeline: beginning with schools

This Part focuses on primary (between the ages of 5 and 11 – Key Stages 1 and 2 in England) and secondary schools (between the ages of 11 and 16, when pupils complete compulsory schooling – key stages 3 and 4 in England).

The high levels of skills required for video games and visual effects production mean that these industries recruit primarily at graduate level and above. But it is schools which equip young people with the knowledge and skills foundation on which universities build. They also provide advice and guidance that shape the career aspirations of young people, and information about how to fulfil them.

"Given that the new online world is being transformed by creative technology companies like Facebook, Twitter, Google and video games companies, it seems incredible that there is an absence of computer programming in schools. The UK has gone backwards at a time when the requirement for computer science as a core skill is more essential than ever before. When Sir Clive Sinclair launched the ZX Spectrum in 1982, affordable computers were eagerly purchased for the homes of a creative nation. At the same time, the BBC Micro was adopted as the computer platform of choice for most schools and became the cornerstone of computing in British education in the 1980s. There was a thirst for creative computing both in the home and in schools creating a further demand at universities for courses in computer science. This certainly contributed to the rapid growth of the UK computer games industry.

But instead of building on the BBC's Computer Literacy Project in the 1980s, schools turned away from programming in favour of ICT. Whilst useful in teaching various proprietary office software packages, ICT fails to inspire children to study computer programming. It is certainly not much help for a career in games. In a world where technology affects everything in our daily lives, so few children are taught such an essential STEM skill as programming. Bored by ICT, young people do not see the potential of the digital creative industries. It is hardly surprising that the games industry keeps complaining about the lack of industry-ready computer programmers and digital artists.

Ironically today's children are naturally attracted to the digital world. They are a connected generation. They prefer to access and process information when needed using whatever media devices are available. Calculators and smartphones are not a substitute for learning; they enable it. It would be a simple matter to inspire them with creative computing. Enable them to build digital bridges for their shared world. Collaborating in teams with different but complementary skills naturally prepares them for their working life. It would be impossible to make any video games without teams of computer programmers and digital artists working together. And it's not just about the video games and VFX industries; these skills are transferable and afford people a career in all of the digital creative industries."

Ian Livingstone

"VFX, and video games sit at the vanguard of the creative industries in their use of computer technologies as creative tools. As with any craft, to produce truly outstanding work requires a complete mastery of the tools of the trade. The tools of the high-tech creative industries are computers and the software that runs on them. Understanding just how to use the software rather than the machine that sits behind it limits the ability of the user. In the same way a Grand Prix racing driver understands the engineering of their car to excel at what they do, so those in the high-tech creative industries will excel if they understand the engineering of their computer. The more fluent that we can make our school children, not just in using the software that sits on their computers but also in using the computer languages that sit behind them, the better. So science and computer science are key skills for VFX and video games.

Art is vital too: our industries create convincing and beautifully designed images. Schools push pupils to choose between art and science rather than bringing them together (a split that is rigidly perpetuated by the faculty structure in our universities). As a longer-term ambition we must move away from this."

Alex Hope

The challenge

Our interviews with university course assessors and surveys of young people, parents and teachers suggest that not enough young people are leaving schools with the essential knowledge required to succeed on the most demanding and industry-relevant university courses. In particular, we find that: (i) there are large technical skills gaps in areas like computer programming; (ii) too few applicants to specialist courses are leaving school with the ability to work in multidisciplinary teams; and (iii) young people are applying to specialist university and FE college courses with shockingly low levels of knowledge of how the industries work and what working in them entails.

We identify three major obstacles that must be removed to resolve these problems:

- Schools are not providing students with the computing knowledge needed for industries like video games, visual effects and other high-tech sectors of the future.[51] Information and Communication Technology (ICT), the subject that young people, parents and teachers most associate with a career in video games and visual effects, is not the most relevant for these industries, as it focuses on using office software applications such as word processors and spreadsheets (IT literacy), rather than on essential technical knowledge. ICT teaching at school may actively be discouraging young people from pursuing programming-intensive degrees from which these two industries recruit.

- There are too few opportunities for cross-curricular learning across STEM and arts subjects, including the use of technology in art. Not enough schools make use of work-based projects where young people collaborate and develop the team working skills that new high-tech industries like the video games and visual effects industries require.

- Young people, parents and teachers lack awareness about the UK's strength in making video games and visual effects and the career opportunities in them. They have wildly inaccurate pictures of which subjects young people need to study at school to work in these industries. Although significant numbers of video games and visual effects employers and universities do engage with schools, they do not do so on a systematic basis. This makes it hard to raise general awareness about these industries as promising career destinations for the brightest young people, or about the knowledge required to do well in them.

University course assessors paint a worrying picture of the quality of young people applying to their courses.[52]

- Two-thirds of course assessors report that school leavers are poorly prepared for their courses. Only 7 per cent believe that students are getting better over time.

- Half of respondents say that the STEM skills of school-leavers are inadequate (40 per cent single out the poor quality of maths).

- Forty per cent of course assessors say that they would like to see better computer programming skills in their applicants.

- Nearly 50 per cent stress poor soft skills including team working and communication. This is particularly the case with universities providing talent to the visual effects industry where pretty much all the course assessors identify poor team working. For example, candidates are seen as unable to take criticism from other people and unable to solve problems creatively.

- An overwhelming 70 per cent of course assessors report a poor or unrealistic understanding of what working in the video games or visual effects industries actually involves.

- Forty per cent of respondents stress that the poor quality of school leavers has a negative impact on their courses. For instance, high student dropout rates can lead to funding difficulties for a department. Lecturers also spend a significant amount of time on low-performing students, correcting fundamentals such as basic mistakes in their programming code when they could be focussing on preparing students at a more advanced level. Our interviews confirm that low levels of achievement are demoralising for both lecturers and students.

The causes

There are grave misunderstandings about the skills required to succeed in video games and visual effects

Our overview of video games and visual effects in Part 2 demonstrates the reliance of these industries on a mix of personnel with STEM skills and creative talent ranging from animation to design and fine arts. Young people wanting to work in these industries should be advised to build their knowledge in those areas, with a view to developing them further as they continue with their education. Insufficient information in this respect has three negative consequences:

Crackdown copyright Microsoft Game Studios

a. Promising young people who might otherwise have an interest in a career in video games or visual effects make the wrong choice of subjects early at school, thus reducing their prospects of gaining employment in these industries later on.

b. Young people who do choose STEM subjects or art at school do not realise the pivotal role that these subjects play in video games and visual effects production, and therefore do not see these industries as suitable career options.[53]

c. Young people are actively put off by the subjects that they think are required to gain employment in the video games and visual effects industries.

Our surveys of young people, parents and teachers show that subjects such as maths, art and physics are not seen to be most important in pursuing a career in the case of both industries. More often – and especially in the case of teachers – they mention ICT.[54] Very few teachers highlight computer science, perhaps – in England at least – because it is not a Key Stage 3 or 4 subject and is not widely taught at schools (Tables 2 and 3).

ICT isn't it?

Although in theory one might expect 'Information and Communication Technology' (ICT) instruction to provide young people with the essential knowledge required for high-tech industries like video games and visual effects, in practice, as currently taught this subject is not teaching the knowledge and skills these industries need.

Research by e-skills UK has shown that young people find the existing ICT curriculum to be boring, poorly

Table 2: The choice of subjects that a young person needs to make to pursue a career in the video games industry

	The most important subject			Among the other most important subjects		
	Young People (n = 564)	Parents/ carers (n=918)	Teachers (n=403)	Young People (n=564)	Parents/ carers (n=918)	Teachers (n=403)
ICT	30%	18%	44%	25%	13%	28%
Computer Science/ Computer Studies	24%	33%	5%	22%	15%	2%
Art	6%	9%	9%	17%	19%	30%
Design and Technology	12%	9%	3%	20%	15%	15%
Mathematics	3%	7%	15%	14%	25%	35%
Science	1%	2%	1%	2%	4%	12%
Physics	0%	0%	0%	3%	2%	2%

Sources: Ipsos Mori young people surveys 16-23 September 2010. Ipsos Mori parents survey 17-30 September 2010 and 15 October-1 November. Ipsos Mori teachers survey 15 October - 16 November 2010.

22%

Proportion of ICT teachers who think they are good at creating basic computer programmes

Table 3: The choice of subjects that a young person needs to make to pursue a career in the visual effects industry

	The most important subject			Among the other most important subjects		
	Young People (n = 564)	Parents/ carers (n=918)	Teachers (n=403)	Young People (n=564)	Parents/ carers (n=918)	Teachers (n=403)
ICT	31%	15%	42%	25%	14%	31%
Computer Science/ Computer Studies	29%	32%	2%	23%	15%	2%
Art	9%	11%	16%	15%	21%	35%
Design and Technology	9%	8%	4%	24%	15%	13%
Mathematics	4%	10%	13%	17%	26%	35%
Science	1%	2%	1%	4%	5%	18%
Physics	0%	0%	2%	2%	3%	2%

Sources: Ipsos Mori young people survey 16-23 September 2010. Ipsos Mori parents survey 17-30 September 2010. Ipsos Mori teachers survey 15 October – 16 November 2010.

taught, too basic, and perhaps most importantly, too narrowly focused on office applications. This has a knock-on effect on their perceptions of computing-related careers as poor, dull, repetitive and low-paying – the poor quality of ICT teaching has been partly blamed for the 43 per cent decline in the numbers taking computing A Levels between 2001 and 2006, and the 50 per cent decline in the number of applicants for computer-related HE degrees over the last five years.[55]

Schools have neither the capacity nor incentives to impart rigorous technical knowledge when they teach ICT

Our consultations with experts suggest that the problems with ICT perhaps have less to do with the way the ICT national curriculum is defined than with the way it is implemented in most schools. Although, in principle, the curriculum does allow for the teaching of more challenging skills (such as the basic programming demanded by video games and visual effects university course assessors), a lack of confidence and capacity amongst ICT teachers, as well as strong incentives in schools to ensure that the largest possible number of young people pass GCSE and vocational ICT examinations, means that the focus remains on 'lowest common denominator' requirements.

In practice, this often means the use of mundane ICT applications with which most young people are already familiar.[56] Low levels of challenge in the subject appear to be reflected in the grades awarded to students. In 2010, 30 per cent of UK students taking ICT GCSEs were awarded A* or A, by contrast to an average of 21.6 per cent for all subjects, and 15.6 per cent for maths.[57]

Concerns with teacher capacity are echoed by the findings of our teachers' survey. Only 19 per cent

Box 2. Video games and STEM subjects in the classroom

In a randomised control trial experiment involving urban high-school students in the southeast of the US, Kebritchi, Hirumi and Bai (2010) found that modern maths computer games had a significant positive impact on maths achievement in US high schools. The trial involved a treatment group playing a set of educational games in which players completed maths-related missions within a 3D immersive environment for 30 minutes each week over an 18-week period. The researchers detected that the treatment group had significantly improved results in a district-wide maths test compared with a control group that had not played the games.

This study joins a growing body of rigorous evidence that video games can be used to improved STEM learning outcomes in the classroom. Six of the eight other studies examining the impact of video games on maths outcomes in school reviewed by the authors find a positive effect (the other two showed mixed results). Vogel *et al.* (2006) conduct a meta-analysis of 32 empirical studies and conclude that interactive simulations and games have a bigger impact on young people's cognitive gains compared with traditional classroom methods. Interestingly, Carbonaro, Szafron, Cutumisu and Shaeffer (2010) provide evidence that girls are as likely as boys to enjoy and benefit from experiments with video games development that teach young people higher-order thinking skills that are essential for science and valuable computer science abstraction skills.

Sources: Kebritchi, M., Hirumi, A. and Bai, H. (2010) The effects of modern mathematics computer games on mathematics achievement and class motivation. 'Computers & Education.' 55, p.427-443; Carbonaro, M., Szafron, D., Cutumisu, M. and Shaeffer, J. (2010) Computer-game construction: a gender neutral attractor to Computing Science. 'Computers & Education.' Volume 55, Issue 3, November 2010, pp.1098-1111; Vogel, J.F., Vogel, D.S., Cannon-Bowers, J., Bowers, C.A., Muse, K. and Wright, M. (2006) Computer gaming and interactive simulations for learning: A meta-analysis. 'Journal of Educational Computing Research.' 34, pp.229-243 is a large-scale metastudy of the literature.

of ICT teachers have a degree or higher degree (or equivalent qualification) in their subject, compared with 32 per cent of the sample overall.[58]

Alarmingly, only 22 per cent of ICT teachers consider themselves to be good at creating or modifying even basic computer programmes (the percentage drops to 8 per cent for the creation or modification of advanced computer programmes). Furthermore, significant numbers of ICT teachers are not able to rate themselves in these tasks because they have never undertaken them (Figure 4).[59] This means that at least three-quarters of ICT teachers would struggle to go beyond what they are teaching now, even if they wanted to.

Video games and visual effects technologies are being deployed in the classroom…

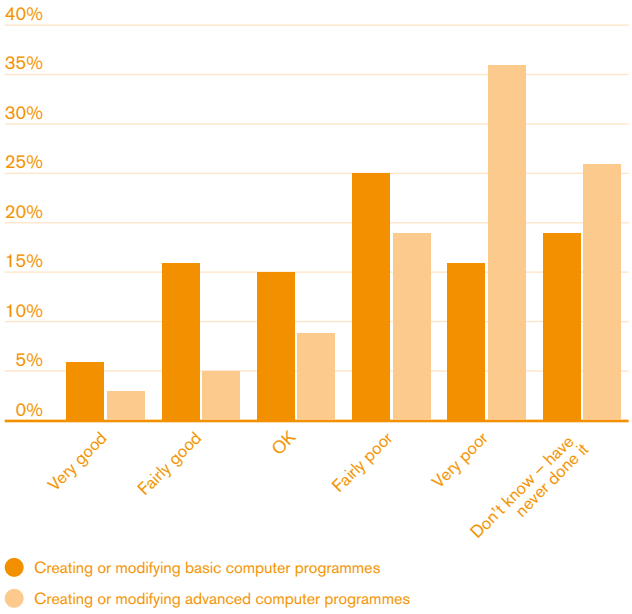
Our teachers' survey shows that many teachers are already using video games and animation technologies to support learning in classrooms. Sixty-seven per cent claim to have already used video games for this purpose in the current or previous academic year. Interestingly, all those who have used video games plan to do so again in the future. It is striking how an overwhelming 93 per cent of mathematics teachers believe that 'using computer games in the classroom can help young people learn useful STEM skills'. This is in line with emerging research findings on the impact of video games technology on learning outcomes, particularly in STEM subjects such as maths and physics (Box 2).

…yet it is not clear whether this is done following best practice

There is too little rigorous empirical research in the UK into how much the use of video games makes a positive difference to classroom outcomes (a frequent problem is the lack of control groups).

An exception to this rule is the work of Learning and Teaching Scotland which is undertaking formal evaluations of educational games initiatives. However,

Figure 4: ICT teachers' self-identified programming capabilities



Source: Ipsos Mori teachers survey 15 October - 16 November 2010.

Box 3. An integrated approach to cross-curricular teaching in the Finnish National Curriculum

The Finnish education system has received many accolades after the success of its students in the latest Programme for International Student Assessment (PISA) survey, carried out by the OECD. Finland incorporates several 'cross-curricular themes' in its National Core Curriculum, including 'growth as a person', 'cultural identity and internationalism', 'media skills and communication', 'participatory citizenship and entrepreneurship', 'responsibility for the environment', 'well-being and a sustainable future', 'safety and traffic', and 'technology and the individual'.

Schools are able to combine subject requirements and cross-curricular themes, linking different learning domains. These themes are implemented in the working culture of schools, including teaching and special activities.

The Finnish Ministry of Education has acknowledged that that the need to teach cross-curricular themes can be demanding on educators, so it has reformed teacher training and CPD accordingly. For instance, in the case of Media Skills and Communication (which includes as one of its aims the development of verbal, visual, technical and social skills amongst young people), the Ministry of Education has taken action to promote the development of methods and materials for its advancement as a subject in schools. It also funds the Finnish Society on Media Education, which supports the implementation of Media Skills initiatives across the country, involving teachers, child and youth workers, librarians, early childhood educators, stakeholders from the creative and cultural industries, cultural organisations and researchers.

Sources: Finnish Society on Media Education (2009) 'Finnish Media Education Policy: Approaches in Culture and Education.' Available at: http://www.mediakasvatus.fi/files/u4/mediaeducationpolicies.pdf; QCDA (2009) 'Finland's National Core Curriculum for Basic Education 2004.' Available at: http://www.qcda.gov.uk/resources/assets/Core_curriculum_in_Finland.pdf; Kupiainen, S., Hautamäki, J. and Karjalainen, T. (2009) 'The Finnish Education and PISA.' Available at: http://www.pisa2006.helsinki.fi/files/The_Finnish_education_system_and_PISA.pdf

those limited studies which exist report positive impacts.[60] Crucially, variation in results is often explained by differences in implementation – the benefits of using video games technology in the classroom are after all shaped by the interplay between learning strategies, teaching strategies and teachers' and pupils' familiarity with technology.[61] This means that using technology for technology's sake without thinking through how it fits in a learning environment will not improve learning outcomes – indeed, it can even be distracting.

In the absence of centralised repositories of 'best-of-breed' educational video games resources, or specific teacher training to support the adoption of best practice for the deployment of video games in the classroom, there is a danger that schools may not be fulfilling the potential of video games as a learning technology. This risk is intensified by the limitations in teachers' technology skills that we have already alluded to.

Art teachers do not have the skills to train young people with graphics tools

Our teachers' survey also shows that a large number of schools are providing their students with training in animation software packages (68 per cent report doing so). But only 6 per cent of art teachers describe themselves as very good at using software to edit and create images, videos and animations, compared with 27 per cent of ICT and 15 per cent of physics/science teachers. This may partly be an artefact of the data (our sample included proportionately greater numbers of older art teachers compared with the other subjects we surveyed). Nonetheless, it suggests we need to take a fresh look at how computing technologies which are revolutionising creative industries like visual effects are used in school art rooms.

There is little scope for cross-curricular and work-based learning where young people can develop team working and problem-solving skills

Our interviews with university course assessors have revealed concerns about school-leavers' lack of team working and creative problem solving skills. This echoes wider dissatisfaction with school and college leavers' skills reported in the Confederation of British Industry's (CBI) latest Education and Skills survey.[62]

These shortcomings in school leavers' skills may be linked to long-standing concerns that young people are forced to specialise at too young an age in the English school system, and that subjects are taught in disciplinary silos with little crossover between them.[63] They may also reflect the view that schools do not give young people enough opportunities to solve problems in real-life contexts using team working and collaborative methods.[64]

Happily there are no widespread prejudices holding back interest in video games and visual effects at school

No one questions that video games and visual effects are young and 'cool' sectors that resonate with a younger generation that has grown up playing *Super Mario* video games at home, and watching Pixar blockbusters in the cinema. At the same time, history suggests that all emergent entertainment media

Tomb Raider
copyright
Square Enix

initially attract negative attention – such was the case for published fiction, film and television (remember video nasties?) and the same is true of video games.[65] Conceivably, wide-held prejudices could be distorting parents' and teachers' perceptions of these industries. For this reason we examined in some detail young peoples', parents' and teachers' perceptions of the video games industry in case there are any biases or prejudices which may hold back young people from pursuing a career in it (Table 4).

Our results confirm the enthusiasm young people have for a career in video games, and dispel the suggestion of strong prejudices against them amongst parents – only 12 per cent actively disagree that video games can be a good career for young people. As a mainstream form of entertainment, with which large numbers of adults engage,[66] the public has apparently become less susceptible to the negative headlines that video games still occasionally attract, at least insofar as it determines their perceptions of what make good careers for young people. Surprisingly, perhaps, teachers overall are even more positive about the potential of a career in the sector than young people.[67]

We have also gauged young peoples' and parents' perceptions of the UK visual effects industry as a high-growth, well-remunerated industry (Table 5). Our results imply that both young people and parents do see the potential of a career in visual effects. Both groups clearly recognise visual effects as being at the forefront of the UK film industry, in terms of business growth and salaries for employees.

But there is a lack of awareness of the importance of the UK's video games and visual effects industries

If bright young people across the UK do not appreciate the existence of a successful UK industry, we should not be surprised if they do not apply for the degrees that could earn them a job in it – even if, as we have just seen, they appreciate the attractions of careers in it.

Our surveys of young people, parents and teachers paint a stark picture in this respect (Figures 5 and 6). Although UK video games and visual effects companies are behind some of the best-selling and highest grossing franchises in the world, this commercial success does not equate with public awareness that there are UK companies behind them.

Only a tiny number of young people responding to our survey recognised that *Grand Theft Auto*, *SingStar* and *Lego Star Wars* – three of the most successful video games of the last few years – had been developed by UK companies (Edinburgh's Rockstar North, Sony

Table 4: Perception of video games as a career for a young person

	Can video games be a good career for a young person?		
	Young People (n=564)	Parents (n=918)	Teachers (n=403)
Strongly agree or Agree	70%	62%	84%
Strongly disagree or Disagree	11%	12%	2%
N	**537**	**887**	**403**

Sources: Ipsos Mori young people survey 16-23 September 2010. Ipsos Mori parents survey 17-30 September 2010. Ipsos Mori teachers survey 15 October - 16 November 2010. Ipsos Mori teachers survey 15 October - 16 November 2010.

Table 5: Perceptions of visual effects as a high-growth, well-paid industry

	Young People	Parents
In financial terms, which one of the following do you think is the fastest growing part of the UK's film industry?		
Film Distribution (including DVD Sales, TV Sales and Online Sales)	34%	28%
Visual Effects and CGI	21%	41%
Cinema Admissions	17%	8%
Film Production	12%	9%
Which of the following parts of the UK film industry do you think has the jobs with the highest wages?		
Visual Effects and CGI	33%	47%
Production and Scriptwriting	30%	31%
Sound and Electrical	14%	5%
Camera Operators	6%	4%
N	**564**	**918**

Sources: Ipsos Mori young people survey 16-23 September 2010. Ipsos Mori parents survey 17-30 September 2010.

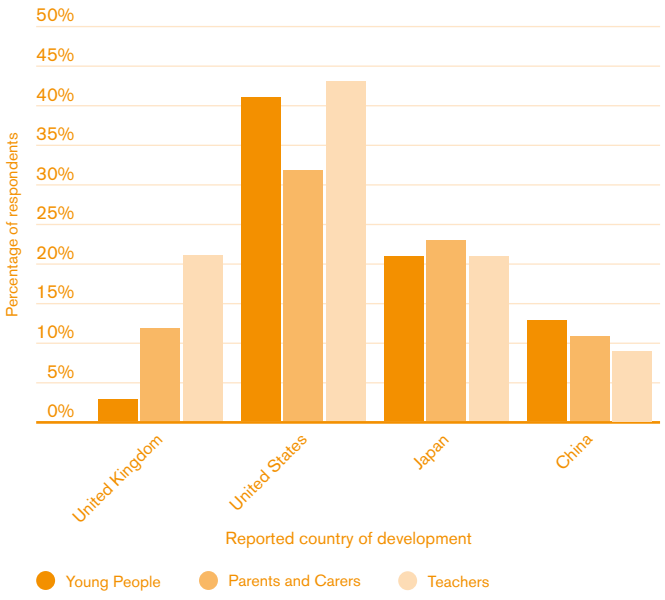
Computer Entertainment London, and Cheshire's Traveller's Tales). Instead, 41 per cent thought that these video games had been developed in the USA, 21 per cent from Japan, and 13 per cent from China. Figure 5 shows that awareness of the UK origin of these video games is not that much greater amongst parents and teachers.

The visual effects industry does not fare much better. Just 9 per cent of young people knew that UK companies were behind the visual effects and CGI for blockbusters such as *Harry Potter*, *Prince of Persia* and *The Sorcerer's Apprentice* (Figure 6). Many more thought that these had been produced in the USA (52 per cent) and Japan (16 per cent). Most parents and teachers also believed that the visual effects for these films had been produced in the USA, rather than in London.

Young people are not receiving sufficient guidance about what working in high-tech creative industries like video games and visual effects entails

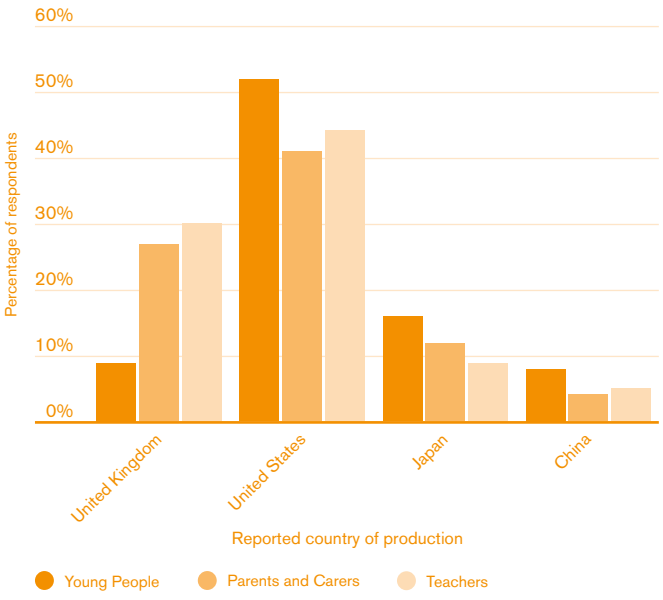
University course assessors' complaints about a lack of industry awareness in applicants to video games and

Figure 5: Where were *Grand Theft Auto*, *Lego StarWars* and *SingStar* developed?



Source: Ipsos Mori young people survey 14-21 October 2010. Ipsos Mori parents survey 15 October-1 November. Ipsos Mori teachers survey 15 October - 16 November 2010.

Figure 6: Where were the visual effects for *Harry Potter*, *Inception*, *Prince of Persia* and *The Sorcerer's Apprentice* produced?



Source: Ipsos Mori young people survey 14-21 October 2010. Ipsos Mori parents survey 15 October-1 November. Ipsos Mori teachers survey 15 October - 16 November 2010.

Table 6: Knowledge of development processes and career guidance about industry before doing a degree

	Video games		Visual effects	
	Overall (n=688)	Specialist video games design, programming and art courses (n=161)	Educated in the UK (n=439)	Educated overseas (n=260)
Knew about development processes in the industry	25%	28%	19%	25%
Didn't know anything about the industry	9%	4%	14%	11%
Received guidance about the industry from a career advisor	5%	11%	5%	9%
Received personal advice from an industry professional	11%	17%	13%	26%
Received information about the industry at a careers fair	8%	18%	7%	11%
Had an open day in a company	2%	6%	2%	6%
Accessed online information about the industry	11%	20%	8%	12%
Didn't receive any of the types of guidance above	78%	61%	75%	60%
N	**910**	**161**	**439**	**260**

Source: Video games and visual effects talent surveys, 2010.

visual effects courses are echoed in the results of our talent survey (Table 6). Only a quarter of respondents to the video games talent survey with degrees claimed to have known about development processes in the industry when choosing their degrees (the percentage was only marginally higher for those applying to courses specialising in video games programming, games design and games art). And very few of them had received any sort of guidance about the industry from career advisers or professionals.[68]

In the visual effects talent survey, there is some evidence of a difference in experience between those who studied for their degree in the UK, and those who went to university overseas: it appears that those who studied overseas selected their degrees with a greater awareness of the development processes in the visual effects industry, and received more comprehensive advice, particularly from industry professionals – around a quarter did so – although the numbers are still low.[69]

This is consistent with wider concerns about the quality of Information, Advice and Guidance (IAG) services available in UK Schools

In 2010, the National Foundation for Educational Research (NFER) reported low levels of confidence in English careers guidance and in the consistency with which it is delivered across the curriculum.[70] Ofsted's review of careers education that same year raised further concerns about the consistency and impartiality of the advice offered to young people.[71] It found that provision depended greatly on the school, ranging from a good, comprehensive programme, cross-referenced to the Department for Education's quality standards, to an unsatisfactory and informal series of lessons and presentations from visiting speakers. According to the study, the staff providing careers advice did not always have current knowledge of career paths or the world of work outside education to support students effectively or to challenge career stereotypes; they were only able to offer limited advice, guidance and support. Some of the staff were found to teach careers education simply because there was time available in their timetables or because careers education was provided in tutorial time. Major changes in career guidance provision are planned in the future.[72]

The fact that the video games and the visual effects industries are relatively young can only magnify these problems, particularly given the lack of awareness amongst teachers, and misunderstandings about the subjects that young people need to pursue a career in them.

Many video games and visual effects companies engage with schools on some level

Forty-six per cent of all video games companies responding to our employers' survey said that they had engaged with schools in the previous 12 months. Of those that had engaged, 11 per cent had done so through an open day for young people, 28 per cent had collaborated with a school in a video games initiative (such as a competition), and a third had sent a member of their staff to lecture at a school.

Broadly the same percentage of visual effects companies reported having engaged with schools over the same period. Where it happened, engagement consisted of open days (10 per cent of those that

collaborate with schools had done this), participating in visual effects initiatives such as competitions, and lecturing at schools (13 per cent in both cases).

The main barrier to industry engagement is lack of time

Time constraints were mentioned as the main barrier to further engagement by a third of video games and almost half of visual effects companies. Only a minority in both sectors (17 per cent in video games, and 14 per cent in visual effects) said that engaging with education was not a priority for them. Nine per cent of video games and 13 per cent of visual effects companies said that it was prohibitively expensive to send staff out for the day.

Universities also engage with schools, but not systematically

Seventy per cent of university course assessors reported that they interacted with schools by networking with teachers and offering presentations, workshops and summer schools. Almost half of them had run open days where prospective students could come and learn more about their courses. They also said that they had participated in careers fairs, conferences and exhibitions, and provided online outreach programmes and sampler courses for young people. Less than a third of respondents characterised these as continuous projects, while 55 per cent described them as *ad hoc*, sporadic and, in many cases, dependent on a particular teacher or tutor championing the effort.

University courses specialising in the visual effects industry were, perhaps, somewhat less engaged with schools – only half of respondents had collaborated with schools in any capacity (though the sample size is too small to draw too much from this finding).

Our vision, and how to achieve it

Our vision for schools is one where:

- **All schools have the teaching capacity and resources to equip their pupils with an essential knowledge base in computer science alongside maths and physics, feeding into the most demanding university courses from where video games and visual effects recruit.**
- **Schools harness the 'cool factor' and technology potential of video games and visual effects to draw in more young people to computer science and STEM subjects, and improve their learning outcomes.**
- **Schools follow best practice in countries like Finland in providing spaces for cross-curricular activity between technology and art in particular, and for multidisciplinary, work-based, team working activities.**
- **Bright young people are aware of the UK's growing high-tech, creative industries like video games and visual effects as potential career destinations, and of the skills that they should acquire to pursue careers in them.**

This is what needs to be done to achieve it:

Recommendation 1: Bring computer science into the National Curriculum as an essential discipline

A growing number of voices including the British Computer Society, Computing at School, Institute of Physics and the Royal Academy of Engineering argue that ICT, as it is currently taught, fails to prepare young people for those demanding programming-intensive courses from which high-tech industries like video games and visual effects recruit.

ICT literacy is of course an important skill, but there is an excessive focus in ICT lessons on the use of everyday office applications with which most young people are already familiar. This wastes valuable time that would be more fruitfully applied to the teaching of rigorous computer science knowledge.

The Government is conducting a wholesale review of the National Curriculum so that in the future it focuses on providing young people only with essential knowledge, leaving the teaching of non-essential knowledge and skills to the discretion of individual schools.[73] We believe there is an overwhelming industrial case for computer science to be considered as an individual subject providing essential STEM knowledge alongside maths and physics. All young people should have an opportunity to pursue computer science up to Key Stage 4.[74]

Although it is difficult to find international data on computer programming content in the school curriculum, it is striking that in eight of the 13 technology applications areas in schools considered by the IEA SITES 2006 study, Singapore – a country with one the world's highest performing education systems – topped the league tables. Other high performers were: Denmark; Alberta (Canada); Hong Kong, and Slovenia. It is no coincidence that the proportion of maths and science teachers that reported having used ICT in their lessons is also highest in places like: Singapore (73 per cent maths and 83 per cent science); Alberta, (Canada) (62 per cent maths and 79 per cent science); Ontario, (Canada) (75 per

RuneScape copyright Jagex Games Studio

cent maths and 75 per cent science); Denmark (77 per cent maths and 70 per cent science) and Hong Kong (70 per cent maths and 82 per cent science)[75] – all countries that have outstanding school STEM performances in the international league tables.

The government wants to benchmark the UK's education system with the best in the world. Here is one way to do so. Including computer science in the revised National Curriculum would be a strong statement to the rest of the world that the UK views technical understanding of computing as essential knowledge for the high-tech economy of the 21st century.[76]

If this were done, our view is that The Royal Society, which is currently conducting a comprehensive review of computing in schools, would be excellently placed to work with bodies like the British Computer Society, Computing at School, the Institute of Physics, the Royal Academy of Engineering and industry (including video games and visual effects) to give the Department for Education guidance on curriculum content and qualifications at Key Stage 4. We welcome the UK awarding body OCR's trialling of a new GCSE in Computing,[77] and curriculum design should be informed by its evaluation. From the industry viewpoint, computer science should be a highly rigorous course in schools that focuses on the essentials of programming, algorithms, logic and data structures, as well as computer systems and networks;[78] it should also incorporate a practical element, where students develop an understanding of human-computer interactions and how computers work.[79]

We recognise that introducing computer science in this way would be a significant change that, to be successful, would require both supply-side and demand-side actions. We address them in that order.

Recommendation 2: Sign up the best teachers to teach computer science through Initial Teacher Training bursaries and 'Golden Hellos'

Although much has been done recently to recruit more STEM-qualified teachers in schools, and we have seen more specialist STEM teachers as a result, the pace of recruitment is not yet fast enough to satisfy the needs of the UK economy.[80] The situation is particularly acute in computer science, which did not form a substantial part of the previous government's review of the country's STEM skills requirements.[81] This means that few potential teachers have showed an interest in the subject as a priority area. Data from the General Teaching Council (GTC) suggests that of the 28,767 teachers who were awarded Qualified Teacher Status (QYS) passes and registered with the GTC in 2010, only three qualified in computing or computing science as their primary qualification (compared with 750 in ICT).[82]

To address the problem, our proposed change in the National Curriculum needs to be accompanied by an aggressive drive to recruit teachers with the right expertise (including people with a good computer science degree, or significant experience in the computing industry). To achieve this, the Training and Development Agency (TDA) – whose key functions, it has been announced, will be transferred to the Department for Education – needs to separate computer science from the umbrella of ICT specialist training where it has been neglected by teachers in favour of ICT literacy. Doing this will signal its strategic importance.

Computer science should remain incorporated into the 'Secondary Priority' category for Initial Teacher Training (ITT), and as such receive a higher bursary, while ICT specialist training is made 'Secondary Non-priority',

Box 4. Finland's *Computer Science in Schools* Programme

Experience from overseas suggests that universities can also play an important role in enhancing computer science education at schools. For example, Finland's *Computer Science in Schools* programme (DASK), whereby universities have got involved in providing high-school students (aged 16-19) with online computer science courses, has helped build capacity in schools for computer science that would not otherwise have existed. Initiated in 2002, the scheme has proved very popular with both young people and teachers.

The intended purpose of the programme was to give young people a realistic view of what it is like to study computer science at university. The contacts with schools through the programme allowed universities to market computer science in a new way and to develop close co-operation with teachers in maths, physics, chemistry and other natural sciences.

The Finnish experience was that the greatest challenge for both students and university lecturers was time-related – the *DASK* courses not being given time in the curriculum, something our proposal to include computer science in the national curriculum tackles head on.

Sources: Grandell, L. (2005) High School Students Learning University Level Computer Science on the Web – A Case Study of the DASK-Model. 'Journal of Information Technology Education.' Volume 4.

which would reduce the bursary payable to ICT trainee teachers from £9,000 to £6,000.[83] The TDA should monitor carefully the impact on physics and chemistry ITT numbers from last year's decision to cut the bursary for lower priority biology and applied sciences courses, as this may give some guidance on the likely effect of lowering the ICT bursary. The TDA must ensure it collects the data it needs to fully evaluate the impact of separating out computer science.

Computer science teachers should enjoy the same higher-rate 'Golden Hellos' that are offered to new teachers with maths, science or applied science training, rather than the lower-rate 'Golden Hellos' that are offered to ICT teachers,[84] as well as possible accreditation through a professional body.

This direct association of computer science with STEM can generate additional benefits: the Institute of Physics suggests, for example, that physics and engineering graduates may be shying away from a teaching career because the general science syllabus they would typically have to teach currently includes biology and chemistry – subjects they often last encountered in GCSE, but might have to teach when they join a school science department. For them, maths, physics and computer science are a much more natural fit.

Investments to retrain existing ICT teachers (and provide CPD training for computer science specialists) should also be made a priority, though the relatively high expense of this would require a careful consideration of the options. (Box 4 outlines one approach that has been taken in Finland to build computer science capacity in schools). e-skills UK's Vital pilot programme of specialist CPD in IT for teachers, run in conjunction with the Open University, is an interesting model to look at in this regard: it delivers CPD in 'bite-sized', low-cost chunks of no more than 15-20 minutes which is more attractive for time-pressed teachers.[85]

Recommendation 3: Use video games and visual effects to draw in greater numbers of young people to computer science and STEM

Building a robust infrastructure for the provision of computer science at schools does not guarantee that young people will demand it. The continued decline in young people taking computer science at A-level has already been mentioned. It may take some time to redress prejudices against this subject, which some perceive to be dry and 'geeky'.

The content and delivery methods of computer science teaching will need to change to address these misperceptions (especially in the eyes of girls).[86] This is where evidence suggests that technologies like video games can play a significant new role. Not only would raising the computing skills and STEM requirements of the video games industry itself attract more young people to computer science and STEM, but video games and visual effects modules should be used to make computer science and STEM lessons more engaging.

McChesney and Alexander (2007) highlight the importance of teaching the basic principles of computer science "in the context of topics which students enjoy and want to study."[87] Video games and visual effects production require the application of knowledge from many subjects, ranging from design to physics and mathematics.[88] What better way to teach

Box 5. Video games in the STEM classroom: some examples from the UK

Innovative teachers are already deploying video games in the classroom to help young people learn subjects such as maths and physics. Avril Denton, at Girvan Primary School in West Scotland, uses Kodu, a video games design program developed by Microsoft, to teach her students maths. In the Priestsic primary school in north Nottinghamshire, a Year 5 teacher has developed arithmetic and geometry lessons using Nintendo's Wii consoles and DS handhelds. The video games in education expert at Learning and Teaching Scotland, Derek Robertson, has used *Dr. Kawashima's Brain Training* in Scottish classrooms.

Video games also show much potential in physics teaching. The Institute of Physics itself has produced SimPhysics, a collection of video games inspired by commercial titles such as *The Sims* that teachers can download to use in lessons about energy, astronomy and the physics of sound.

young people these subjects than by applying them to practical video games – and visual effects-related projects?

As we have already argued, the potential for using video games and visual effects in the UK for STEM teaching is great. In fact, in the Review, we came across excellent examples of this already happening (Box 5). One way to transfer and scale this best practice up might be to include video games and visual effects modules in teachers' ITT training for computer science, maths and physics, and regularly offering updated short courses that earn them recognised CPD points.

Recommendation 4: Set up a one-stop online repository and community site for teachers for video games and visual effects educational resources

Our teachers' survey has shown that video games and animation technologies are being widely used across UK classrooms. It is important to ensure that the lessons from this widespread experimentation are shared, to spread best practice, improve learning outcomes and attract bright young people to computer science and STEM subjects. This will be even more important when many more schools – at least in England – have greater individual control of how they implement the national curriculum.

This is why we are calling for the launch of a one-stop online repository of educational resources for video games and visual effects that teachers from computer science and STEM subjects can draw on to enhance learning in the classroom (Box 6 contains some examples). This repository should include mostly open source (and therefore free for schools to license and modify) video games and visual effects applications, and support discussion, learning and information-sharing activities amongst communities of innovative teachers. The repository should also include resources (such as lesson plans) for commercial video games technologies and animation which are freely available for educational institutions (such as Unity or Unreal Engine), and link up with existing educational online gaming platforms (such as Mangahigh, Whizz Education and Mathematics).

The National STEM Centre, based in the University of York and supported by The Gatsby Charitable Foundation, is currently developing an Open Source library of educational materials that teachers can access for use in the classrooms. This site also enables them to share their lessons with a wider community of like-minded, innovative educators. The video games and visual effects industries should work with the Computing at School network of computer science teachers to explore whether our proposed repository of video games and visual effects material can be incorporated into the library that the National STEM Centre is already developing, and also whether the resource can be used to encourage active collaboration across schools on classroom activities using video games and visual effects technologies. We know from our consultation that there is some appetite from universities to get involved too. Skillset could usefully task one of those running an accredited course to take responsibility for overseeing the repository and ensuring it remains up to date.

Recommendation 5: Include art and computer science in the English Baccalaureate

In its Schools White Paper, the Department for Education announced the creation of an English Baccalaureate (EBacc) award aimed at recognising those students who secure good passes in a broad and rounded combination of rigorous subjects for their GCSEs, including English, maths, the sciences, a modern or ancient foreign language and a humanity such as history or geography.[89] These subjects were

Box 6. Some examples of video games and visual effects software packages for use in education

Scratch, a programming language developed by MIT specifically for children, is already being used in some British schools.

Lego Mindstorm NXT is a basic computer programming language used to engage students in engineering tasks.

UDK provides an easy to use 3D editor for creating virtual environments.

KISMET is a visual scripting tool that allows interactions within a 3D environment and that can be implemented without any programming experience. It can be used at a basic level but advanced features can be activated for older students.

Python is a scripting language used in the visual effects industry and most modern animation packages. Like KISMET it can be used on a basic, as well as advanced level, thus making it useable in schools. It is also open source and free. Downloadable packages can be designed to extend its use in various areas of the school curriculum, for instance supporting learning in 3D graphics, physics and maths.

Blender is an open source and free 3D Creation suite which is already being used across US schools.

DreamSpark is a program that enables students of all ages to access and learn Microsoft's professional developer tools free of charge. Tools available include Visual Studio Professional, XNA, Expression Suite, Windows Phone Developer Tools and SQL Server.

Kodu is a complete game-authoring tool with its own unique icon-based language. Aimed at school-age students, it provides an introduction to the logic and problem solving activities involved in software development.

first accredited in the January 2011 league tables.

However, there has been some concern among headteachers about the range of subjects accredited. We support a more rigorous curriculum in schools, but believe that the EBacc criteria should be reconfigured to include art, just as in the International Baccalaureate Middle Years Programme (11-16). As a GCSE qualification in computing science becomes available this should also be included as a valid subject. (Computing science is an elective in the maths qualification in the International Baccalaureate programme for 16-19 year olds). An alternative, supported by a growing number of headteachers, would see a rigorous TechBacc accredited alongside the EBacc, with maths, English and science complemented by more technological subjects. Computer science and art could be among the additional subject options, if this option is pursued.

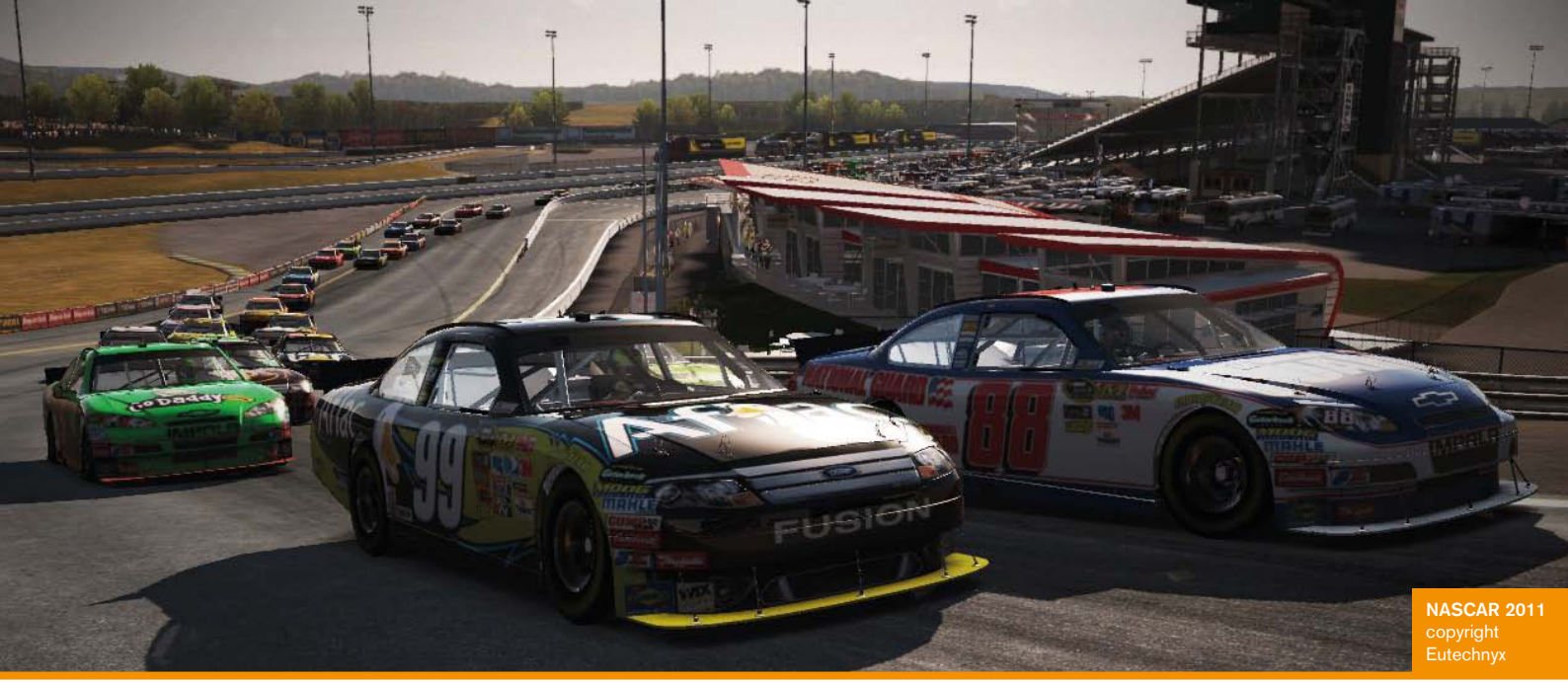
In this way, young people keen to pursue a career in high-tech creative industries like video games and visual effects would be provided with an excellent foundation in essential knowledge across STEM and creative subjects that they can then develop into industry-relevant skills at a later stage of their education. The government should bring art and computer science within the frame of the English Baccalaureate (or an alternative TechBacc), and high-tech creative industries like video games and visual effects industries should promote it through the initiatives discussed in Recommendations 7-10 below, as a sensible choice for those interested in following a career in these industries.

Recommendation 6: Encourage schools to promote art-tech crossover and work-based learning through school clubs

Creativity is one of the areas where the UK is genuinely seen throughout the world as at the leading edge.[90] The UK's future economic strength lies in further nurturing and exploiting this creativity. A consistent theme throughout our industry research is the great importance of cross-curricular and multidisciplinary thinking in the creative workforce. The success of our video games and visual effects industries lies in their fusion of technology and creative skills.[91]

Many teachers give up their spare time to run computer clubs, supported by organisations like STEMNET and e-skills UK. Such extra-curricular clubs can be an effective forum for developing young people's problem solving skills and giving them opportunities to work in multidisciplinary teams.[92]

Today, more than 1,600 schools already have STEMClubs, reaching more than 100,000 young people. Projects range from one-off, short projects to longer-term collaborations. Schools affiliate for free to the STEMclubs.net network, which gives them access to advice on how to run a club, information resources,



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CPD training for schools as well as experts within STEMNET to help them set up projects.

We recommend that the video games and visual effects industries work closely with Learning Without Frontiers, which is developing its own proposal for a national network of computer clubs, and with schools through the STEMClubs network to pilot extra-curricular video games and visual effects clubs which bring together computer science, maths, physics and art teachers. Historically, STEMNET has found that STEMClubs rarely run computer science projects, perhaps reflecting insufficient numbers of technically-trained teachers as discussed earlier. But well configured cross-curricular tasks around video games and visual effects projects could engage young people in the same way these technologies appear to be doing in the classroom.

We call upon industry to provide video games and visual effects resources to ensure that work-based projects are engaging for young people and easy to set up for teachers. This will be all the more important when funding cuts may risk some schools withdrawing from extra-curricular clubs altogether. Universities and FE colleges should also contribute. In doing this, we advise them to look closely at the experience of e-skills UK's Computer Clubs for Girls initiative which, since it began in 2003, has reached over 135,000 girls in 3,700 schools, making important strides towards addressing the gender gap in computing at schools (e-skills UK's evaluation suggests that over two-thirds of those who have participated in the clubs would now consider a career in computing).[93]

Recommendations 7-10: Involve industry in existing initiatives and networks to galvanise young people's interest and awareness of the video games and visual effects industries

Our research has shown that time constraints and high perceived costs create barriers to engagement between the video games and visual effects industries and schools. At the same time, there is an infrastructure of networks and initiatives currently in place through which video games and visual effects companies can participate to increase their visibility in the eyes of school children, careers advisors and teachers at a low cost.

These activities should target young people between 10 and 14 years in particular. This would help ensure that they have the best possible information about the video games and visual effects industries before they make important decisions (for instance in terms of academic subjects) which could open (or close) doors to career opportunities in these high-tech creative industries further down the line.

To demonstrate their commitment to achieving the vision set out in this Review, we ask the video games and visual effects industries to:

- **Recommendation 7:** Contribute staff to the successful STEMNET and Teach First Ambassador programmes to provide industry role models for young people.

  STEMNET is a network of over 26,000 ambassadors across the UK. What individual ambassadors do with schools varies widely depending on the appetite and availability of the Ambassador, the needs of schools and the training materials to which they have access. Industry engagement is therefore critical to the network's success. Currently, only 38 of over 26,000 Ambassadors have reported working in the video games industry or having a video games

Hellboy 2: Courtesy of Universal Home Entertainment/ Double Negative

degree, and only one works in visual effects.

We seek the commitment of industry figures in the Brighton, Dundee, Guildford, Leeds, Cambridge, Liverpool, London, Manchester and Coventry/Leamington Spa video games clusters to sign up as STEMNET Ambassadors and key staff in the largest visual effects companies. One of their main responsibilities would be to lead an ambitious campaign to recruit more industry Ambassadors from their regions.

Teach First is a charity addressing educational disadvantage by transforming exceptional graduates into inspirational teachers. Teach First teachers work in schools in challenging circumstances for a minimum of two years. Since its inception in 2000, 2,520 graduates have gone through the Teach First programme: 50 per cent have stayed on in teaching, and over 67 per cent remain actively engaged in addressing educational disadvantage in the long term. The programme is being expanded by the government.

Teach First has recruited the highest calibre STEM and art graduates into teaching and has the potential to raise awareness of the high-tech creative industries like video games and visual effects as career opportunities in the eyes of pupils. Discussions with Teach First suggest that leaders in our most successful video games and visual effects businesses, with their unique combination of creative and technology skills, would have a lot to offer as mentors to Teach First trainees in STEM and art subjects.

- **Recommendation 8:** Design and fund new National Games Development and National Visual Effects competitions for schools, building on the excellent work of BAFTA, Dare to Be Digital, and the Animation 10 competition in Manchester.

Competitive challenges can be effective ways of engaging young people and supporting their career choices. For example, the proportion of participants in BAFTA's 2010 games design competition saying they were very interested in working in video games increased from 50 per cent to 81 per cent over the course of the competition, and 64 per cent claimed they had changed the subjects they would like to study as a result of taking part. The National Games Development and National Animation competitions would provide an overarching competitive framework for developing the interest in and skills for the video games and visual effects industries.

The competitions might cover complementary areas, including: developing animation skills, where students submit finished animations; designing video games concepts, where students pitch outlines of gameplay, narrative or key characters; and developing games prototypes, where students programme and submit a game. In-kind prizes for winning entries might include hardware or software, or opportunities for older age group winners to gain work experience. Joint branding and marketing would enable these competitions to achieve greater reach than they would individually, and present opportunities to share costs. NESTA has agreed to seed fund the competitions in their first year.

- **Recommendation 9:** Fund the implementation of a Next Generation of Video Games and Visual Effects Talent Careers Strategy aimed initially at recruiting 100 of the very brightest young people with the right mix of technical STEM and art skills for these two industries. The strategy would make young people aware of the potential that working

in these industries offers and the transferability of their graduate technical skills. It would provide continued engagement with them such that those who choose to do so experience a pathway into the industry through lectures from industry professionals and high-quality careers guidance. The strategy should be developed over at least a four-year period so that a quantitative uplift in top talent entering the industries can be rigorously evaluated.

- **Recommendation 10:** Contribute educational resources and materials for teachers and careers advisers, to be hosted, wherever possible, on popular online platforms with careers information, such as e-skills UK's BigAmbition. BigAmbition is a free website resource for teenagers which provides information on IT-related education and careers. As well as interactive features it contains company profiles and videos on specific job roles that include interviews with young professionals. Some material has already been developed with video games companies (though none with visual effects companies). BigAmbition currently has 8,000 young people registered and many more visitors that come to the website. All websites with resources and materials about careers in video games and visual effects industries should also provide information on which university courses are more likely to land young people a job in these industries, by linking back to the information resources we call for in Recommendation 14.

  Careers guidance in schools is set to undergo major changes in coming years following the government's decision to commit to a new all-age careers service. The video games and visual effects industries must ensure that their skills needs are reflected in new strategic initiatives to provide careers guidance on high-tech careers. For example, video games and visual effects should appear in any STEM Careers Training modules by the National STEM Centre as proposed by Sir John Holman and Peter Finegold in their recent review of STEM careers.[94]

More generally, the video games and visual effects industries need to work closely with those learned societies like the Institute of Physics, the Royal Academy of Engineering, and the Computing at School part of the BCS Academy of Computing, which have tried and tested structures for making industry materials and information available to teachers and young people. Like STEMNET, such bodies have strong existing networks with schools – with 75 per cent of physics teachers affiliated in the case of the Institute of Physics (and around 3,000 young people participating in the Youth Membership Scheme). Networks such as the Institute of Physics are excellently placed to distribute teaching and careers-related video games and visual effects material (e.g. through their Annual Schools Lecture Tour and Teachers Networks). Through the Review, these bodies have already signalled their enthusiasm for working with the video games and visual effects industries, not least because they too recognise the important role that video games and visual effects can play in attracting young people into STEM subjects.

Recommendation 1.	Bring computer science into the National Curriculum as an essential discipline.
Recommendation 2.	Sign up the best teachers to teach computer science through Initial Teacher Training bursaries and 'Golden Hellos'.
Recommendation 3.	Use video games and visual effects at school to draw greater numbers of young people into STEM and computer science.
Recommendation 4.	Set up a one-stop online repository and community site for teachers for video games and visual effects educational resources.
Recommendation 5.	Include art and computer science in the English Baccalaureate.
Recommendation 6.	Encourage art-tech crossover and work-based learning through school clubs.
Recommendation 7.	Build a network of STEMNET and Teach First video games and visual effects Ambassadors.
Recommendation 8.	Introduce a new National Video Games Development and Animation Schools Competition.
Recommendation 9.	Design and implement a Next Generation of Video Games and Visual Effects Talent Careers Strategy.
Recommendation 10.	Provide online careers-related resources for teachers, careers advisers and young people.

Where the Wild Things Are:
Image Courtesy of Warner Bros. Pictures/Framestore

Part 4. The Talent Pipeline: universities, further education colleges and vocational education

In this Part we look at higher education, further education and vocational education. Most UK video games and visual effects recruits are educated to these levels. Ensuring that universities and colleges provide these industries with the right talent is crucial if they are to remain internationally competitive and continue to grow.

"If you want to be a chef, you shouldn't study kitchen design. And if you want to be a games developer, you shouldn't study media studies. Knowledge is good, but skills are essential to produce video games. Students shouldn't just learn about the philosophy of games but about the hard skills necessary to make them. We need games designers, of course, but we need a lot more programmers and artists.

Digital high-tech industries like video games need computer science and art graduates who can hit the road running as well as those with excellent general STEM and art skills. Today, the majority of university video games courses are failing to produce graduates with industry-relevant skills. Just because the word 'games' is in the course title does not mean it is a passport to employment. We must put an end to the current situation where young people invest their time and money on university courses that fail to provide them with the skills they need to find a job in the industry. It's no good for the students, no good for industry and no good for the economy."

Ian Livingstone

"Anyone seeking out a route into the visual effects industry is confronted by an ever-increasing number of courses. Sadly, in most cases, the courses are simply not producing graduates with the skills that industry needs. Universities too often appear to be focused on attracting students onto their course rather than pushing up the standards of those graduating. Universities need to raise their entry standards, requiring applicants to have a demonstrable aptitude for art, maths and computer science skills. They should not shy from failing those on their courses if they don't make the grade. And they should embrace teaching of subjects like maths and programming, as these will give students the core skills they need to succeed.

Skillset and industry needs to assist universities who do meet their standards, by ensuring that course applicants know that industry recommends and actively participates in their courses. This, aligned with the reforms set out in Lord Browne's report, can move us to a place where courses are judged and funded on the basis of their outcomes rather than their inputs.

A key part of improving the quality of teaching is ensuring that lecturers have up to the minute understanding of current industry practices. Lecturers need to have their skills refreshed and those on accredited courses should be expected to spend time with industry to do this. Universities should give time to lecturers for this and industry should make opportunities available.

Industry and educators need to find new ways of working together. The principal constraint for industry here is time. Skillset divides its work with the creative media industries across 11 sectors, which presents challenges for supporting skills such as VFX which sit horizontally across sectors. I welcome Skillset's recent initiative with UK Screen Association to target VFX, which will make it easier for the industry to engage. This horizontal striping across sectors might even be a template for other skills types."

Alex Hope

The Wolfman: Image Courtesy of Universal/MPC

The challenge

Our findings confirm that most university courses specialising in video games and visual effects are failing to produce graduates of the calibre that these industries require. As a result, most graduates from these courses fail to gain employment in video games and visual effects companies. Even though our results suggest an excess of supply of specialist graduates, employers report difficulties filling vacancies for entry-level positions across almost all disciplines (particularly in those areas requiring technical skills).

All of this means that many video games companies end up recruiting large numbers from non-specialist courses such as computer science, maths, physics and engineering. Visual effects companies, for their part, rely on recruiting large numbers of international talent.

We have also found that most courses are failing to provide their students with the commercial and project management skills required to develop new business models, deliver large-scale projects or, indeed, set up their own company.

The reasons for this are as follows:

- Few specialist courses teach their students difficult subjects such as maths which give them the aptitude they need to adapt their technical skills in the workplace, nor do they provide hands-on technology training with the programming languages and software applications being used in industry. As a consequence, when our talent survey asked people working in these industries which educational qualifications and training had helped them most in securing a job, the most common responses from those employed in the video games industry were 'self-taught' at 37 per cent and 'hands-on technology skills' at 32 per cent. Only 29 per cent cited higher education. In the case of visual effects, only 18 per cent said that higher education had helped them most in securing a job.

- University applicants lack basic information about the skills that are required to gain employment in the video games and visual effects industries, or about the actual content and quality of the courses for which they are applying. In the case of visual effects, those who graduated overseas were twice as likely to have received personal advice from an industry professional or guidance about the industry from a careers adviser compared with those who had studied in UK universities.

- University students do not fare much better in acquiring the commercial and management skills that the video games and visual effects industries need to deliver their projects on time and on budget, and (in the case of video games in particular) make the most of new opportunities in booming online and mobile gaming markets.

- Our visual effects survey shows that UK graduates had a poorer educational experience than those who studied overseas. These overseas graduates said that their courses provided them with stronger art skills and a much better understanding of industry production pipelines and workflows. They were also more than twice as likely to have benefited from work experience in the industry (20 per cent compared with 8 per cent). Forty-one per cent of UK graduates say that they now recognise that their course had lacked teaching in industry-relevant skills, compared with 25 per cent of those who had studied overseas.

Few video games or visual effects companies appear to see further or vocational education as direct sources of talent. Most of the specialist courses provided by FE colleges are perceived as too basic, and of too low quality for the high-tech needs of these industries. There are substantial economic barriers to the take-up of apprenticeships.

12% *Proportion of graduates from specialist video games courses who find a job in the video games sector within six months of graduating*

Most video games graduates are not up to scratch

Universities are producing an excess supply of specialist video games graduates

Our skills audit includes data for 56 universities providing 141 video games specialist courses.[95] In 2008-2009, 1,585 people graduated from these courses (with a further 7,145 studying on them).[96] Most were either in computer programming (64 courses) or design (38 courses). 112 of the courses were at undergraduate and 29 at postgraduate level (Table 7).[97]

The number of graduates considerably exceeds the numbers of new graduates that the industry needs. Based on our employer and talent surveys we estimate that between 130 and 230 new graduates were

Box 7. We have carried out a comprehensive audit of specialist skills supply for the video games and visual effects industries

We have drawn on official data sources such as the Higher Education Statistical Agency (HESA) and the University and Colleges Admissions Service (UCAS) to produce a comprehensive audit of the specialist supply of skills from UK universities for the video games and visual effects industries for the most recent year for which data are available (2008-2009). Our initial list of specialist courses was compiled with Skillset's advice, and subsequently augmented with a keyword search in HESA's and UCAS's databases (including terms such as 'video games', 'games', 'computer games', 'visual effects' and 'post-production'). In the case of visual effects courses, we have used industry feedback to further expand our list of courses.

For these courses, we have counted the number of people enrolled, the numbers graduating from them, and their employment destinations by sector. We have supplemented this information with data we have collated from course prospectuses to establish which discipline these courses teach (e.g. programming versus art), what are their entry level requirements and whether or not they provide teaching in subjects such as maths, as well as if they provide hands-on instruction in technology.

Our skills audit does not include general courses such as computer science or physics that supply graduates, although these are a significant source of recruits for both industries. There are two reasons why we have focused on specialist courses rather than all university courses.

1. Because we heard at the outset of the Review that employers were concerned about the quality of specialist courses producing talent for the video games and visual effects industries. Employers often say that they recruit such large numbers from generalist courses because the graduates from specialist courses are not of the required calibre.

2. Specialist courses attract people who are, in principle, keen to work in the video games and visual effects industries. As such, they should be the first 'port of call' for video games and visual effects companies seeking talent with a passion for the industry. Because of their supposed industry focus, these courses should also be in a much better position than generalist courses to provide hands-on training with the specific software, hardware and programming languages that industry uses, and to introduce their students to its ways of working and development processes.

58%

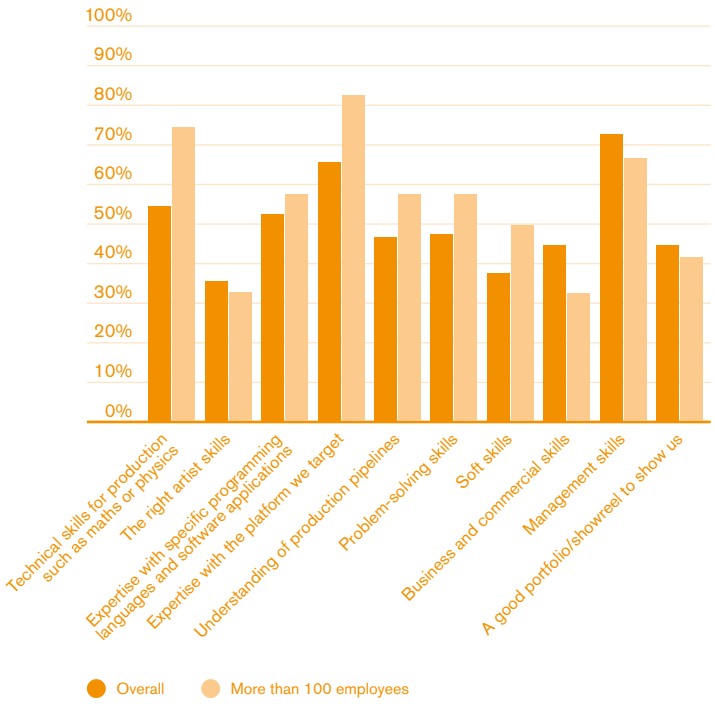
Proportion of video games employers who report difficulties filling positions with recruits straight from education

needed in 2009 (which was a bad year for the industry, with growth rates of 2.5 per cent compared with to 10 per cent in other years) and around 450 in 2010.[98] Although these estimates are only rough and need to be taken with a good deal of caution (given the assumptions that have had to be made to derive them), they strongly indicate that universities are producing too many specialist video games graduates.

Lacking the skills that employers demand

Given this excess supply of graduates, we'd expect UK video games companies to be spoilt for choice when filling positions. But this is not so. Fifty-eight per cent of all respondents to our employer survey (and 71 per cent of companies with more than 100 employees) say that there are positions where it is particularly difficult to find recruits straight from education with the required skills. When asked which positions are hardest to fill, they mention computer programmers (43 per cent), followed by designers (15.9 per cent), artistic roles (particularly technical artists with the right blend of arts and technology skills) and project management roles (around 7.2 per cent each).

Figure 7: The skills that are hardest to find in people straight out of education according to video games employers who recruit straight from education



Source: Video games employer survey, 2010.

Worryingly, large numbers of employers recruiting from education stress important shortcomings in university applicants (Figure 7). They are particularly concerned about graduates' lack of expertise with the gaming platforms that they target, insufficient technical skills in areas ranging from maths to programming, and their management skills.

Larger companies (employing more than 100 people) are overwhelmingly concerned about graduates' lack of expertise in the platforms on which they focus and poor technical skills (both of which relate to the ability, or lack thereof, of new entrants to contribute productively soon after joining the company). They are also more likely to find their recruits lacking in an 'understanding of production pipelines' in the industry. This is intuitive, given the higher complexity of platforms such as consoles on which larger companies focus, as well as the larger scale of their projects.

Consistent with this, almost 35 per cent of respondents to our talent survey who are working in the video games industry said that they now know that their course lacked industry-relevant skills.

This is reflected in poor labour market outcomes for graduates from specialist video games courses

We have used data from HESA's Destinations of Leavers from Higher Education Institutions Survey to gauge the success of graduates from these specialist

Table 7: Numbers of graduates from specialist video games courses, and their six-month performance in the labour market

	Total no. courses	Qualified*	Still studying*	Employment rate	Games rate employment
Animation	**12**	130	590	55.0%	9.9%
Arts	**7**	160	530	34.2%	14.0%
Design	**38**	480	2110	53.6%	8.8%
Programming	**64**	725	3430	53.6%	14.8%
Other and NA	**20**	90	485	15.4%	NA
Total	**141**	**1585**	**7145**	**51.2%**	**12.2%**
Undergraduate	**112**	1440	6810	50.0%	10.8%
Postgraduate	**29**	145	335	69.8%	32.3%

Source: Skills Audit drawing on HESA data.

* Amounts rounded to the next 5 following HESA's guidelines

courses in joining the video games industry within six months of finishing their degree.[99] Our results present a stark picture: only 12 per cent of those for which we have destination data had managed to gain employment in the sector within that timescale. As could be expected, given industry demand for people with a higher level of qualification, graduates from Masters courses are more likely to end up working in the industry: around a third do so, compared with only 10.8 per cent of those just finishing an undergraduate degree (Table 7).

Most specialist courses do not provide hands-on technology training...

Our skills audit shows that many video games courses do not provide any hands-on technology training. Out of 142 courses for which we were able to collect information, barely half mention any technology training in their prospectuses.[100] Less than one-third mention C++, the standard programming language for higher range platforms such as consoles, while less than 5 per cent provide training in Flash, the dominant multi-media platform for fast-growing browser gaming markets. Only 20 per cent mention hands-on work with gaming platforms and development kits as part of the course (13 per cent mention video games engines).

Shortcomings in the provision of technology skills by universities are supported by the findings of our talent survey, where around half of graduates from specialist courses say that their degree failed to provide them with expertise in gaming hardware (Table 8). Less than half consider that their degree provided them with strong skills in the use of software applications and programming languages in use in the industry (although this proportion, at 68 per cent, is higher for

Table 8: HE provision of technical skills for video games for different types of degree as reported by graduates

	All (n=688)		Overall specialist courses (n=161)		Overall courses non-specialist (n=527)		Games Programming (n=97)		Computer Science (n=186)	
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Technical skills such as maths and physics	49.0%	34.6%	42.2%	39.1%	51.0%	33.2%	63.9%	17.5%	75.3%	5.9%
Expertise with specific software applications and programming languages	41.7%	39.5%	49.7%	28.6%	39.3%	42.9%	68.0%	13.4%	61.8%	16.1%
Expertise with hardware	18.9%	37.9%	23.0%	50.9%	17.6%	34.0%	29.9%	42.3%	25.3%	48.9%
Understanding of production pipelines	23.1%	57.7%	48.4%	33.5%	15.4%	65.1%	49.5%	30.9%	12.9%	62.4%
Soft skills	48.0%	21.1%	58.4%	14.3%	44.8%	23.1%	61.9%	10.3%	39.8%	21.0%

Source: Video games talent survey, 2010.

Batman: Arkham City
copyright Warner Bros. Interactive Entertainment

graduates from video games programming courses).

...or even maths

We were able to identify only 36 courses (27 per cent) in our skills audit that offer courses in maths.[101] Given the importance of this subject as a foundation for software programming, it is somewhat alarming that fewer than 40 per cent of computer programming courses provide this subject.

Students are ill-informed about course content, and ways of working in the industry, and a significant minority have concerns about their standards of rigour

Thirty-eight per cent of all graduates from specialist courses in our video games talent survey complain that they had not been given a clear idea of their course content or prospects for employment in the industry when selecting which course to do. Over one-fifth of them say that the entry requirements and standards of assessment in their courses were insufficiently rigorous (these proportions go up to 30 per cent among those who studied on video games design courses).

Most courses fail to equip their graduates with strong business skills

Technical and art skills, understanding production pipelines and the ability to work as part of a team are all essential parts of video games production. At the same time, running and growing a video games company successfully requires commercial (including sales and marketing) and management skills to deliver projects on time and to budget. As studios start going direct to customers in online markets, often employing novel business models, they need to be able to access finance and promote their products in innovative ways. Lower barriers to entry in mobile and online markets also make it easier for entrepreneurial new graduates to start their own businesses.

However, the results of our talent survey show that the overwhelming majority of courses are failing to provide their students with the commercial and project management skills required to start and build new businesses, deliver their projects successfully, and stay on top of rapidly shifting gaming marketplaces. As Table 9 shows, 68 per cent of graduates complain that their course was weak in equipping them with commercial skills (including sales and marketing). And just over half say the same about project management skills.

Our employer survey also suggests that these shortcomings in the business skill sets of graduates present particular challenges for video games companies operating in emerging gaming markets such as mobile, where self-publishing and new business models are having a stronger impact. As

Table 9: HE provision of business skills for video games as reported by graduates

	Strong	Weak
Commercial skills	15%	68%
Project management skills	26%	51%

Source: Video games talent survey, 2010.

Table 10: Difficulties in finding specific skills in recruits straight out of education, by target platform, as reported by employers recruiting straight from education

	Console	Mobile
Commercial skills	35%	44%
Project management skills	46%	56%

Source: Video games employer survey, 2010.

Table 10 shows, those respondents targeting mobile platforms were more likely to flag up difficulties in finding recruits straight from education with good commercial and project management skills than those operating in more established markets, such as consoles.

Our findings raise particular concerns about the quality and industry-relevance of video games design courses

Graduates from video games design courses have a particularly poor showing in the video games labour market: Table 7 shows that only 8.8 per cent had managed to gain employment in the sector within six months of graduating, compared with 14.8 per cent in the case of video games programmers. Their median salary is also below most graduates from other types of courses (Figure 8).

This may of course be partially explained by there being a particularly large excess supply of graduates from these courses (they comprise 30 per cent of all the graduates in our skills audit). However, our talent survey points to other explanations, linked to the quality of teaching in these courses, and their content.

We already noted that the proportion of graduates from video games design courses that complain about insufficiently rigorous entry or assessment standards in their degrees was substantially higher than the population overall. But our results also show that 27 per cent of video games design courses found their degree easy (compared with 17 per cent for the population overall). And as Table 11 indicates, video games design courses lag behind video games programming courses in providing strong technical skills, skills with specific programming languages and software applications, and gaming platforms.

Interestingly, video games design courses are reportedly stronger in providing their graduates with a knowledge base about the philosophy of video games as a creative medium – 38 per cent of video games design graduates say their course was very strong in this respect compared with 24 per cent of video games programming graduates. On the whole, employers seem to care little about this kind of knowledge (though Skillset points out that games design courses are precisely where you would expect some instruction in the philosophy of video games). Forty-two per cent of video games design graduates now realise that their course lacked industry relevant skills (compared with only half that proportion of video games programming graduates).

Many video games companies end up recruiting large numbers from non-specialist courses

The results from our talent survey show how the majority of video games personnel with a degree have graduated in non-specialist degrees like computer science and other STEM subjects. Only 20 per cent of graduates currently working in the sector graduated from video games programming, design and art courses. This compares with 29 per cent with computer science degrees and 19 per cent who studied maths, physics, sciences or engineering and design.

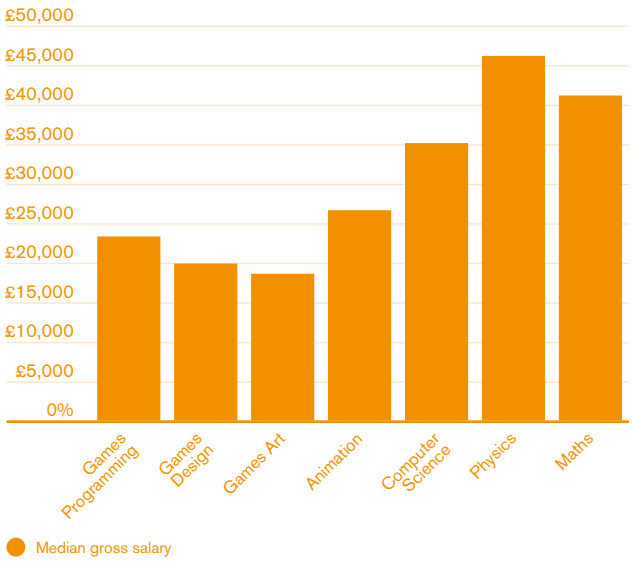
Interestingly, of those 640 respondents providing salary information, the median salary of computer science, physics, mathematics and engineering and design graduates is higher than games programming, animation, games design and games art graduates, consistent with graduates from these non-specialist STEM courses being more highly valued by their employers (Figure 8). An important note of caution however is that this calculation does not control for the number of years of experience of different graduates (so graduates from (newer) games design courses would be expected to have less experience than, say, physics graduates, and therefore have lower salaries).

The UK's visual effects industry has to tap international talent pools to address its skills shortages

UK universities produce a smaller number of specialist graduates for the visual effects industry

Table 12 presents the outputs of our skills audit for visual effects. We have identified 35 universities providing 56 specialist courses that feed talent into

Figure 8: Salaries of respondents to video games talent survey by university degree



Source: Video games talent survey, 2010.

15.4%

Proportion of graduates from specialist VFX courses who find a job in the sector within six months of graduating

Table 11: Skills provision by different types of video games courses, as reported by graduates

	Video games design (n=45)		Video games programming (n=97)	
	Strong	Weak	Strong	Weak
Technical skills such as maths and physics	11%	73%	64%	18%
Expertise with specific programming languages and software applications	24%	53%	68%	13%
Expertise with gaming platforms	13%	66%	30%	42%

Source: Video games talent survey, 2010.

the sector.[102] In 2008-2009, 605 people graduated from these courses,[103] with a further 2,445 enrolled on them.[104] The majority of these courses focus on animation (46 out of 56). We have also identified nine postgraduate courses.[105]

The excess over the number of new graduates demanded is less striking than in the case of video games. We estimate that in 2010 the visual effects industry may have hired over 300 people straight from university.[106]

Most of which fail to gain employment in the industry

One might expect that the smaller number of individuals graduating from visual effects specialist courses, compared with video games, means that they have had much better employment prospects, not least because the industry has been growing rapidly throughout this period. However, our analysis of the HESA Destinations of Leavers Survey data shows that even then the majority of graduates from specialist visual effects courses failed to gain employment in the

Table 12: Numbers of graduates from specialist visual effects courses, and their performance in the labour market

	Total courses	Qualified	Still studying†	Employment rate	Film and Visual Effects employment rate
Undergraduate*	**47**	565	2,360	49.0%	15.2%
Postgraduate**	**9**	40	85	73.7%	36.8%
Total	**56**	**605**	**2,445**	**47.7%**	**15.4%**

Source: Skills Audit drawing on HESA data.

* Data incomplete for 4 courses ** Data incomplete for 1 course † Amounts rounded to the next 5 following HESA's guidelines

sector, at least in the six months after graduation.[107] Only 15.4 per cent of all graduates in 2008-2009 managed to find employment in the Film and Visual Effects industries within six months of graduation (Table 12).[108]

Visual effects companies report difficulties filling vacancies at the entry level…

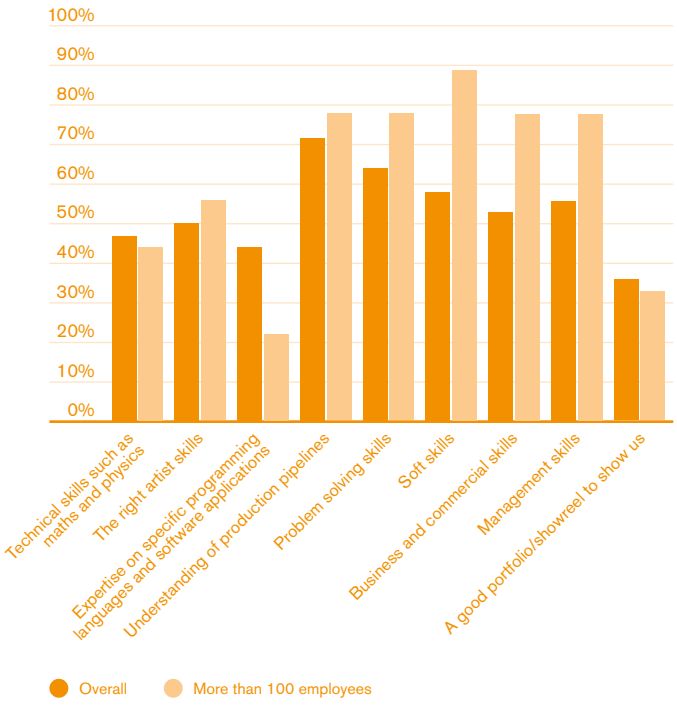
Fifty-five per cent of visual effects companies responding to our employer survey said that they had had difficulties filling entry-level positions (the proportion rises to 89 per cent in the case of companies with more than 100 employees). Animation positions are particularly hard to fill (they are mentioned 20 per cent of the times).There are several other areas of the business where it is difficult to find the right recruits from education. Just over 12 per cent mention CG Artists and project managers and production staff. Just over 11 per cent report that motion graphics designers are hard to come by, and 11.1 per cent say the same about Research and Development staff, shader writers and programmers.

…and also that people straight from education are lacking important skills

Figure 9 presents those skills that are hardest to find in people straight from university according to visual effects employers. Overall, graduates are predominantly seen to lack an 'understanding of production pipelines' followed by problem-solving and soft skills, and commercial and management skills. Half of respondents recruiting new graduates say that the right artistic skills are hard to find, while 47 per cent say that graduates lack the right technical skills in areas such as maths and physics.

Companies with more than 100 employees are particularly concerned with graduates' soft skills and problem-solving abilities followed by an understanding of production pipelines, and business and management skills (all of which are mentioned by just over three-quarters of employers). New graduates with the right artistic and technical skills such as maths and physics are also hard to come by. Their stronger emphasis on production and team working skills compared to the population overall may be explained by the fact they engage in larger-scale projects involving bigger teams, which requires a better understanding of production processes, and better coordination with other team members.

Figure 9: The skills that are hardest to find in people straight out of education according to visual effects employers recruit straight from education



Source: Visual effects employer survey, 2010.

Many specialist visual effects courses at universities do not provide hands-on technology training

Just under half of visual effects courses mention hands-on technology training in their prospectus. Two-thirds teach their students how to use AutoDesk's Maya or 3D Max (the dominant graphics applications in the industry), while less than 16 per cent provide training with Nuke, which is now the industry standard for compositing.

And almost none teaches maths

Our analysis of specialist visual effects courses show that just 5 per cent of the 56 courses for which we have curriculum data offer maths teaching, despite the important role that this subject plays as a foundation for many of the technology development activities involved in visual effects production. It is important to note that one of the courses offering maths is the 'Computer Visualisation and Animation' course provided by Bournemouth University, which as we will show below stands out amongst all UK specialist visual effects courses in producing large numbers of graduates that succeed in gaining employment in the industry.

Students complain of lack of information about course content and employment prospects

Forty-six per cent of UK graduates say they had not been given a clear idea of course content and prospects for employment in the industry when they selected their course.

Visual effects companies also end up recruiting graduates from non-specialist courses, although to a lesser degree than video games companies

Our talent survey shows that, as with video games, visual effects companies recruit talent from non-specialist courses, including STEM degrees such

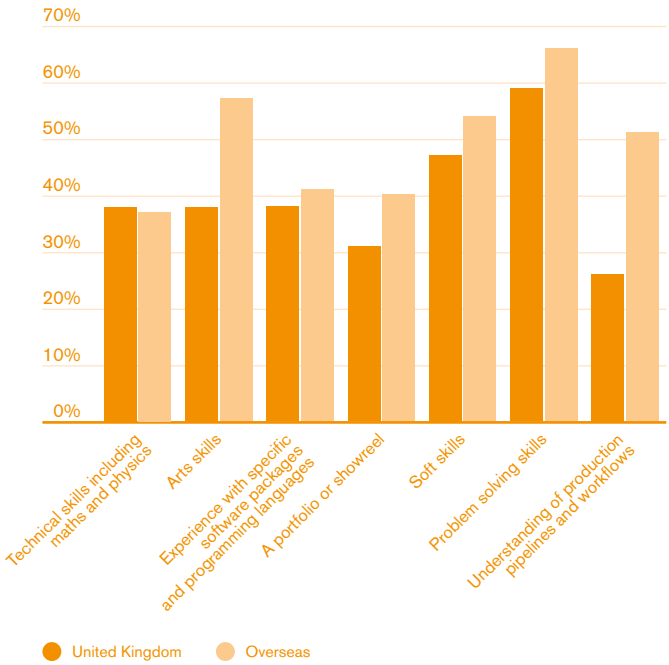
Robin Hood: Image Courtesy of Universal Pictures/MPC

as maths, physics and computer science: indeed, proportionally, our sample presents as many STEM graduates as it does animation graduates (around a quarter of respondents in each case).

Our talent survey shows that overseas institutions are ahead in several areas

As Figure 10 shows, there seem to be important differences between the quality of higher education provision in the UK and overseas, as reported by respondents to our talent survey. The differences are particularly visible in two areas, 'arts skills' (where 50 per cent more of those who graduated overseas say that their courses were strong or very strong), and 'understanding of production pipelines and workflows' (where twice as many graduates from overseas highlight the strength of their courses). Overall, only a quarter of graduates educated outside the UK complain that their course lacked industry-relevant skills (compared with 41 per cent of those that studied in the UK).

Figure 10: Strength of courses in different areas, according to VFX graduates



Source: Visual effects talent survey, 2010.

They are also more likely to benefit from work experience in industry

Our talent survey does not show too many differences between UK and overseas-educated respondents regarding the kinds of industry-relevant activities they had followed at their universities (Table 13). One exception is that those who studied overseas are more likely than UK graduates to say that their course taught them how to develop solutions to problems regardless of software packages. Also, interestingly, the overseas-educated respondents are more than twice as likely to have benefited from work experience in the industry as part of their degree.

Specialist visual effects graduates from the UK are not picking up commercial and management skills during their degrees

Visual effects projects are often large-scale endeavours bringing together dozens of professionals from different disciplines, in some cases across several companies. In order to deliver top quality on time and to budget, visual effects companies need to manage their technical and creative talent effectively. At the same time, commercial skills are important in securing new projects and growing the business.

But as we already noted, visual effects companies (particularly those with more than 100 employees) are having difficulties finding people straight from education with strong commercial and management skills. This finding is mirrored in the responses to our talent survey, which shows that the UK's universities are failing to produce the sort of business leaders and managers which the UK visual effects industry needs to remain world-leading (Table 14). It is a cause for

Table 13: Practical learning and visual effects-relevant activities in the UK and overseas

	UK-educated (n=439)	Overseas-educated (n=260)
Received hands-on training in a specific software package	67%	60%
Learned the principles needed to develop solutions regardless of software packages	49%	60%
Received practical training in a programming language	36%	33%
Received practical training in a software package	58%	57%
Participated in an activity/project which represented real industry experience	41%	45%
Developed your portfolio/showreel	55%	53%
Participated in a competition	23%	27%
Received lectures from industry professionals	54%	57%
Benefited from work experience in industry as part of a degree	7.7%	19.6%

Source: Visual effects talent survey, 2010.

concern that only 11 per cent of graduates say that their course provided them with strong commercial skills (the percentage goes up to 25 per cent in the case of project management). Once again, overseas degrees are seen to provide their graduates with better skills in these areas, although only marginally.

Overseas talent is stepping into the breach

Unsurprisingly, given the higher quality of education in some other countries, it appears that UK visual effects companies have managed to thrive in the face of skills shortages by recruiting top talent from overseas. Box 8 describes the German Film School and the Savannah College of Arts and Design, two institutions that seem particularly adept at producing the kind of talent that the UK visual effects industry seeks. In our talent survey, 30 per cent of all university graduates working in the industry in the UK had studied overseas (half of these were non-EU citizens). These are people working in all areas of the business, including in technical positions (31 per cent of whom were educated overseas), in animation (31 per cent of whom were foreign educated), in art (37 per cent) and in compositing (33.6 per cent).

The industry's use of international talent including personnel from outside the EU to plug gaps in the local skills base is illustrated by the Government's decision to include 18 visual effects jobs on the approved shortage occupation list with a Tier 2 Visa.[109]

Where do graduates from specialist video games and visual effects courses end up?

We have used HESA data to examine graduate employment destinations outside of these two industries, and found them spread across many sectors of the economy (Table 15). As might be expected, a small yet significant percentage find work in other IT & Digital-related sectors (such as Telecommunications and Software Consultancy), half of which studied video games programming courses. But other than this, video games and visual effects graduates are found throughout the economy.

Table 14: Business skills in UK university courses and overseas

	UK-educated		Overseas-educated	
	Strong	Weak	Strong	Weak
Commercial skills	11%	70%	19%	56%
Project management skills	25%	49%	33%	42%

Source: Visual effects talent survey, 2010.

Box 8. Best practice in visual effects higher education: The German Film School and the Savannah College of Art and Design

The German Film School is a private university for digital media production based in Elstal, near Berlin. Founded in 1998, it offers a Diploma in Digital Arts and a Masters course in Character Design and Development. The School's programmes are designed to provide students with a mix of theoretical knowledge, commercial skills and hands-on training with the latest hardware and software. Its lecturers include many international professionals with experience in film, television and advertising. As part of their education, students participate in team-based projects, and produce short films, commercials and music videos in an environment that simulates real business conditions. The explicit goals of the School include keeping its programme and technologies up-to-date with changes in the animation and visual effects industries, and providing training services for digital media professionals. In addition to equipping its students with industry-relevant skills, the German Film School also carries out basic research, particularly in the area of Virtual Environments.

http://81.169.138.57/site/en/int/container-startseite_en.php

The Savannah College of Art and Design (SCAD) is a university with locations in Savannah and Atlanta (in the US state of Georgia), Hong Kong, and Lacoste, France. Its School of Film, Digital Media and Performing Arts offers degrees in Animation, Interactive Design Game Development, TV and Film Production and Visual Effects amongst other subjects. During their degree, students work with high-end digital tools, learn from faculty members who are practitioners as well as mentors, and have opportunities to collaborate with each other in a way that reflects the real-world experience of film and digital entertainment production. The Visual Effects programme builds on a traditional fine arts foundation by providing its students with programming and technical skills, including the use of software applications such as Nuke, RenderMan and Houdini. Students can put into practice what they learn in an industry-standard digital production with two green-screen stages and a motion capture studio. Each year, the College organises the SCADDY Award where a panel of industry professionals review student submissions in several areas (including animation). The winning projects then enter into the ADDY® Awards, the advertising industry's professional award competition

http://www.scad.edu/

Video games and visual effects companies recruiting general STEM graduates are competing with other sectors

As we have shown above, both video games and visual effects companies recruit graduates from general STEM degrees. This is not surprising, given existing concerns about the poor quality of most specialist video games and visual effects courses, and the advanced needs of their industries.

But doing this means competing with businesses from many other industries that also depend on the analytic and technical skills of STEM graduates. In fact, businesses across the whole economy report difficulties recruiting STEM graduates:[110] 17 per cent of the 694 employers surveyed by CBI in 2010 say that they have faced STEM recruiting difficulties at the graduate level (the percentage goes up to 39 per cent in the case of science/high-tech/IT companies) – and these skills shortages are expected to get worse in the coming years.[111]

There is the risk that ever-increasing competition for highly sought-after STEM graduates may intensify difficulties in filling vacancies and push the average salaries of the video games and visual effects sectors further, hindering their ability to compete against other countries where production is subsidised, labour is cheaper, and/or the STEM talent pool is larger.

The UK's further and vocational education institutions supply little talent directly into the video games and visual effects industries

Video games specialist FE colleges produce a significant number of graduates

To complement our skills audit of specialist university courses for the video games and visual effects industries, we also collected data on the supply of skills from further education, identifying 42 FE colleges that we estimate produced around 400 graduates in 2008-2009, predominantly from video games courses (Table 16).[112]

Analysis of course curricula reveals a striking degree of uniformity, with courses providing an introduction to a wide number of somewhat disparate areas in video games development (including animation, video games development, video games design, web, digital sound and critical approaches to media production amongst others). Perhaps unsurprisingly given their

Lego Harry Potter: Years 1–4 copyright Warner Bros. Interactive Entertainment

Table 15: Employment rates of video games and visual effects specialist graduates in other parts of the economy

Sector	Employment rate
Wholesale and retail	11.2%
IT & Digital	6.7%
Education	3.9%
Arts, Entertainment and Recreation	3.7%
Accommodation and Food Service Activities	3.5%
Professional, Scientific and Technical Activities	2.8%
Manufacturing	1.7%
Administrative and Support Service Activities	1.6%
Financial and Insurance Activities	1.6%
Human Health and Social Work Activities	1.2%

Source: HESA.

more vocational focus, FE colleges are however more likely to offer hands-on technology teaching than universities: 65 per cent provide training with AutoDesk Maya or 3D Max, and a over a third teach Flash.

But it is not clear how many of these end up working in the industry

The results of our talent survey suggest that only a very small proportion of the video games workforce goes direct from FE into employment in both the video games and visual effects industries. Only 4 per cent

Table 16: Audit of FE Courses

Number of courses	Enrolled students 2008-2009 (n=31)	Graduated 2008-2009 (estimate) (n=29)	Teach maths (n=37)	Teach C++ (n=35)	Teach Flash (n=35)	Teach Maya/ 3DMax (n=35)
42	808	400	13%	17%	37%	65%

Source: Data Services.

of respondents working in the video games industry and 8 per cent in the visual effects industry had FE as their highest qualification (though this does not include those who go on to use their FE qualification as a stepping stone to HE). In the case of visual effects, only 31 per cent of the respondents who report FE as their highest qualification have studied in UK institutions (the rest coming from overseas colleges).

The same is true of those who identified their highest qualifications as vocational qualifications, including apprenticeships. Only 2 per cent of those currently working in video games and 3 per cent in visual effects arrived directly through a vocational education route. This is also echoed in our employer surveys, where only 14 per cent of video games companies and 21 per cent working in visual effects had offered any apprenticeships in the 12 months prior to being interviewed.

Our talent survey shows that FE courses fail to equip students with important skills for the video games industry

Our consultations with industry suggest that video games and visual effects companies do not see FE as a significant source of talent: we heard that employers consider most of these courses as too basic and too general to equip students with the skills they need to get a job in these industries. Our analysis of the talent survey results for video games (where we have just enough respondents whose highest qualification was from a UK FE college to carry out a descriptive analysis) are consistent with this view (Table 17).

Only a quarter of those who had studied at an FE college (compared with just under half of university graduates) report that their course was strong or very strong at providing them with the sort of technical skills that video games companies look for in job applicants. The differences between FE colleges and universities are also visible (although less notable) in the provision of hands-on teaching with software applications and programming languages, and expertise with platforms (where, as we have already shown, universities also leave much to be desired). Both types of institution were perceived by their students as providing them with a poor understanding of production pipelines in the industry. A stark outcome of all of this is that almost half of those who had studied at an FE college responding to our talent survey say that they now know that their course lacked industry-relevant skills (compared with 35 per cent of university graduates).

FE does nevertheless play a role in the education ecosystem for the video games and visual effects industries, by feeding able students into universities

Over 50 per cent of those individuals completing our video games talent survey whose highest qualification was from an FE college said that when they chose to do their course they saw it as a pathway into the video games sector. This may raise potentially serious questions about how realistic are students' expectations of career prospects in the industries, given the low proportion of the workforce in our talent survey with FE as their highest qualification.

Yet, at the same time, FE courses may be an important stepping stone for students with the right talent who for whatever reason choose not to go straight to university from school. Consistent with this, of the 6.8 per cent of our video games talent survey sample in full-time education, 15 per cent listed FE as their highest qualification to date (unfortunately there were too few respondents in full-time education in the visual effects survey to give an equivalent number).

Separately, our analysis of the highest qualification on entrance to HE specialist courses in our skills audit confirms this view: we have identified as many as 1,355 people currently enrolled in specialist university video games and visual effects courses who entered university after having completed a course at a FE college.

Table 17: HE and FE Provision of skills for the video games industry

	Studied at university (n=688)		Studied at FE (n=45)	
	Strong	Weak	Strong	Weak
Technical skills	26%	38%	49%	34%
Software and programming skills	29%	34%	41%	39%
Experience with platforms	20%	49%	18%	37%
Understanding of production pipelines	29%	60%	23%	57%

Source: Video games talent survey, 2010.

Almost three times

How much more likely are graduates from Skillset accredited games courses to find a job in the video games industry within 6 months of graduating compared to non-accredited graduates

Our vision, and how to achieve it

Our vision for higher, further and vocational education is one where:

- **Video games and visual effects companies in the UK have a choice of talented graduates from specialist university courses who come armed with both specialist skills, such as use of relevant programming languages, and technical knowledge, such as maths and art, that the industry needs.**
- **Video games and visual effects companies in the UK attract the highest-qualified graduates from general university courses such as computer science, maths and physics who have the ability to adapt their technical skills to the needs of the industry.**
- **Talented individuals who want to pursue careers in these industries have access to the information they need to choose suitable courses, in both FE colleges and universities.**
- **All university students on specialist video games and visual effects courses have practical knowledge of the way things work in industry, acquired through workplace simulation and the opportunity to participate in competitions supported by industry, or in the case of the brightest talent, internships and work placements.**
- **Universities and FE colleges work in partnership to ensure that FE colleges provide students who have an interest in the video games and visual effects industry with a strong knowledge base that they can develop further at university.**

A number of things need to change to realise this vision

We should begin by acknowledging that the UK already boasts an elite of universities providing specialist talent that has what it takes to succeed in the video games and visual effects industries.

Skillset-accreditation

In 2006, Skillset launched its industry-accreditation programme for video games programming and games art courses.[113] This was motivated by the rapid increase there had been in the number of video games-related courses being delivered by universities in the UK, and employer concerns about the quality of the graduates they were producing.

Accredited courses must strictly comply with industry standards. In the case of programming courses, they must include maths, computer programming, compilation, optimisation, and algorithm development. In the case of games art, they must include compliance with industry standards on observational drawing, visual invention and visual communication, 2D digital art, CGI 3D modelling, texturing, rendering and lighting.

There are currently nine Skillset-accredited games programming and games art courses, of which six are at undergraduate and three at postgraduate level, provided by seven universities.[114] Twenty-two courses in total have been formally assessed. While Skillset's accreditation scheme aims to serve as an industry kitemark, a good deal of Skillset's accreditation resources also go towards working with the non-accredited sector, assisting in modifying curricula and course delivery to help courses raise their standards and move in line with industry needs. In 2008-2009, the nine Skillset-accredited video games courses

53%

Proportion of NCCA graduates who find a job in visual effects or video games within six months of graduation

between them produced 245 graduates (15 per cent of all those qualifying from video games specialist courses in our skills audit that year), with a further 820 still studying on them.

Skillset has begun working with the large visual effects employers in recent months to design accreditation pathways for visual effects courses too, though there are challenges associated with the rapid pace of technological change that mean that courses lag behind actual processes that are going on within visual effects businesses. Accreditation procedures will need to be responsive to the fast-changing needs of industry, and one way this can be achieved is by breaking down VFX into series of modules, such as foundation in visual effects compositing, visual effects paint, restoration and rig removal, which can be accredited as course modules. Courses seeking accreditation can then pull together a series of these modules to establish the goals for particular parts of the course. Skillset has this process in hand already, which has been welcomed by industry.

Skillset is organised around 11 creative media sectors, and engages with visual effects across three of these: Facilities, Film and Animation. To more effectively engage with industry it is recommended that Skillset organises itself around a visual effects focus. This rationalised process of engagement will improve the feedback that industry can give Skillset and create the environment to review the modules annually and ensure they stay relevant.

Does accreditation work?

Our analysis of HESA's Student Destination Survey shows that the employment prospects of graduates from Skillset-accredited courses are rosier than those of people coming from non-accredited courses:[115] 27 per cent of those graduating from the nine Skillset-accredited video games courses gained employment in the video games industry within six months of graduating, almost three times more than the 10 per cent of those graduating from non-accredited courses.[116]

This more impressive employment performance of accredited courses might reflect the fact that students on these courses are brighter than those on non-accredited courses. Certainly, Skillset courses require an average UCAS tariff of 260 points from applicants (the average on non-accredited courses is 226). And the actual grades of students on accredited courses reveal a greater proportion of the highest-qualified candidates: in 2008-2009, 8 per cent of those studying on Skillset-accredited courses had a UCAS tariff of 401 or higher (the equivalent of two A*s and one A-grade at A-Level), compared with only 1.7% of those studying on non-accredited courses.

To investigate this, we built a simple econometric model that estimates the difference in near-term industry employment performance between Skillset-accredited courses and other courses, controlling for the 'ability' of students as proxied by their pre-university qualifications.[117] We found that those graduating from Skillset-accredited courses are significantly more likely to have found employment in the industry within six months, *even controlling for ability*. Box 9 describes video games education at Abertay University, illustrating why Skillset-accredited courses succeed at producing candidates of the right calibre for the video games industry.

Excellence in visual effects education: The National Centre for Computer Animation at Bournemouth

In 2008-2009, the National Centre for Computer Animation (NCCA) at Bournemouth University provided two courses comprising 8 per cent of all those who qualified from visual effects courses that year in our skills audit. Our analysis of the Student Destination Survey shows that, within six months of graduating,

The Chronicles of Narnia; Voyage of the Dawn Treader: Image Courtesy of Twentieth Century Fox/Walden/Framestore

Box 9. Video games education at Abertay University

Abertay University was, in 1997, the first university in the world to establish a specialist course for the video games industry. Since then, it has remained at the forefront of specialist video games education, presently offering three of the nine UK courses accredited by Skillset. It also hosts the UK Centre for Excellence in Computer Games education, and offers undergraduate degrees in Computer Games Programming and Arts, and a Masters qualification in Computer Games Programming and Professional Practice. The demanding courses provided by Abertay teach their students advanced skills in digital design and programming, underpinned by a solid foundation in academic disciplines such as maths and physics.

The university has also pioneered research that demonstrates how video games technologies can be used as a generic innovation tool. Examples include visualisation and simulation tools for police firearms training, infection control models for the health service, cancer therapy treatment pathway modelling and integrated town planning and sustainability models for local authorities.

Abertay University organises the celebrated Dare to be Digital Competition and operates a UK-wide prototype grant funding service for SME games developers.

42 per cent of those for which we have destination data were in the film and visual effects industries, and a further 11 per cent were in video games. By contrast, only 12.5 per cent of graduates from all other courses had joined the visual effects or film industries over the same six-month period. In fact, almost half of all graduates from specialist VFX courses who gained employment in the industry according to the Student Destination Survey had in fact graduated from Bournemouth University. Box 10 describes some of the practices that have put the NCCA at the forefront of education for the visual effects and animation industries.

Recommendation 11: Develop kitemarking schemes, building on Skillset accreditation, which allow the best specialist HE courses to differentiate themselves from less industry-relevant courses

The radical reforms to university funding set out in Lord Browne's report[118] rest on fee-paying students being able to make informed decisions on which courses are more or less likely to help them find employment. Courses not providing industry-relevant skills should struggle to attract students and dwindle over time, and as such Lord Browne's reforms are to be welcomed. However, in a noisy market, where there are many more specialist courses than the industry can support, effective industry kitemarking can play an important signalling role to students, helping to ensure that the most industry-relevant courses continue to attract students and that young people applying to less industry-relevant courses are at least aware that their employment prospects from doing so are weak. We call Skillset to focus its industry accreditation as a kitemark for excellent courses – judged by their

industry relevance – and less as a tool for raising the standards of video games in higher education provision. The latter is what the market in university funding proposed by Lord Browne should, at least in the long run, achieve.

A long-standing criticism of university structures is that they are not conducive to the multidisciplinary working methods that characterise industries like video games and visual effects. We hope that as universities reconsider their financial models following the Browne reforms, they will also review the barriers that they place in front of cross-faculty collaborations. Through the consultation, we have come across many examples of enthusiastic course leaders who are dedicated to teaching their students industry-relevant skills, but who confront closed doors when trying to break down faculty walls that simply do not reflect what happens in industry. Universities UK (2010)[119] gives a number of examples of how inventive course leaders are grappling with these challenges. Box 10 discusses a shining example – Bournemouth University – which supplies talent to both the video games and visual effects industries.

Industry and universities need to find ways to work more effectively together. The principal challenge to industry is the time it takes. Skillset divides engagement with industry across eleven sectors. This vertical striping presents challenges in targeting skills that sit in horizontal stripes across a number of sectors. Visual effects are one such skill, sitting across three of its sectors – film, facilities, animation. Skillset's recent initiative with UK Screen to target visual effects is hugely welcome. It will allow industry to give joined up thinking in an efficient manner to universities.

Recommendation 12: HEFCE should include industry-accredited specialist courses in their list of 'Strategically Important and Vulnerable' subjects that merit targeted funding. Industry must in turn demonstrate its commitment to these courses through industrial scholarships and support for CPD for lecturers

The government has already announced that there will be significantly less funding routed to institutions as grants to universities, and that increased tuition income routed through students will substitute for this.[120] Part of our case for treating industry-accredited specialist video games and visual effects courses as 'Strategically Important and Vulnerable' ones which still merit some public support in the future rests on

Box 10. The National Centre for Computer Animation (NCCA) at Bournemouth

The National Centre for Computer Animation at the University of Bournemouth, founded in 1989, is a global leader in education and research in computer animation and visualisation. Fifty-five of its graduates were involved in the production of the visual effects for Avatar, the highest grossing film of all time. But what is it that makes its courses so successful at producing the kind of graduates that the visual effects (and indeed video games) industry wants?

For a start, NCCA animation courses combine a strong foundation in fine arts and technical skills (including computer programming and applied maths), with hands-on training using the latest software packages. Their aim is to turn applicants with A-levels in both creative and STEM subjects into 'technophile' artists with a real understanding of production processes. As part of their course, students are involved on experimental/research work where creative or technical failure (for instance because of an excess of ambition) is not penalised. They also have access to a 24-hour computer lab designed to foster collaboration between them. Senior students mentor those in years below through a 'peer-assisted-learning' scheme.

An Industrial Advisory Board including leading companies such as Double Negative, Framestore, Lionhead and Dreamworks provides feedback for the development of the Centre's programmes. Practitioners also visit frequently, and give students insights about what working in the industry is actually like.

Every year, the NCCA invites industry to a screening room in Soho where it showcases the work of its students, often leading to job interview opportunities for graduates. According to a recent study, around half of its graduates end up as Technical Directors in the visual effects and animation industries, and the other half as Technical Artists in video games (Comninos *et al.* (2010)).

The NCCA is also the highest-rated research centre in Computer Animation in the UK, having been awarded a top score in the Research Assessment Exercise of 2008.

Sources: Comninos, P., McLoughlin, L. and Anderson, E.F. (2010) Educating technophile artists and artophile technologists: A successful experiment in higher education. 'Computer and Graphics.' 34 (6).

48%

The percentage of graduates working in the video games industry who have STEM degrees

the strategic importance of video games and visual effects as growth industries that combine STEM and creative expertise. But part rests on our view that they are vulnerable, at least in the transitional period when the Government's reforms to university funding are being implemented. The very large number of specialist courses available, combined with the fact that prospective students have such low levels of industry and course awareness, means that we should expect the market in university course funding, at least in the short term, to fail. Targeted support from HEFCE would give a valuable boost to industry-accredited courses producing talent with the skills to fuel growth in two of the UK's world-leading industries.

The larger employers in return should demonstrate their commitment to these elite courses by offering industry scholarships to the most able students. This might take the shape of competitive scholarships offering to pay the final year of course fees for the most able students, access to other industry support such as online or in-person mentoring[121] from industry professionals and industry internships. Alternatively, industry and universities may wish to build scholarships around industrial placement for the most able students on undergraduate programmes. Even a small number of scholarships at these accredited courses could provide a strong incentive for the most able young people to apply to study on these courses, and would send a powerful signal to government that the industry is serious about investing in higher education.

If universities are to produce graduates able to hit the ground running in video games and visual effects companies, it is important that lecturers themselves are up to speed with the latest industrial developments. To achieve this, video games and visual effects companies should actively participate in the Continuous Professional Development (CPD) of lecturers on the best courses. One way this can be achieved is through short secondments where university personnel spend some time embedded in video games and visual effects companies, learning about their techniques and production processes. Another is through one-to-one mentoring by industry professionals.

This will require universities, for their part, to give their accredited tutors more individual autonomy and freedom to change their courses in light of changing industry needs. They need to be given dispensation within staff development time, greater opportunities for sabbaticals and allowed more flexibility when bringing in industry speakers (in our consultation we came across examples of industry practitioners who wanted to share more of their experience, but who had faced bureaucratic barriers).

In all of this, it is important to ensure that the recommendations we make for English universities do not introduce policy discontinuity vis-à-vis universities in Scotland, Wales and Northern Ireland. Talent movement, industry interactions with academia and UK inward investment opportunities do not respect such demarcation. This will require associated actions to be undertaken in parallel in these Devolved National Administrations to ensure parity.

Recommendation 13: Raise awareness of the video games and visual effects industries in the eyes of STEM and arts graduates

The video games and visual effects industries should work closely with established and well-connected institutions, including the Institute of Physics, the British Computer Society and the Royal Academy of Engineering to increase their visibility as a career choice for STEM and art graduates, as well as people with the sort of business skills that both sectors need

to continue growing. They should also engage with the STEM HE Programme at the University of Birmingham, which works with universities and encourages them to explore new approaches to recruit more students from STEM subjects in universities (with a specific focus on widening participation within maths, physics, chemistry and engineering).

HE STEM courses and industry stand to gain much from this collaboration: highlighting the applications of hard STEM knowledge in exciting areas such as video games and visual effects is bound to increase the attractiveness of these disciplines for prospective applicants, while at the same time raising the profile of these industries in the eyes of STEM students. Raising awareness of the pivotal role played by computer scientists in the video games and visual effects industry can also, perhaps, help to address the decline in the numbers of people enrolling in computer science degree courses.

Competitive challenges are one way that video games and visual effects industries can raise awareness of opportunities in their industries for STEM and art graduates. Employers might, for example, set technical video games/visual effects-related problems they are currently grappling with and offer small in-kind prizes for the most impressive solutions by STEM and art students. Microsoft's Imagine Cup, which considers the use of technology to solve social problems, is an inspirational model in this regard: starting in 2004 with just 1,000 student competitors, the challenge involved 325,000 registered students in 2010.[122] Empirical evidence suggests that problem solvers, even if not trained in the specialist discipline in which the problem is situated, are enthusiastic about participating in such technical challenges.[123]

Recommendation 14: Give prospective university applicants access to meaningful information about employment prospects for different courses

The forthcoming changes to university funding more than ever require students to have access to the right information when they opt for a course, including information on course content and methods of assessment, the quality of facilities and the employment prospects of graduates. Lord Browne recommends that all applicants should have ready access to information about the proportion of students in employment and their average salary in the first year after completing the course. On November 2010, HEFCE, Universities UK and GuildHE launched a consultation on what information ('Key Information Sets') should be made available to prospective students, how this information should be collected and where it needs to be made available.[124]

In the case of specialist video games and visual effects courses that are intended to supply talent to these particular industries, there is a case for employment destination information to be made available at a more fine-grained level of detail than it is currently being considered in the HEFCE consultation. Skillset and industry should explore with HESA, HEFCE and e-skills UK the feasibility of producing yearly 'video games' and 'visual effects' league tables that rank courses by the record of their graduates in getting jobs specifically in video games and visual effects companies. Importantly, these league tables should include general STEM and art courses as well as specialist courses. Skillset's current sole focus in its work on specialist courses risks distorting the HE market insofar as it under-emphasises to students the importance of high-quality general courses like computer science and fine art for many employers.

This detailed information should be made available beyond university websites and the UCAS and UniStats portal – online portals with career guidance for the video games and visual effects industries such as those that we propose in Recommendation 10 should have prominent links to this information. Industry also has an important role to play in directing young people to those courses which are best in producing industry relevant graduates. Video games and visual effects companies should follow the example of Blitz Games, whose Blitz Academy website provides information about the skills required to secure a job in the industry, by setting up education sections in their websites with similar information. At the very least, those video games and visual effects companies recruiting from education should link to the video games and visual effects league tables that we are calling for.

The video games and visual effects industries should also develop relationships with the main networks of careers professionals, such as the Institute of Career Guidance, which has a specific community of practitioners who specialise in guidance issues as they relate to entry into higher education and the graduate implications of these choices.

Recommendation 15: Skillset should work with the UK Centre for Excellence in Computer Games Education at Abertay University to develop a template for introducing credit bearing workplace simulation into other specialist video games and visual effects courses in the UK, based on the successful Dare to be Digital competition

F1 2010 copyright Codemasters Software Co Ltd.

Abertay University has, over the last ten years through its Dare to be Digital competition, become a world-leader in the application of workplace simulation approaches to video games education (Box 11).

Skillset should work with Abertay University to develop a template for workplace simulation that can be adopted by other universities. It should draw on other interesting examples of workplace simulation such as Hyper Island in Stockholm,[125] Gamer Camp in Birmingham City University[126] and the National Academy for Digital Interactive Entertainment in Denmark.[127]

As an example of best practice in giving consistent and, importantly, academically-accredited simulated workplace experiences to multidisciplinary student teams, universities should also consider ways to bring students from different accredited courses together to exploit economies of scale in delivering workplace simulations, strengthening the case for HEFCE priority funding for these courses.

Box 11. Workplace simulation

In workplace simulation, students deploy the skills that they have learned in the classroom in real-life campus-based projects where they collaborate with practitioners from different disciplines to deliver a finished product. This helps them to understand the way industry works, and to develop their team-working and problem-solving skills. It also provides a consistent learning experience for individual cohorts of students, compared to the variability of internships and placements.

Abertay University pioneered the workplace simulation approach in video games through its Dare to be Digital competition, which brings to Dundee teams of students from different disciplines. There, they spend nine weeks turning a promising idea for a video game into a working prototype with industry mentorship. These prototypes are then showcased at an event where the general public and industry vote for their favourites. The three highest-scoring teams win a £2,500 prize, and also compete for the 'Ones to Watch' award at the video games BAFTAs.

Abertay has built on the workplace simulation experience from Dare to be Digital to develop its Master of Professional Practice, currently offered at the Centre for Excellence in Computer Games Education. Students enrolled in the course work on practical projects and are mentored by industry professionals with projects presented routinely to industry audiences for evaluation.

In workplace simulation, students deploy the skills that they have learned in the classroom in real-life projects where they collaborate with people from different disciplines to deliver a finished product. This helps them to understand the way industry works, and to develop their team-working and problem-solving skills.

Guinness 'Surfer':
Image courtesy of AMV BBDO/Academy Productions/Framestore

Recommendation 16: Leading universities and FE colleges providing creative education should work together to sponsor a high-tech creative industries University Technical College (UTC), with clear progressions routes into HE

UTCs are specialist schools for the 14-19 group bringing together academic subjects with specialist vocational areas. Their aim is to provide teaching in essential subjects like English and maths, but to also prepare students early for industrial specialisations. The creative-STEM demands of high-tech creative industries like video games and visual effects may be met in a UTC if, for example, a strong fine art training was blended with maths, computer science and physics.

Sponsoring colleges and universities work closely with the local council and relevant employers. For example, the JCB Academy which is up and running is closely aligned with universities like Loughborough and Cambridge and employers like JCB, Rolls-Royce and the National Grid. Industry engagement in the JCB Academy takes the form of input to designing the curriculum, work placements, provision of technology and equipment and by keeping teachers up to date with industry developments. Leading universities and FE colleges should follow the example of the JCB Academy, and work together to sponsor a dedicated UTC for the high-tech, creative industries.

Recommendation 17: Skillset should work with FE and those universities offering industry-accredited courses to kitemark FE courses that offer students the best foundation in skills and knowledge to progress into HE

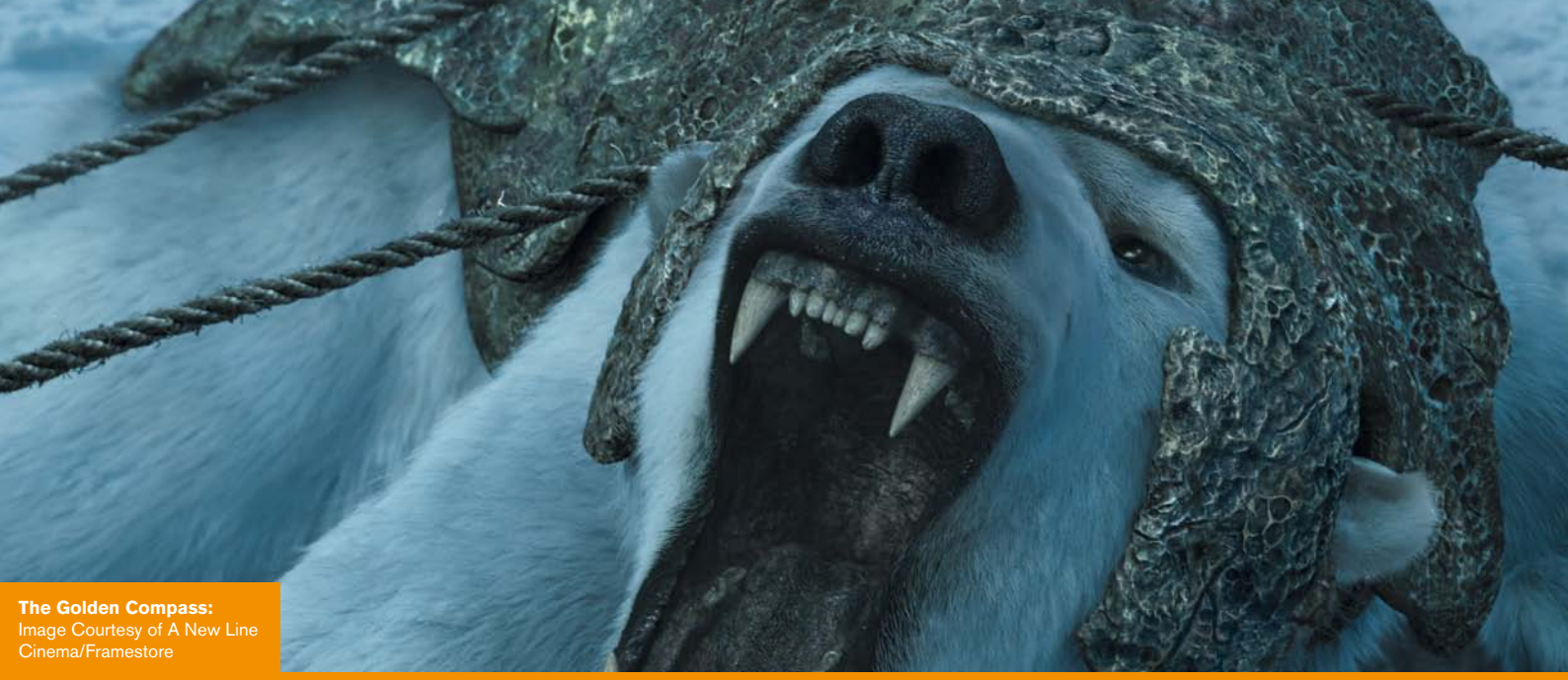
Under the government's *Skills for Sustainable Growth* skills strategy,[128] Sector Skills Councils like Skillset and e-skills UK have no formal role for development of vocational qualifications. Instead, as with universities, a market is envisaged in which market forces will become the ultimate driver of quality and choice. But in losing the formal remit to inform and shape the FE vocational offer, the Sector Skills Councils can still play an important role in helping this market to function better.

The large disconnect between the numbers of students on specialist video games and visual effects FE courses in our skills audit and the low numbers of industry professionals whose highest qualification was FE in our talent surveys, suggests that progression into HE is especially important for able students on FE courses who want to work in the industries. Skillset can play an important role in kitemarking those FE courses that offer students the highest-quality and relevant knowledge bases for progression into HE.

1,355

Students going from FE into video games and VFX specialist university courses

Recommendation 11.	Develop kitemarking schemes, building on Skillset accreditation, which allow the best specialist HE courses to differentiate themselves from less industry-relevant courses.
Recommendation 12.	HEFCE should include industry-accredited specialist courses in their list of 'Strategically Important and Vulnerable' subjects that merit targeted funding. Industry commits to these courses through industrial scholarships and support for CPD for lecturers.
Recommendation 13.	Raise awareness of the video games and visual effects industries in the eyes of STEM and arts graduates.
Recommendation 14.	Give prospective university applicants access to meaningful information about employment prospects for different courses.
Recommendation 15.	Develop a template for introducing workplace simulation into industry-accredited video games and visual effects courses, based on Abertay University's Dare to be Digital competition.
Recommendation 16.	Leading universities and FE colleges sponsor a high-tech creative industries University Technical College (UTC), with clear progression routes into HE.
Recommendation 17.	Kitemark FE courses that offer students the best foundation in skills and knowledge to progress into HE.



The Golden Compass:
Image Courtesy of A New Line Cinema/Framestore

Part 5. The Talent Pipeline: training and continuous professional development

Video games and visual effects are fast-moving industries, where new technologies are being constantly introduced, disrupting markets and business models. This is illustrated by the shift to online gaming in video games and the advent of 3D in film. This means that UK companies will need first-rate training options to keep the technical and business skills of their workforce at the cutting edge.

"The defining characteristic of the video games industry is change. Who would have thought even two years ago that social network games like ***CityVille*** *would have over 100 million monthly active users on Facebook in little over a month after its release? This requires a new breed of talent in the industry: those who combine adaptability with hard computing and art skills. They also need to understand new technology, and new ways of delivering and playing games. But it also places a high premium on exceptional business and project management skills. Today's games developers need to apply their creative thinking to new business models, not just making games. Of course, the video games industry is not alone in this regard. The commercial opportunities afforded by the digital revolution have caused upheaval in all the high-tech creative industries. This has implications for all parts of the education system, but most obviously in continuous professional development. If companies are to upgrade the skills of their workforce they need a wide range of affordable training options. Historically, universities and colleges have not been serious players in this market. They need to reconsider this."*

Ian Livingstone

"Technological innovation and evolution have been fundamental to the growth of the visual effects industry. Maintaining this will be key to the future success of the UK industry in the face of international competition from new entrants. This requires all in the industry to constantly upgrade their skills. Companies largely do this in-house at the moment, as there is a lack of appropriate independent options. There is scope for this to be rectified and options such as online tutorials can be designed to deliver this to the desk of the VFX artist."

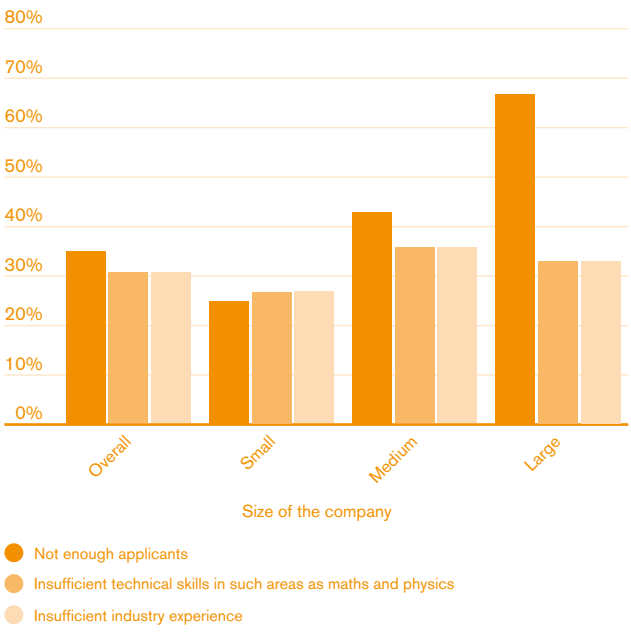
Alex Hope

The challenge

Acute skills shortages are not just confined to positions for people straight out of education: UK video games and visual effects companies are having difficulties recruiting the right personnel at all levels of the business. People with good technical skills, as well as professionals with a mix of technical and art skills, are particularly hard to find. A liquid market in specialist recruitment agencies has arisen to ensure that these industries are able to source the talent they need wherever it is located. Substantial numbers of employers in both industries report that the skills of their workforce need an upgrade, and respondents to our talent surveys agree. These trends are driven by:

- Rapid technological change and new developments in the business (such as the advent of online distribution and mobile gaming in the case of video games and 3D in visual effects) which mean that old skillsets (and even ways of working) need to be overhauled.
- Barriers to accessing the right kind of training including high costs, time constraints and lack of suitable training options. Right now, businesses are not using universities and FE colleges as a source of training and continuous professional development for their staff.
- In the case of video games, cherry picking by overseas companies of senior UK talent. Both video games and visual effects companies recruit skilled personnel from overseas, but the tightening of migration caps is constraining access to international talent.

Figure 11: Reasons why it's difficult to fill vacancies (as a proportion of those who face barriers) by size



Source: Video games employer survey, 2010.

The video games industry: new technologies and business models are creating skills shortages in the labour market, and making it urgent to upgrade the skills of the workforce

A substantial number of video games companies – and particularly the largest ones – have difficulties finding the right personnel

Over a third of all respondents to our video games employer survey report difficulties filling vacancies at all levels of the business, but that percentage climbs steeply for larger companies that employ most of the workforce and are involved in the most technically ambitious projects: two-thirds of those employing between 50 and 99 permanent employees, and almost three-quarters of those with more than 100 employees, find it hard to fill vacancies in their business. The main reasons given for this are a lack of suitable candidates, and the fact that candidates lack the required technical skills and sufficient industry experience (see Figure 11).

Although skills shortages span all disciplines, there are specific problems sourcing technical personnel and people with skills in online and mobile game development

The right computer programmers are particularly hard to come by (mentioned 52 per cent of the times), followed by artists (12.5 per cent), designers (10 per cent) and management personnel (7 per cent). There seem to be particular difficulties in finding programmers and animators with skills in online game development (including expertise with programming languages and platforms such as ActionScript, Java or Flash, as well as server management and network engineering). There are also constraints in the supply of personnel with the right mix of technical and artistic skills (such as technical artists to bridge the gap between computer programmers and artists and animators in studios) and artists proficient in 3D.

Difficulties recruiting are having a negative impact across the UK video games industry

Thirty-one per cent of our respondents say that skills shortages are having a real impact on their business. They include delays and quality issues (mentioned by 13 per cent of respondents), difficulties expanding and loss of business (highlighted by 7 per cent of the total in each case). The situation is starker for larger companies: 35 per cent of the total say that the skills shortages are leading to delays and quality issues, and 17 per cent are recruiting from overseas to fill vacancies.

Grand Theft Auto IV copyright Rockstar Games

Shifts in technology and business models create new skills needs...

The technology and market landscape in the video games industry is being shaken up by the introduction of new gaming platforms and the emergence of novel business models in areas such as online and mobile. Staying on top of these trends requires access to new skill sets (ranging from online video games development using new programming languages to network and server maintenance and business development in online and mobile markets).This is reflected in the trends that employers report as impacting their skills needs. At 29 per cent, new gaming platforms are mentioned most often, followed by 18 per cent who mention new software applications and 15 per cent who refer to developments in hardware (for instance, changes in chip architectures). Seventeen per cent of video games companies with more than 100 employees say that 'changes in distribution methods' will impact on their future skills needs, which illustrates ongoing shifts from traditional distribution via retail to booming online and mobile markets.

...and make a skills upgrade urgent

A third per cent of video games employers report that their workforce needs an upgrade in its skills, which goes up to 65 per cent in the case of larger companies. Forty-six per cent of respondents to our video games talent survey say that they have training needs at the moment. Concerns about skills gaps in the commercial and management side rank highly amongst the workforce – 43 per cent of those with training needs say that they need to upgrade their skills because they will have to manage a team in the future, while 32 per cent highlight the need to develop their commercial skills.

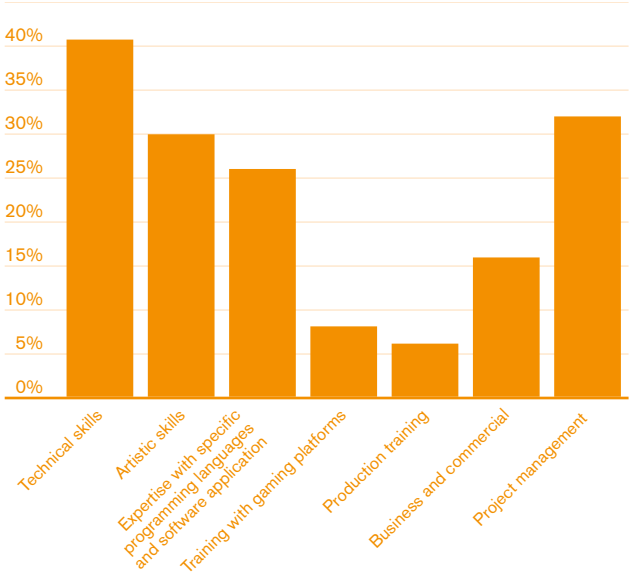
Other business and technology trends are also important. Forty per cent say that their training needs are a consequence of higher levels of competition, while 36 per cent and 33 per cent respectively link them to increasing demand for content on multiple platforms and demand for higher quality content.

It is sobering that two-thirds (67 per cent) point out that they need to learn industry-relevant skills that they didn't acquire in their education.

Training focuses on technical skills and project management

Over half of video games companies responding to our employer survey had provided some form of training to their employees over the previous 12 months. While smaller companies train their staff less often (only a quarter of those with fewer than five employees had done so over the previous 12 months), the percentage goes over 80 per cent for respondents with more than 25 employees.

Figure 12: Areas where training is taking place (as a percentage of those who provide training)



Source: Video games employer survey, 2010.

Video games companies are training their staff in technical skills such as maths, physics and programming, management skills, artistic skills (including animation) and specific programming languages and software packages (Figure 12). Larger companies focus more strongly on technical skills and management, while medium-sized employers (between 25 and 99 employees) provide commercial training more often (almost a quarter of those training their staff report doing so).

There seems to be a deficit of business training in the UK video games sector

We have matched the responses to our employer and talent surveys in order to compare the training being provided by employers with the skills needs identified by the workforce (Figure 13). It appears that while video games companies are staying on top of technology trends in their markets, they are not doing enough to plug gaps in the workforce's commercial and management skills – this is particularly visible in the case of commercial skills, where the proportion of employees highlighting the need to upskill is almost twice the share of employers providing training. It seems that the video games industry is not doing enough to ensure that its workforce has the business skills required to make the most of commercial opportunities in booming gaming markets such as mobile and online.

Training is mostly organised internally, or provided by private firms

Of those video games companies that provide training, half do it internally through mentoring and coaching. A further 37 per cent organise training sessions run by their own staff. Private sector providers play an important role in training – 44 per cent of those companies training their workforce do so through private firms – particularly by sending their staff to external courses. Only 3 per cent and 4 per cent of respondents training their staff respectively use the services of universities or colleges.

Lack of time and high costs are the main barriers to training, and large companies are suffering the most

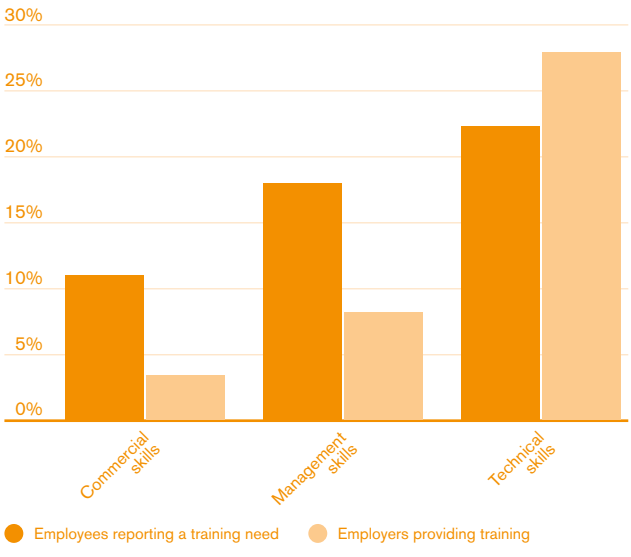
Fifty-one per cent of all respondents to the employer survey report barriers to training, particularly lack of time (21 per cent of all respondents) and price: 15 per cent of businesses complain that courses are too expensive. Larger video games companies claim to suffer higher barriers to training: 82 per cent report having them. As many as half of larger companies say that training is too expensive, and that they have insufficient time to engage with it. A further 17 per cent say that available courses are not well adapted to their needs.

Visual effects: a similar picture

Skills shortages are also prevalent in the visual effects industry

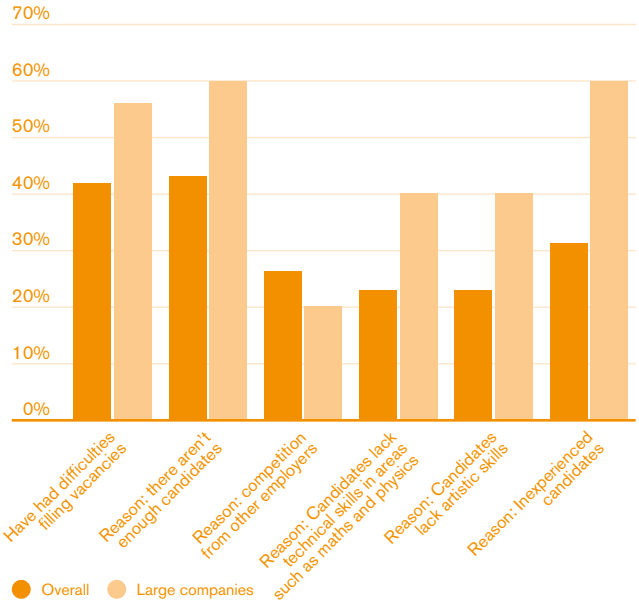
Forty-two per cent of employers (and 56 per cent of those who employ more than 100 permanent employees) report problems filling vacancies at all levels of the business. As Figure 14 shows, the main reason for these difficulties is a lack of suitable

Figure 13: Video games training provision and skills needs in technical and business areas (as a proportion of all employers and employees)



Source: Video games employer and talent surveys, 2010.

Figure 14: Skills shortages in the visual effects labour market, and their reasons



Source: Visual effects employer survey, 2010.

38%

Proportion of visual effects companies who say that difficulties in recruiting are impacting their business

applicants, followed by lack of industry experience and competition from other employers. Nearly half of those facing difficulties filling vacancies point out at deficiencies in candidates' technical (such as maths and physics) or artistic skills. As was the case for video games, larger employers face more severe skills shortages: 60 per cent of companies employing more than 100 permanent employees say that they do not have enough candidates, and a similar proportion point out that those who apply lack sufficient industry experience. They also report concerns about candidates' technical and artistic skills more often.

There are positions that are difficult to fill across many areas of the business

The main positions where businesses are having difficulties recruiting are technical (mentioned 29 per cent of the time). Some of the specific skills singled out as hard to find are related to pipelining, shader-writing, character animation and compositing.

Skills shortages are holding back some visual effects companies

Thirty-eight per cent of visual effects employers say that difficulties recruiting are having a real impact on their business. Fifteen per cent of all respondents say that they have led them to lose business, and a further 15 per cent report that they are leading to quality issues and delays. Larger companies, at 22 per cent, are more likely to say they are losing business because they can't find personnel to take on projects.

Technological change and increasing competition explain existing shortages, and are expected to give rise to new ones

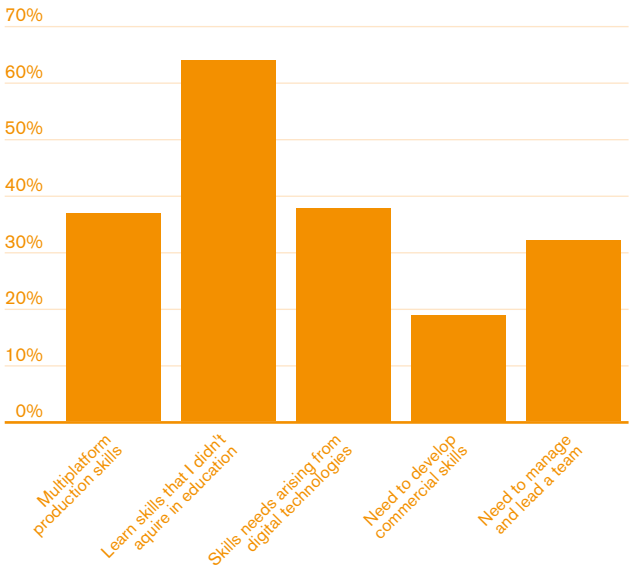
There is a wide range of opinions about the trends that will drive future skills needs in the visual effects industry. Although technology is expected to have the greatest impact (almost a quarter of employers flag up that changes in software will require new skills), some think that shifts in the competitive landscape will also play a role (it is mentioned by 10 per cent of respondents). There is a clear expectation that, as other countries develop their own visual effects industries, competition for the kind of top talent on which UK visual effects companies rely will heat up.

The main skill that visual effects employers anticipate they will find in short supply is 'understanding of 3D stereoscopic work' (17 per cent of all respondents, and 22 per cent of large companies), followed by expertise with new software applications (11 per cent of all respondents, and a third of large companies).

There are skills gaps in technological and management areas

Fifty-nine per cent of all respondents to our talent

Figure 15: Skills needs reported by the visual effects workforce (proportion of those with skill needs)



Source: Visual effects talent survey, 2010.

survey flag up training needs (Figure 15). As with video games, these are often linked to shortcomings in education (64 per cent of all who have training needs say that they need to learn industry-relevant skills that they did not acquire in their education). Almost half (45 per cent) of respondents to our talent survey link their training needs to increasing competition in the labour market, 38 per cent attribute them to the arrival of new digital technologies, and 37 per cent to rising demand for content on multiple platforms/ across multiple media. Although almost a third link their skills needs to managerial responsibilities, the proportion of employees that say they need to develop their commercial skills is small by comparison to video games – this is possibly linked to the relative stability of visual effects value chains and markets.

Visual effects companies are upgrading the skills of their workforce
Almost two-thirds of visual effects companies (and all the large ones) say that they trained their staff over the previous 12 months – a larger proportion than was the case with video games. Training focuses on technical skills in areas such as maths or physics, and artistic skills (around 44 per cent of those providing training do it in these areas), and specific programming languages and software packages (33 per cent). Large companies provide artistic training more often (67 per cent of them do), followed by management and technical skills (56 per cent and 44 per cent respectively).

Although there seem to be some gaps in business skills training
As was the case with video games, we have found that the proportions of employees reporting commercial and management skills needs are higher than the share of firms providing training in those areas (Figure 16). Although the visual effects industry is not experiencing the same sort of disruptive changes in markets and business models that are currently reshaping the video games sector, the relative lack of attention to resolving skills gaps in the commercial area should still be a cause of concern.

Training is organised internally, or provided by private firms, both physically and online
Most visual effects companies provide training internally through mentoring and internal sessions: 56 per cent and 46 per cent of those providing training do it this way. 29 per cent use private firms (either bringing them in-house or sending staff to external courses), and 28 per cent access online training. As was the case with video games, few draw on colleges or universities to train their staff – only 2 per cent report doing so.

Unsurprisingly, a majority (67 per cent) of large employers organise internal training sessions for their staff, and almost half of them provide some form of online training. The visual effects industry relies more on online training than video games. This is possibly linked to the availability of high quality online training providers such as Animation Mentor.

Sixty-five per cent of all visual effects employers report barriers to training. High costs and lack of time, which are mentioned most often overall (26 per cent and 21 per cent respectively) seem to be a particular source of worry for larger firms. Fifty-six per cent of them say that private courses are too expensive, and a further third flag up that they lack time to train their staff.

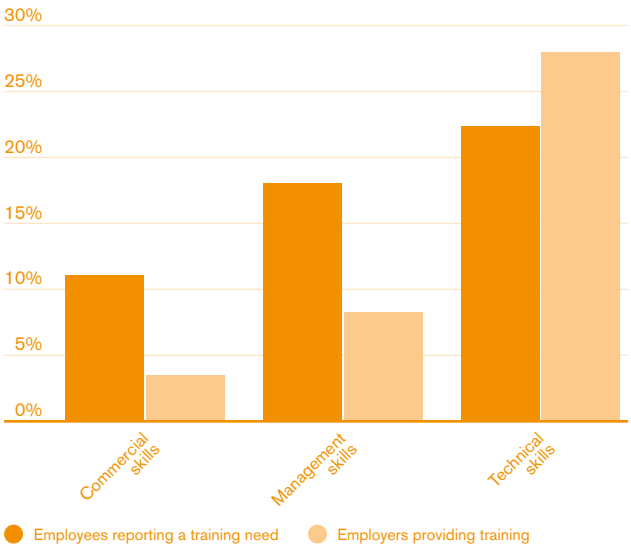
The recruiters' view

In our recruiters and headhunters study we interviewed 15 separate agencies providing specialist services to the video games and visual effects industries.

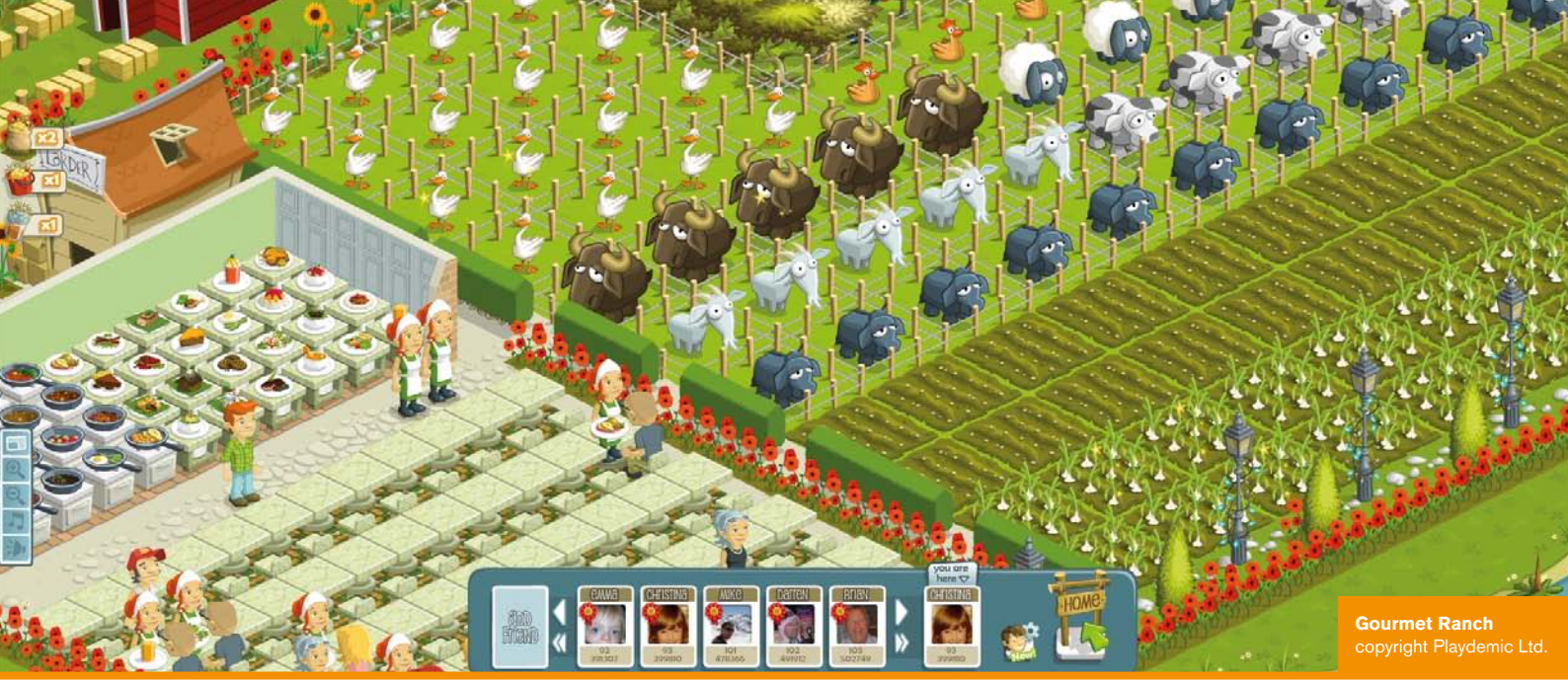
Skills shortages have led to the emergence of a liquid recruitment market
Business in the recruitment services market is brisk because of the skills shortages, particularly in technical positions (where 70 per cent of their placements take place). Demand for computer programmers is on the rise.

There is evidence of a brain drain of senior video games personnel to overseas territories
According to our interviews with recruitment agencies and headhunters, almost one-quarter of UK video games talent placed by recruitment agencies has been to overseas companies. Agencies had over

Figure 16: Visual effects training provision and skills needs in technology and business areas (as a proportion of all employers and employees)



Source: Visual effects employer and talent surveys, 2010.



Gourmet Ranch
copyright Playdemic Ltd.

the previous year placed roughly the same amount of overseas talent into the UK, suggesting that net emigration is a lot smaller. But these numbers mask the 'cherry picking' of the UK's more experienced video games talent. Of the 13 video games recruiters actively involved in making international placements, almost a third highlighted the high skills level of UK candidates as being their big draw.

And confirmation of the importance of high-skilled immigrants to the UK visual effects industry

A third of UK visual effects talent placed by the recruitment agencies we interviewed has been to companies overseas. But agencies place roughly the same number of overseas talent into the UK, confirming the importance of high-skilled immigrants for the visual effects industry.

Our vision, and how to achieve it

Our vision for the wider labour market and training ecosystem for the UK's video games and visual effects industries is one where UK companies have access to a wider range of low-cost, high-quality training options. Universities and FE colleges should play a more substantial role in the continuous professional development of the workforce.

Recommendation 18: Skillset Creative Media Academies and e-skills UK's National Skills Academy for IT to work with industry to develop specialist CPD training for video games and visual effects industries

Universities and FE colleges that are already recognised as world-class centres for expertise in video games and visual effects should be encouraged to develop a programme of specialist CPD for these industries. This could be developed around the existing infrastructure of the best-performing Skillset Creative Media Academies (which include Abertay and Bournemouth Universities) and e-skills UK's National Skills Academy for IT.

Skillset's new Build Your Own MA modular approach is an attractive example. This programme of flexible, credit-bearing short courses combines face-to-face training with online instruction, thus minimising disruption to work. It is delivered by the Academies themselves, accredited in-house schemes or by approved private sector providers. Courses can be taken individually or combined with other courses to add up to a recognised qualification, a postgraduate certificate, a postgraduate diploma or an MA. Importantly, all the Academies recognise each others' credits for their awards, thus enabling learners to benefit from specialisms across the network.

As a cross-creative media programme, Build Your Own MA also has the additional advantage of exposing visual effects and video games professionals to a wider range of cross-platform and cross-media CPD (for example around management) than they otherwise would.

Skillset, e-skills UK and the video games and visual effects industries should look for public support of these elite centres of excellence from the new Growth and Innovation Fund and Regional Growth Funds.

£753 million

Inward foreign investment in UK film production

Recommendation 19: Support better research-oriented university-industry collaborations in video games and visual effects

Our talent and employer surveys have shown the impact of new technology development on the skill needs of the UK video games and visual effects industries. It is clear that both sectors need to build their research and development skills to stay on top of – and shape – technology trends in their markets.

The Knowledge Transfer Partnership (KTP) programme, one of the largest graduate recruitment schemes in Europe, can help video games and visual effects businesses develop their innovation skills.[129] This programme, administered by the Technology Strategy Board (TSB) with funding from 17 bodies (including the TSB and research councils), co-funds an associate (usually a bright graduate) who is placed inside a business to develop a research project with support from academic experts at a university department, and access to funding for training. The business benefits from valuable research outputs and insights, access to wider university resources, and last but not least, the opportunity to hire a smart graduate with a good mix of research skills and understanding of the way their business works – in fact, 53 per cent of associates involved in a KTP between 2009 and 2010 remained with the business after the project finished.[130]

An examination of the archive of past and current KTPs suggests that UK video games and visual effects companies are not making the most of this scheme.[131] The TSB and universities based in video games and visual effects clusters need to do more to raise the visibility of KTPs, and their potential benefits for the two industries.

There are many other good practices that can help to develop better networks between universities and industry. Industrial Advisory Boards such as the one that we described for the National Centre for Computer Animation in Bournemouth is an example. The Professors of Practice programme put in place by the University of Newcastle in 2004 is another. Professors of Practice are typically scientists – entrepreneurs with a foot in academia and another in industry. As part of their role they support the commercialisation of university research outputs, build better relationships between university and industry, and identify and develop research in areas that are relevant for businesses.[132] We encourage universities – particularly those located in video games and visual effects clusters – to explore ways of creating 'revolving doors' between university and industry that support stronger relationships between them, leading to the effective exploitation of their knowledge base by innovative video games and visual effects companies.

Recommendation 20: It is essential that the 18 visual effects occupations on the Government's shortages list continue to be treated as shortage occupations in the points-based system and that the industry's need for well-paid, highly academically qualified personnel continues to be recognised

Total film production activity in the UK in 2009 was £957 million, £753 million of which came from inward foreign investment.[133] As a global centre of excellence, the UK's visual effects industry is a key draw for this investment. There would be a direct knock-on effect on the UK visual effects industry's ability to compete successfully for such lucrative international projects if the number of migrant workers is significantly reduced, non-EEA workers having typically accounted for 10-15

Evian, 'Skating Babies': Image Courtesy of BETC/MPC

per cent of the industry's overall headcount.[134]

The labour market for visual effects is global and talent highly mobile. Overseas companies have access to our talent and it is important that UK businesses have their pick of the best global talent too.

In November 2010, the Government announced that from April 2011 it will impose annual limits for those coming into the UK under the skilled and highly skilled routes of the points-based system. It is essential that the 18 visual effects occupations on the shortages list continue to be treated as shortage occupations and that the need for highly academically qualified personnel is recognised. The impact of the annual limits on high-tech industries with acute skills shortages such as visual effects should be monitored carefully and addressed quickly if damage is being done.

Recommendation 18.	Skillset Creative Media Academies and e-skills UK's National Skills Academy for IT to work with industry to develop specialist CPD training for video games and visual effects industries.
Recommendation 19.	Support better research-oriented university-industry collaborations in video games and visual effects.
Recommendation 20.	Continue to treat the 18 visual effects occupations on the Government's shortages list as shortage occupations.

Inception © Warner Bros. Entertainment Inc. and Legendary Pictures. All Rights Reserved./Double Negative

Conclusions. Effecting change

This part concludes the Review and highlights how the video games and visual effects industries will need to develop an effective voice to engage with an education system that is becoming increasingly decentralised.

"Progress is all about simplification not complication. In order to be clearly heard, it is important to speak with a single voice. To be taken seriously the video games industry and its trade bodies must be united to raise awareness of the opportunities it offers and the issues it faces. Only then will it be able to effect change. This will only be achieved if there is a single voice representing the interests of the entire industry, both publishers and developers whose historic differences are crumbling with the acceleration of online consumption of interactive entertainment. A single voice will be more effective in its working with government, government agencies, schools and universities, the media and other digital entertainment industries. It will be essential, following the Browne reforms to university funding, that students make informed decisions on which courses will help them find employment. Industry accreditation of courses will be even more important. Skillset will need the full backing of the games industry if it is to evolve their accreditation procedures in the way we recommend. It is also important for industry to engage and collaborate with academia and vice versa for their common benefit, replicating, for example, the success of Abertay University's relationship with local games development studios.

During the course of this Review, I have become aware of the potentially important opportunities that exist for synergies between Skillset, the Sector Skills Council for Creative Media, and e-skills UK, the Sector Skills Council for Business and Information Technology. Both Skills Councils have a common interest in equipping our workforce with the technology skills they need for the high-tech economy, and it is important they exploit opportunities to work together for the interest of industries like video games.

The increasing consumption of online content heralds a second 'Golden Age' of games and a great opportunity for the UK development community. I hope that the recommendations in this report will enable UK content creators to realise that opportunity."

Ian Livingstone

"With its focus on relatively new and fast-changing industries this Review has necessarily been underpinned by a great deal of data collection and original research. But this has all been a means to an end: to inform a programme for change. We want to be clear about who we feel must take ownership for progressing our recommendations.

We've listed those recommendations that call on government to act. We believe these are in line with the latest thinking on education and skills policy, and we have also been acutely sensitive to the state of the public finances when developing them. We've identified those recommendations that fall to educators, industries and skills agencies like Skillset. Fundamental to this is that these different bodies find more effective ways to work together, to put these recommendations and other existing initiatives into practice.

We have seen how at present engagement by the visual effects industry is largely undertaken by individual companies working independently with schools, universities and Skillset. The UK Screen Association, our trade body, can provide a portal for engagement with Skillset and universities to reduce the duplication of effort, give us a louder voice by working collectively, and effect the change we seek. This is however only possible if we as members take the leading role. We cannot sit back and allow others to do it for us. We must step up and contribute."

Alex Hope

New and emerging industries

In this report, we have set out a comprehensive programme of measures, which if implemented will go a long way towards transforming the UK into the world's leading talent hub for the video games and visual effects industries. Our 20 recommendations for policymakers, industry and educators amount to nothing less than a Call for Action to the UK to ensure that two of its most high-tech and fast growing creative industries have access to the skills they need to thrive in the future. In the box which summarises our recommendations we allocate lead responsibilities for actioning these, but responsibility falls on all parties to work together.

Twenty recommendations across the talent pipeline

Schools		**Lead responsibility**
Recommendation 1.	Bring computer science into the National Curriculum as an essential discipline.	Government
Recommendation 2.	Sign up the best teachers to teach computer science through Initial Teacher Training bursaries and 'Golden Hellos'.	Government
Recommendation 3.	Use video games and visual effects at school to draw greater numbers of young people into STEM and computer science.	Schools
Recommendation 4.	Set up a one-stop online repository and community site for teachers for video games and visual effects educational resources.	Skillset
Recommendation 5.	Include art and computer science in the English Baccalaureate.	Government
Recommendation 6.	Encourage art-tech crossover and work-based learning through school clubs.	Schools
Recommendation 7.	Build a network of STEMNET and Teach First video games and visual effects Ambassadors.	Industry
Recommendation 8.	Introduce a new National Video Games Development and Animation Schools Competition.	Industry
Recommendation 9.	Design and implement a Next Generation of Video Games and Visual Effects Talent Careers Strategy.	Industry
Recommendation 10.	Provide online careers-related resources for teachers, careers advisers and young people.	Industry
Universities, Colleges and Vocational education		**Lead responsibility**
Recommendation 11.	Develop kitemarking schemes, building on Skillset accreditation, which allow the best specialist HE courses to differentiate themselves from less industry-relevant courses.	Industry and Skillset
Recommendation 12.	HEFCE should include industry-accredited specialist courses in their list of 'Strategically Important and Vulnerable' subjects that merit targeted funding. Industry commits to these courses through industrial scholarships and support for CPD for lecturers.	HEFCE and Industry
Recommendation 13.	Raise awareness of the video games and visual effects industries in the eyes of STEM and arts graduates.	Industry
Recommendation 14.	Give prospective university applicants access to meaningful information about employment prospects for different courses.	Skillset and Universities

Recommendation 15.	Develop a template for introducing workplace simulation into industry-accredited video games and visual effects courses, based on Abertay University's Dare to be Digital competition.	Skillset and Universities
Recommendation 16.	Leading universities and FE colleges sponsor a high-tech creative industries University Technical College (UTC), with clear progression routes into HE.	Universities and FE colleges
Recommendation 17.	Kitemark FE courses that offer students the best foundation in skills and knowledge to progress into Higher Education.	Skillset and Universities
Training and continuous professional development		
Recommendation 18.	Skillset Creative Media Academies and e-skills UK's National Skills Academy for IT to work with industry to develop specialist CPD training for video games and visual effects industries.	Skillset Creative Media Academies and e-skills UK's National Skills Academy for IT and Industry
Recommendation 19.	Support better research-oriented university-industry collaborations in video games and visual effects.	Technology Strategy Board and Industry
Recommendation 20.	Continue to treat the 18 visual effects occupations on the Government's shortages list as shortage occupations.	Government

But the implications for the UK's economy, and the strength of our case, goes much further than these two industries, however important they may individually be. Our Call for Action should in some ways be seen as a wakeup call to UK policymakers and educators that there are major risks for the UK's high-tech economy more generally if we don't address the bottlenecks we have identified in the talent pipeline for these industries. The urgent need to consider computer science as essential knowledge for young people is a case in point. It is no coincidence that in conducting this Review we have identified strong, natural alliances with the case that venerable bodies like the Institute of Physics and The Royal Academy of Engineering have been making for computing in schools.

And the UK must not ignore the great potential we have to use high-tech, creative technologies like video games and visual effects to address some of our most pressing wider skills challenges, such as the continued shortfall in young people opting for science subjects (including computer science) at school and university and pursuing STEM-related careers.

Greater awareness of the technical needs of the video games and visual effects industries will itself make STEM subjects more attractive for some young people. But there are, for example, a growing number of international studies showing how interactive technologies such as video games can be used, in some cases very significantly, to improve mathematics and physics outcomes in the classroom. Through this Review we have learned of some incredible examples of this happening in UK classrooms. One of our objectives has been to suggest how such best practice cases can be shared and mainstreamed, and some of our recommendations are aimed at addressing just this.

If considered separately, and implemented only in piecemeal fashion, our recommendations will have only limited impact in addressing the skills challenges of these two industries. The consequences for UK plc would be all too clear, as video games and visual effects companies are already seeing the negative impact that skills gaps and shortages have on their business. But if implemented as a coherent and strategic programme of actions, the UK has a real opportunity to turn the tide in these industries.

The next few years are likely to see some of the most radical changes in the way that education at all ages is provided and resourced, at least in England. Decentralisation is a watchword. No longer will the skills challenge for emerging industries simply be to be heard at the top table in Whitehall. An implication is that fast-growing, new industries made up largely of dynamic – yet fragmented – enterprises will need to develop more effective voice mechanisms to communicate directly with educators. As well as being well organised, the industries must identify which networks the industries can tap into, and what are the priority partnerships they must build with other industries and professional bodies. We hope that this Review has made a good start in doing this for the video games and visual effects industries.

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40. See http://boxofficemojo.com/
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45. By contrast to the UK Film Production Tax Credit, which is only available for film productions shot in the UK.
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49. These results are in line with Skillset data reported in Oxford Economics (2010) 'Economic Contribution of the UK Film Industry.' Oxford: Oxford Economics. Available at: http://www.ukfilmcouncil.org.uk/media/pdf/i/r/The_Economic_Impact_of_the_UK_Film_Industry_-_June_2010.pdf.
50. The STEM needs of these industries needs to be seen in a wider context for the UK, with three-quarters of employers more generally valuing the knowledge and techniques that STEM employees bring to the business, yet 59 per cent of employers predicting problems in finding staff with STEM skills over the next years. See CBI (2010) 'Set for Growth.' London: CBI.
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uk/assets/bispartners/foresight/docs/general-publications/10-1252-technology-and-innovation-futures.pdf

52. We interviewed 27 course assessors and heads of department from 22 different education providers, including 19 HE, one FE and two private training providers, as well as seven UK industry experts and nine international experts from leading countries (from Singapore, France, Germany, Sweden and USA). Our interviewees were drawn from those public and private institutions which, according to industry, are currently producing the best graduates. We estimate that the 19 HE institutions we interviewed account for around 30 per cent of all university supply of specialist talent for the video games and visual effects industries.
53. The evidence strongly suggests that decisions to follow careers in Science, Technology, Engineering and Mathematics subjects are largely formed by the age of 14. In one US study even, 65 per cent of graduate students and scientists said their initial interest in science was sparked before the age of 11. See Institution of Mechanical Engineers (2010) 'When STEM? A Question of Age.' London: IMechE.
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67. Those newest to teaching, with five years or less experience, are significantly more likely to agree with this statement (92 per cent) compared with the most experienced teachers with 25 years or more of experience (76 per cent). When considering teachers by subject, however, we find that art teachers are on average less favourable towards video games as a career for young people (around a quarter are negative or indifferent about compared with 14 per cent for the sample overall).
68. Table 3.5 refers to those survey respondents who had completed a degree or higher qualification. Of those with formal qualifications of any sort – 95.8% of the sample in the case of video games – only 4.6% received any guidance from a careers advisor before joining the industry; only 7.5% got information about the industry from a careers fair; and only 2.1% attended a company open day. Only 11% had sought advice from an industry professional.
69. When considering all respondents with formal qualifications in our visual effects talent survey (93.7% of all respondents), the results are similar – only 7.8% received any guidance from a careers advisor before joining the industry; 9.5% got information about the industry from a careers fair; and only 4.9% attended a company open day. 20.3% had sought advice from an industry professional.
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77. See www.gcsecomputing.org.uk
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93. As part of its internal reporting procedure, e-skills UK collects annual survey data on its CC4G program. In 2009/2010, 80 per cent of the 10-14 year old CC4G students surveyed indicated they were more likely to consider further education in IT which may help them secure a job in IT in the future.
94. STEM Careers Review, Sir John Holman and Peter Finegold: Report to the Gatsby Charitable Foundation, 2010.
95. We are aware of a further 58 courses that we could not collect data for. This is because in some cases course descriptions in prospectuses did not match HESA descriptions; there is also the possibility that some of these courses had been introduced after 2008/2009, which means there would have been no HESA data for them.
96. Graduation numbers were not available for nine courses.
97. To give this some context, Skillset's 'Skills Supply Study' of courses supplying graduates with skills which it judges are relevant for creative media sectors estimates that, in 2009, there were as many as 90,000+ graduates in the UK from courses providing skills which are relevant for the video games sector (for instance, this includes all graduates from Computer Science courses in the UK). See Skillset (2010) 'Mapping Creative and Media Relevant Education and Training Provision in FE, HE, and the Private Sector in the UK.' London: Skillset.
98. This estimate is based on the talent survey: it is calculated by scaling the number of people joining the industry straight from education over a year to estimates of the total workforce taken from TIGA (2010) 'State of the UK Game Development Sector 2010.' London: TIGA. No attempt is made to estimate the demand for mid-career hires.
99. The Student Destination Survey establishes the industry where a respondent works using Standard Industrial Classification codes. We have used two codes (Computer Programming and Publishing of Video Games) to create a video games category. Although Computer Programming includes wider software development activities, not just video games development, this is the best proxy we have.
100. A note of caution is necessary in the interpretation of these findings, as it is conceivable that courses may provide technology training to their students without announcing such activities in their prospectuses. We might nevertheless expect courses to be at pains to signal that they provide industry-relevant skills to prospective applicants.
101. Subject information could not be located for eight courses and hence this percentage is based on a sample of n =134 from a total of 142 courses.
102. We are aware of a further ten specialist visual effects courses that industry possibly recruits from, but 2008/2009 data for these courses were not available.
103. Graduation information was not available for five courses.
104. Current enrolment numbers were not available for four courses.
105. Again, to give this some context, Skillset's study of Skills Supply for Creative Media (which considers all university courses providing skills which are relevant to gain employment in specific creative media sectors) suggests that in 2009, UK universities produced as many as 169,000 graduates with skills that were relevant for the visual effects sector. See Skillset (2010) 'Mapping Creative and Media Relevant Education and Training Provision in FE, HE, and the Private Sector in the UK.' London: Skillset.
106. We have produced this estimate by taking the number of people joining the UK visual effects industry straight out of education in 2010 in our talent survey, and scaling up to the total of the workforce. See UK Screen (2010) 'The UK Facilities Sector.' London: UK Screen.
107. We have defined the relevant destination sector ('audio visual production and visual effects') as comprising the SIC codes 5912 (Motion picture, video and television programme post-production activities), 5900 (Motion picture, video and television programme production, sound recording and music publishing activities), 5910 (Motion picture, video and television programme activities), 5911 (Motion picture, video and television programme production activities), and 5914 (Motion picture projection activities).
108. Career destinations survey information was not available for four of the courses analysed.
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112. Collecting data on the skills supply from specialist FE courses is much more difficult than for HE. In particular, the Data Service, which administers all nationally collected statistics for Further Education, does not collect information at the level of course granularity we require. Building a specialist course database for video games and visual effects courses at FE to match our HE audit would have entailed collecting all the data from individual course leaders – not feasible within our timeframes. Instead, we collected basic course information directly from a sample of FE colleges available through UCAS (where courses are delivered in conjunction with an HEI) and supplied to us by Skillset and industry.
113. In response to demand from industry, Skillset has recently developed a new accreditation system in Games Design at Postgraduate level.
114. They are: the BA in Game Art Design at De Montfort University; MSc in Games Software Development at Sheffield Hallam University; BSc in Computer Games Programming at Teesside University; BA in Computer Arts, BSc in Computer Games Development and MSc in Computer Games Technology (all offered by the University of Abertay, Dundee); BA in Computer Animation in the University of Glamorgan; MSc in Games Programming at the University of Hull; and BSc in Computer Games Technology at the University of West of Scotland.
115. For three of the nine Skillset-accredited courses, there are no Graduate Destinations data from HESA; for these courses we contacted course leaders directly and asked them to provide the short-term (six-month) employment destinations of their graduates by SIC code.
116. There are two main reasons why this percentage is smaller than the numbers previously reported in NESTA (2008) 'Raise the Game.' London: NESTA, according to which over 50 per cent of Skillset graduates found a job in the video games industries. First, the HESA data only captures employment destinations within six months of graduating (while the previous numbers drew on interviews with course assessors that were not restricted to that timeframe). Second, 2009 was a particularly bad year for the video games industry, as a consequence of the recession, something that has been highlighted by the course assessors that we have interviewed. The constancy over time in the differences between the labour market performance of Skillset-accredited and non-Skillset accredited graduates supports the idea that both groups were hit by the difficult labour market in 2009.
117. Details available in the research Appendices, which can be downloaded from NESTA's website at http://www.nesta.org.uk/publications
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121. Skillset is piloting a bursary scheme for an online mentoring programme for final year students studying at Skillset's Media Academies, which will include receiving feedback on showreels from industry practitioners. The programme plans to help visual effects students refine their skills and final-year projects, and will go some way towards tackling the regional barriers that exist, with the high concentration of VFX companies in London and good quality courses and universities existing in other parts of the country.
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131. We have only identified three partnerships involving video games companies, and one with a visual effects business in the KTP archives (see http://www.ktponline.org.uk/database-search-and-administration).
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