Future Skills Requirements of the

International Digital Media Industry:

Implications for Ireland

Expert Group on
Future Skills Needs

To the Minister for Enterprise, Trade and Employment and the Minister for Education and Science

Forfás 

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A study for the Expert Group on Future Skills Needs and Forfás undertaken by

Strategy Advisory Services Division
PricewaterhouseCoopers
Ireland

July 2006

Foreword by Ms. Anne Heraty Chairperson, Expert Group on Future Skills Needs

As high bandwidth digital technologies, ranging from portable devices to wireless and broadband connectivity, become increasingly pervasive around the globe, they will fuel an insatiable demand for high quality content that can be delivered to users over these channels. This content will span entertainment, information, education and business applications, as well as novel applications that we cannot even envisage at present. Consequently there are huge opportunities for a country which can position itself at the nexus of the creative arts and digital technology.

This study was undertaken in response to a request from IDA Ireland to the Expert Group for an assessment to be carried out of the future skills requirements of the leading multinationals in the digital content sector, not currently operating in Ireland. IDA Ireland wished to ascertain what skills would be required in the future in order to make Ireland an attractive location for these multinationals to carry out high value-added activities. Naturally, any success in this regard would provide significant, and immediate, auxiliary benefits for the indigenous industry.

By virtue of the mandate of the Expert Group, this study confined itself to consideration of skills issues for the digital content sector and did not address broader enterprise development issues for the sector.

This report fulfils three roles. Firstly, it provides a deep insight into the occupational composition and associated skills requirements of the leading international firms in the digital content sector. Secondly, it will inform the indigenous sector of the skills-related developments in the international industry and thereby help them to compete more effectively in the global market. Thirdly, the detailed findings of this report should facilitate education and training providers in keeping their curricula and programmes up to date with developments in the industry and thereby maximise the employability of their graduates.

For the first time those involved in digital media education have a detailed occupational breakdown by sector with the associated skills identified in great detail. The minimum or prevalent level of education is also identified for many occupations.

This report should also serve as a resource for Irish industry. By identifying the skills employed by the leading international companies in the digital media industry, the Expert Group is flagging for Irish digital media companies the skills trajectory they are likely to have to follow.

On behalf of the Expert Group I would like to thank the numerous individuals in the firms and colleges, in the US, in the UK and here in Ireland, who so generously contributed their time and expertise to this study and without whose willing participation the study would not have been possible.

I would also like to express my appreciation to IDA Ireland for their support and cooperation during the course of this study and to the members of the Steering Committee for their numerous and valuable contributions. Finally, I would like to thank Forfás for comissioning this study and to commend PricewaterhouseCoopers for their excellent work.

Ms. Anne Heraty
Chairperson, Expert Group on Future Skills Needs
July 2006

Acknowledgement

This report, "Future Skills Requirements of the International Digital Media Industry", has been prepared by the Strategy Advisory Services Division of PricewaterhouseCoopers Ireland on behalf of the Expert Group on Future Skills Needs and Forfás. PwC would like to thank both the companies and the universities and colleges that agreed to participate in the research for the study. PwC would also like to thank the study Steering Committee and the Forfás Secretariat of the Expert Group on Future Skills Needs for their help in carrying out the study.

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Executive Summary

1. Background

In 2005, the Expert Group on Future Skills Needs (EGFSN) published a study on "Skills Requirements of the Digital Content Industry in Ireland". The objective of the study, which was carried out by FÁS in conjunction with the STeM Research Centre in Dublin City University (DCU), was to provide an assessment of the employment and skills needs of the Digital Media industry in Ireland.

IDA Ireland requested that the EGFSN undertake a complementary study into trends internationally, among the global leaders in the Digital Media sector in order to project how the skill needs of this sector will evolve over the medium-term. PricewaterhouseCoopers were commissioned to undertake this study on behalf of the EGFSN.

2. Terms of Reference

This study set out to identify the skills needs of the Digital Media industry on an international basis. The overarching objective of the study was to characterise the qualitative aspects of emergent and future skills requirements of firms operating in the Digital Media space, including among others, the Wireless Services, e-Learning, Computer Games/Animation and Television (incl. interactive) sub-sectors, concentrating on high value-added activity, over the coming 5 years.

Digital Media is a broad concept which encompasses the representation, processing, transmission and storage of a wide range of "human-readable" material for informational, educational or entertainment purposes, using digital rather than analogue methods. The focus of this study was on the creation of this digital content rather than the platform technology or delivery mechanisms.

The specific requirements were to:

1. Establish the mix of technical and non-technical skills required by the leading international firms in the sector;
2. For the technical skills, to ascertain the optimal balance between general and specialist knowledge/ability that is required by these firms;
3. Identify "best practice" for creating critical mass of activity in established clusters;
4. Provide a high-level, qualitative overview of the range of courses provided by the Irish tertiary education and training system currently;
5. Assess the alignment between the findings of points 1 & 2 with those of point 4;
6. Assess the responsiveness of the Irish tertiary education and training system to the evolving skills requirements in this sector;
7. Provide concrete recommendations for addressing any shortcomings identified in points 5 and 6. In addition, provide recommendations on how the international best practice, identified in point 3, can be realised in the Irish context.

3. Methodology

The core methodology was a targeted interview programme with international leaders in the Digital Media industry. In total, key executives and strategists from 18 companies were interviewed during the study, covering seven key Digital Media sub-sectors: Electronic Games; Computer Generated Animation and Special Effects (CGA and SFX); Digital Film; Digital Television; e-Music; Wireless and Mobile Services; and e-Learning.

In addition, four leading Digital Media colleges in the US were also visited: Carnegie-Mellon, UCLA, NYU and Full Sail. In order to provide a basis for comparison, a qualitative assessment was carried out on the current provision of higher level courses in Ireland of relevance to the sector; eight Irish colleges were visited. However, the study did not incorporate a detailed audit of course provision in individual universities and colleges.

PwC's domain specialists, and authors of the biennial PwC Global Entertainment and Media Outlook, based at the Menlo Park research facility in California were also consulted.

4. Report Structure

The introduction is the first of seven chapters in the report. The remainder of the report covers the following areas:

- Chapter 2 provides a contextual background to the study by describing the global Digital Media environment. This includes an overview of the global market, a review of recent industry trends and key drivers of change;
- Chapter 3 assesses international demand for Digital Media skills, based on the evidence of discussions with the target companies. This chapter includes a review of existing skills profiles and future skills requirements within the Digital Media industry;
- Chapter 4 focuses on leading education and training providers in the Digital Media industry. This includes an overview of the key selected course providers, a profile of Digital Media courses and research, procedures for course review and development, and evidence of linkages with industry;
- Chapter 5 focuses on looking at Irish education and training providers in the Digital Media industry, covering the same topics as were covered for the review of leading education and training providers in Chapter 4;
- Chapter 6 looks at the topic of Digital Media clustering and the role that education, research and skills play in fostering and supporting a clustering environment; and
- Chapter 7 concludes the report by summarising the key findings arising from the earlier chapters (including the gap analysis) and then presenting the conclusions and recommendations arising from these findings.

5. The Global Digital Media Environment

The burgeoning of the Digital Media phenomenon over the past decade and has transformed the Information and Communications Technologies (ICT) and Entertainment and Media (E&M) sectors. It has driven the convergence of these sectors, resulting in the creation of new products and services (such as mobile music and interactive television), which are delivered over new distribution channels (such as online and wireless).

Digital Media is still a nascent sector. Notwithstanding the slowdown in ICT related sectors in the early 2000s, many of its sub-sectors are still high growth, with rapid future development projected over the next five years and beyond.

Based on the available data, indications are that the market size for Digital Media was worth at the very least $965 billion in 2004. Furthermore, estimates suggest that it will be worth at least $1.48 trillion by 2009, representing growth of more than 53% in the period. On a sector-by-sector basis, global estimates for market size and growth are as follows:

- The games market is predicted to grow from $25 billion in 2004 to $55 billion in 2009;
- CGA and SFX is expected to grow from $28 billion in 2002 to $33 billion in 2008;
- Digital technologies will impact strongly on the film sector, which is predicted to grow from $84 billion in 2004 to $119 billion in 2009;
- Similarly, digital technologies will also impact strongly on the television sector, which is expected to grow from about $300 billion in 2004 to nearly $415 billion in 2009;
- The e-music market (digital and mobile) is predicted to grow from $4 billion in 2004 to $25 billion in 2009;
- Wireless and mobile service revenues (voice and data) are expected to grow from $388 billion in 2003 to $529 billion in 2010, while wireless and mobile data services alone are expected to grow from $55 billion in 2003 to $235 billion in 2010; and
- The e-learning market is predicted to grow from over $6 billion in 2002 to nearly $24 billion in 2006.

Advances in technology will be at the centre of this anticipated growth. These include: advances in console and mobile technology for games; periodic cycles of innovation in technology for CGA and SFX; the development of new mobile phone technology, portable digital music devices etc; and the increased roll-out of broadband technology, which is facilitating the emergence of interactive/on-demand television, e-music, and wireless and mobile services.

Other notable Digital Media industry trends include: the expansion of project size and costs in the games sector, and the resulting increased focus on delivering “hits”; the “commoditisation” of basic skills and tools for CGA and SFX, which has produced a growth in outsourcing for lower-end activities (especially to Asia-Pacific territories); changes in the way that consumers listen to and purchase music; and the growing customisation of e-learning packages and programmes.

6. Digital Media Skills: International Demand

The key findings to emerge from the interviews with the leading international firms in the DM space were:

- The skills mix required across Digital Media sectors consists of a complex balance of technical, specialist technical and non-technical skills – both across occupational groups and within occupational groups. Very often, Digital Media sectors can require a strong mix of technical, specialist technical and non-technical skills;
- A vital skill need that appears to be common across most Digital Media sectors is the need for strong programming skills. Typically, programmers in Digital Media sectors are needed to build tools and systems that will be used for content creation, content management and content distribution;
- The need for high quality programming skills across Digital Media sectors is symptomatic of a general trend towards increased technical proficiency across Digital Media skills groups. In particular, content creation and production roles are becoming more and more technical across sectors, ranging from technology being an aid to the process through to technology being at the core of the process;
- In addition, Digital Media roles are becoming increasingly specialised – this is most evident in the high levels of specialisation in artistic roles for games, CGA and SFX and the growing level of specialisation in programming;
- Traditional creative skills remain crucial to most sectors, however, regardless of advances in technology; the "commoditisation" of technologies and software makes competitive advantage based on talent even more crucial;
- Non-technical skills also emerged as important traits that are increasingly sought among Digital Media industry employees, in areas such as project management, sales and marketing, communication and interpersonal skills;
- Adaptability is becoming more and more highly valued in Digital Media employees – this incorporates the ability to adapt to different types of work, changes in technologies, and work across different platforms (e.g. programming expertise for console, online and mobile in games); and
- Despite the obvious impact of technology on the skills needs of the Digital Media industry, it is also clear that creative skills remain a crucial input into content creation; Digital Media technology and the associated technical skills are a complement to creative ability, not a substitute for it.

7. Review of US Providers of Digital Media Skills

The key findings to emerge from the interviews with four leading educational providers for the sector in were:

- The scope of Digital Media education and training provided in the US is quite diverse, particularly in terms of the relatively high level of sector specialisation (e.g. the games, animation or film industry etc.) within courses or course modules. However, it must be recognised that this is partly a function of scale i.e. the US has a much larger and more diverse economy that can support a more comprehensive course scope;
- The level of technology specialisation within courses is also significant;
- The ability of US colleges to update course content with speed and flexibility appears to be high; this is vitally important, given the needs of a fast-changing industry such as Digital Media;
- Mechanisms to ensure courses remain up-to-date with industry developments include: structured industry involvement in course review, design and delivery through Advisory Boards, Review Panels and Technology Committees;
- Benchmarking of courses is undertaken by each of the colleges reviewed. The frequency, focus and level of formality of reviews varies between college/university; and
- Industry linkages in the US colleges, both in terms of course design/delivery and course development/update, are well-developed, with evidence of structured industry input mechanisms.

8. Review of Irish Providers of Digital Media Skills

- The scope of Digital Media education and training is quite diverse in Irish universities/colleges, ranging from broader computer science and engineering courses which contain elements of Digital Media education to dedicated courses for the Digital Media industry. However, the range of courses dedicated to specific Digital Media sectors (such as games, mobile/wireless, animation and film & TV) is relatively low with less than 10% of courses reviewed being sector-specific. Interestingly, a small number of more general Digital Media courses, also deliver modules which are specific to a range of sectors. For example, mobile communications, 3D modelling, 3D model animation etc;
- The level of technology focus/specialisation within courses varies. Courses in engineering and computer science typically provide programming skills relevant to all Digital Media sectors. In addition, many offer specialisations such as artificial intelligence, virtual reality and image processing etc. Digital Media courses also provide specific technology education such as 3D computer graphics, digital sound processing, image/video compression, special effects techniques etc. However, it was noted that in specific areas, the technologies may not be industry standard. In addition, key programming skills appear to be taught on computer science etc., rather than on Digital Media courses. Finally, the level of technology focus in some Film & TV courses is relatively low;
- There is greater flexibility for Irish universities/colleges to update course content/course modules rather than introduce new courses. Modifying course content or modules however, can still take anything up to one year;

- Mechanisms to ensure courses remain up-to-date with industry developments include: Programme Boards to review and input into the design of course content, typically comprising industry experts; ongoing fostering of informal industry linkages etc., and industry-funded joint research projects. While industry input is recognised as being vital to ensuring graduates are equipped with the latest industry requirements and that courses keep up-to-date, the universities/colleges visited cited the challenges associated with securing effective industry engagement in these activities and expressed a desire to expand joint activity with industry;

- Benchmarking of Digital Media courses does not involve, for the most part within the colleges/universities reviewed, a structured/prescribed approach. In addition, no formal process is in place to assess how courses rank nationally or internationally, for example, vis-à-vis leading international Digital Media courses in the USA or UK;

- Industry linkages in the Irish universities/colleges consists of: industry input into course design and delivery; joint research programmes; and internships/work placements etc. For the most part, industry input into course design and delivery is informal – secured through industry contacts, guest lecturers and where established, Programme Boards. The review found relatively well-developed industry research linkages as well as start-up business incubation centres. However, again the universities/colleges visited cited the challenges associated with securing effective industry engagement in these activities.

9. Digital Media Skills and Enterprise Clustering

- A variety of factors influence clustering, whether based on Digital Media activities or otherwise. These include the availability of finance/capital, accessibility of anchor firms and mediating organisations, targeted public policy, good quality services and infrastructure, an appropriate base of knowledge and skills, a strong university research base and associated commercial linkages, and a diversity and quality of personal life;

- Education, research and skills does not appear to drive clustering policy or strategy, but it does play an important role in clustering strategies, e.g. through technology transfer, development of research "Centres of Excellence", industry collaboration on Digital Media course content;

- Facilitating collaboration between stakeholders appears highly important to clustering policy and strategy, particularly through the development of "mediating organisations" that can drive clustering;

- Access to education, research and skills can be a factor in influencing location decisions for companies, but it is not necessarily the most important factor. In addition, access to skills appears to be a more important influencer than access to education and research;

- Policy makers generally appear to be the main drivers of clustering initiatives, with companies more lukewarm in terms of initiating activity. This may suggest that large scale clustering activities have elements of market failure, i.e. while it can no doubt generate very positive impacts and outcomes, these impacts are may not be immediately obvious to private enterprise (particularly where it requires enterprise to commit resources).

10. Conclusions and Recommendations

The Digital Media industry offers huge potential for contributing to enterprise development and creating high value employment. However, it is still very much an emerging industry, particularly in Ireland. In the short- to medium-term, there will be opportunities to attract high value FDI in Digital Media and to further develop Ireland's indigenous base in Digital Media. Target sectors of Digital Media should therefore be prioritised based on their global scale and importance, their high growth potential, and any evidence of existing/potential capabilities and an enterprise base within these sectors in Ireland.

Demand for specific skills in Ireland should increase as the industry develops; however, a lack of skills will make it more difficult to attract overseas Digital Media investment to Ireland. Consequently, there is a strong case for "ramping up" of skills provision in order to stimulate overseas investment and also to foster indigenous enterprise.

This could be best facilitated by developing a national approach to Digital Media education and training in Ireland, which would aim to maximise the resources already available and then build on these where necessary. This would involve adopting an integrated approach to providing Digital Media courses, which recognises the existing strengths of courses/colleges, identifies gaps in education and training provision where they exist, and identifies how best particular universities and colleges can contribute to providing an even better Digital Media education and training structure. This may involve the development of actual/virtual "Centres of Excellence" for different Digital Media skills and sectors in Ireland, which could combine education and training strengths and opportunities on a cross-faculty or cross-college basis.

The report makes six high-level recommendations, incorporating 17 different actions (of which 11 are high priority items), spanning three key themes:

i) Making courses relevant to Digital Media potential and needs;

ii) Keeping courses relevant to Digital Media potential and needs; and

iii) Promoting Digital Media clustering.

The recommendations are detailed in Tables I, II, and III.

Table I: Making Courses Relevant to Digital Media Potential and Needs

Recommendation	Actions	Priority	Responsible
1. Prioritise key Digital Media target sectors for course development in Ireland	A. Skills development for Digital Media in Ireland should target the wireless and mobile sector, the games sector, the film and television sectors (with an emphasis on digital technologies), and the e-learning sector. This should include the development of more sector-specific Digital Media courses and more specialist Digital Media modules in related courses.	High	Universities and Colleges, HEA , DES , IDA Ireland
2. Provide high quality mix of creative, technical and programming skills to meet the needs of Digital Media	A. Computer Science and Engineering courses should provide high-end programming skills in C++ and Java, database programming, programming for Internet and networking technologies etc as well as some exposure to specialist programming skills (e.g. artificial intelligence, gameplay, visual effects, animation systems).	High	Universities and Colleges
	B. Where necessary, creative courses should be enhanced by incorporating more Digital Media electives and modules, including appropriate technical training with a more varied range of software and technology tools using up-to-date technologies and platforms (e.g. XSI and Maya for animation, Linux for operating systems).	High	Universities and Colleges, HEA, DES
	C. For programming skills, more Digital Media electives/modules should be provided through Computer Science and Engineering courses to stimulate student interest in pursuing a Digital Media career.	High	Universities and Colleges
	D. Technology specialisation within existing Digital Media and related media courses should be enhanced. This could include a better understanding of technical specialisations within particular Digital Media sectors or roles.	Medium	Universities and Colleges
3. Provide a more practical, industry-oriented focus to Digital Media education and training	A. Course curricula should incorporate practical, industry-oriented elements such as: project work on practical prototypes/outputs (e.g. games prototypes, animation showreels); the development of a standard, structured guest lecturer input into course curricula; "co-running" of classes with industry; industry mentoring of courses/students; and structured work placements and internships.	High	Universities and Colleges, IDA Ireland, EI, industry
	B. Digital Media and related courses should incorporate more modules that equip students with business-oriented and other similar skills. This should include skills required in project management as well as communication skills, interpersonal skills, client management skills etc.	Medium	Universities and Colleges

Table II: Keeping Courses Relevant to Digital Media Potential and Needs

Recommendation	Actions	Priority	Responsible
4. Develop more accessible means of providing Digital Media courses in Ireland	A. Potential cross-faculty and cross-college/ university development and running of courses, on a joint basis, should be explored to leverage synergies or complementarities in college strengths, and to provide options for combining creativity and technology in course design etc.	High	Universities and Colleges, HEA, DES
	B. Electives/modules across all courses should be made available from an early stage in course curricula (Year 1-2) rather than in later years only.	High	Universities and Colleges
	C. Irish universities and colleges should explore opportunities for more accelerated learning in Ireland as a means of developing course access and availability.	Medium	Universities and Colleges, HEA, DES
5. Develop mechanisms to ensure that Digital Media courses remain appropriate to industry needs	A. Given the fast-changing nature of the Digital Media industry, all Digital Media and related courses should be subject to a full, formal review of course content and relevance on a regular basis.	High	Universities and Colleges, HEA, DES
	B. The course review process should be supported by the establishment of: • Course Review Panels, which have powers to modify and review course content in response to industry development; • Industry Panels, which would complement the Course Review Panels by providing a formal and distinct industry input into course review, design and update.	High	Universities and Colleges, HEA, DES
	C. Each university and college should be encouraged, as a standard activity, to develop more consistent ongoing interaction with the Digital Media industry.	High	Universities and Colleges, industry
	D. Irish universities and colleges should develop procedures for formal benchmarking of each Digital Media and related course against leading international Digital Media programmes, for use on an ongoing basis.	Medium	Universties and Colleges
	E. Formal partnerships should be developed and encouraged between Irish universities and colleges and their leading US and UK counterparts.	Medium	Universities and Colleges
	F. Agencies or organisations supporting the Digital Media sector (e.g. relevant industry associations, the new umbrella "Digital Media Forum", Enterprise Ireland or IDA Ireland) should support the course review process by updating universities and colleges on latest Digital Media industry trends and research.	Medium	Enterprise Ireland, IDA Ireland, Digital Media Forum.

Table III: Promoting Digital Media Clustering

Recommendation	Actions	Priority	Responsible
6. Continue efforts to promote Digital Media clustering among the public, private and university/college sectors	A. Government, in co-operation with the relevant Government departments, State agencies and other interested bodies, should continue to develop a Digital Media clustering policy for Ireland by: • building on existing Government-supported activities and initiatives (e.g. the 2002 Digital Content Strategy, the Digital Hub, and the proposed Digital Media Research Centre); • encouraging more initiatives to develop joint industry-academic research activity in the Digital Media industry.	High	Universities and Colleges, DETE , Enterprise Ireland, IDA Ireland, SFI

1. Introduction

1.1 Introduction

The Digital Media industry is widely recognised to be one of the key industries with potential for generating high growth in enterprise development and economic output in future. However, it is still also very much an emerging industry, particularly in Ireland.

The first major study in Ireland of the Digital Media industry was carried out by PricewaterhouseCoopers (for Forfás) in 2002. This study identified a number of sub-sectors of the Digital Media industry that offered potential for Ireland for the future and put forward recommendations for translating this potential into reality. One such recommendation was that the skills requirements of Digital Media sub-sectors be assessed.

1.2 Phase I Study – Skills Requirements of the Digital Content Industry in Ireland

At the beginning of 2005, the Expert Group on Future Skills Needs (EGFSN) published a study on "Skills Requirements of the Digital Content Industry in Ireland". The purpose of the study, which was carried out by FÁS in conjunction with the STeM Research Centre in Dublin City University (DCU), was to provide an assessment of the employment and skills needs of the Digital Media industry in Ireland. The study covered three Digital Media sectors – games, e-learning and wireless/mobile communications – and the main findings of the study are set out in the box below.

Phase I Study – Key Findings and Conclusions

- *There is a need for a better mixture of technical, creative and business skills (including sales and marketing skills) among Digital Content industry employees.*
- *There are specific skills in each sector that appear to be in short supply, e.g. a lack of skills in game console programming and a lack of knowledge of relevant software packages (Maya), a need for more e-learning skills in client management, a need for more audio and video skills for wireless/mobile communications.*
- *Demand for specific skills in Ireland should increase as the industry progresses, however a lack of skills also makes it more difficult to attract overseas Digital Content investment to Ireland.*
- *Computing courses should be revised to include more elements of Digital Content skills. Project management, business and communication skills should also be included in the curricula of both technical and creative courses, along with options for sales and marketing modules.*
- *Related third-level courses should be generally more flexible and capable of following industry developments, while structured training plans should ensure that those working in the Digital Content industry can readily update their skills as necessary.*
- *Academic and industry partnerships will be essential for the success of the Digital Content industry so as to ensure that students are covering the latest developments and relevant areas, while having some genuine knowledge of the industry on graduation.*

IDA Ireland requested that the EGFSN undertake a complementary study into trends internationally, among the global leaders in the Digital Media sector in order to project how the skill needs of this sector will evolve over the medium-term. PricewaterhouseCoopers were commissioned to undertake this study on behalf of the EGFSN.

1.3 Terms of Reference

In line with the recommendation of the Phase I study, the focus of the Phase II study is on identifying skills needs for the Digital Media industry on a global basis. It will therefore build on, rather than duplicate, the research and analysis undertaken in the Phase I study. The Terms of Reference for the study set out to:

- identify the technical and non-technical skill mix (business, creative etc) in place/required by leading Digital Media companies worldwide. This is to include establishing the optimum balance between general and specialist technical skills and expertise within these companies[1];
- for the companies reviewed, identify the skills/education-related factors that help to create critical mass in their geographic regions. For example, eco-systems of education and research institutions and enterprise and/or mechanisms for aligning teaching and research in higher/further education in line with enterprise needs; and
- undertake a qualitative assessment (in terms of discipline/subject matter/curricula scope etc) of the current range and scope of Digital Media courses provided in the Irish third-level education and training system. Allied to this, identify how these courses respond to ongoing developments of the Digital Media industry and how they continue to evolve to remain appropriate and relevant.

In addition to the above, the study set out to make research findings regarding:

- the gaps between the skills requirements of leading Digital Media companies worldwide and the courses available in Ireland to meet these needs; and
- the mechanisms in place to ensure that Irish Digital Media education and training in third-level institutions is synchronised with the evolving developments of the Digital Media industry and, consequently, its evolving skills needs.

Finally, the study set out to make proposals/recommendations on:

- how the gaps in Irish Digital Media education and training in third-level institutions should be addressed;
- the mechanisms required to ensure that Irish Digital Media education and training in third-level institutions is synchronised with the evolving developments of the Digital Media industry and its evolving skills needs; and
- how Digital Media enterprise critical mass can be fostered in Ireland through skills/education-related factors.

1 This also includes considering any business and convergence/technology trends that may have implications for skills requirements as well as considering non-technical activities in the sector such as publishing and intellectual property (IP) management.

1.4 Approach and Method

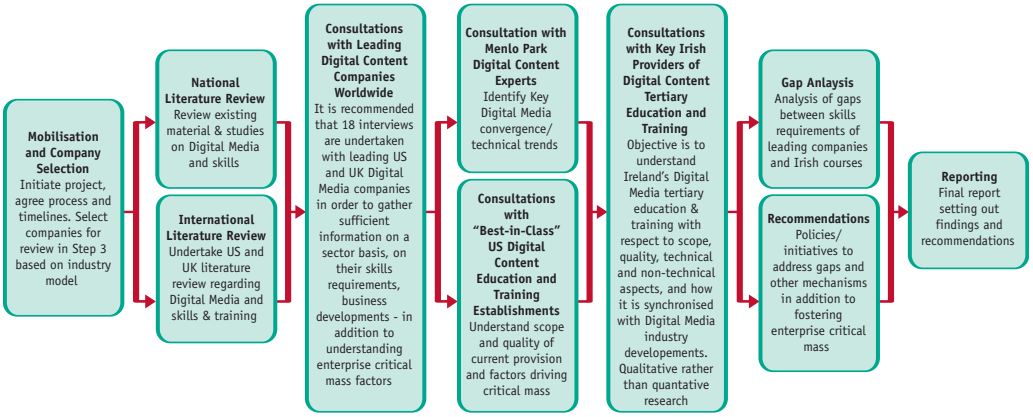
The approach to the research involved a 10-step work programme, which placed a strong emphasis on consulting with leading-edge key informants in the global Digital Media industry (in both the US and UK) as well as examining at a high level the Digital Media skills provision among third-level education and training providers in the US and Ireland. The 10 key steps of the study work programme were as follows:

- project mobilisation and company/college selection;
- national literature review;
- international literature review;
- consultations with PwC's Menlo Park Digital Media experts;
- consultations with leading-edge global Digital Media companies;
- consultations with leading US Digital Media education and training providers;
- consultations with Irish providers of third-level Digital Media education and training;
- Digital Media skills supply and demand "gap" analysis;
- development of key study recommendations; and
- preparation of the draft and final report.

In broad terms, the research approach has involved a high-level review based largely on qualitative interviews with key informants. On the topic of course provision in particular, it has not incorporated a detailed audit of course provision in individual universities and colleges, and report recommendations should therefore be viewed in this context.

Figure 1.1 provides a graphical outline of the methodology. A detailed account of the research approach is set out in Appendix A.

Figure 1.1: Research Approach



1.5 Target Companies

The process for identifying and targeting leading companies for interview across Digital Media sectors involved a number of stages. This included initial research by the consultants on potentially good key informants for each sector, followed by agreement with the client on the companies to be targeted. In addition, the agreed list of companies included both priority targets (i.e. the initial target list) and back-up targets (i.e. targets to be used where it was difficult to get access to targets on the priority list).

Where additional targets were needed over and above the initial agreed list of priority and back-up targets, these were agreed with the client on a case-by-case basis in advance. For confidentiality purposes, the names of the companies who participated in the study have not been presented.

The companies targeted and interviewed represent a mix of both large and small companies as well as established and emerging players in the various sectors. The final list of interviewees included: three companies in the electronic games sector; three companies in the CGA and SFX sector; three companies in the digital film sector; two companies in the digital television sector; two companies in the e-music sector; four companies in the wireless and mobile sector; and one company in the e-learning sector.

Interviews were carried out at a senior level in each company, with people who would have a good knowledge of the company skills base and key skills needs going forward – key informants typically covered a range of senior management roles including Managing Director, Chief Operating Officer, Development Director, Chief Technology Officer, Vice President for Human Resources, Producer etc.

1.6 Report Structure

This introduction is the first of seven main chapters in the report. The rest of the report covers the following areas:

- Chapter 2 provides a contextual background to the study by describing the global Digital Media environment. This includes an overview of the global Digital Media market and a review of recent industry trends and key drivers of change. The chapter also re-visits the global Digital Media "value chain" developed in the 2002 Forfás/PwC study, with a particular emphasis on how the target companies for interview fit into the value chain;
- Chapter 3 seeks to assess international demand for Digital Media skills, based on the evidence of discussions with the target companies. This chapter includes a review of existing skills profiles and future skills requirements within the Digital Media industry;
- Chapter 4 focuses on understanding leading education and training providers in the Digital Media industry. This includes an overview of the key selected course providers, a profile of Digital Media courses and research, procedures for course review and development, and evidence of linkages with industry;
- Chapter 5 focuses on looking at Irish education and training providers in the Digital Media industry, covering the same topics for review as were covered in the review of leading education and training providers in Chapter 4;
- Chapter 6 looks specifically at the topic of Digital Media clustering and the role that education, research and skills play in fostering and supporting a clustering environment. To do this, the chapter examines the evidence available from three sources – the review of international literature on clustering strategy and policy, the evidence from discussions with leading-edge Digital Media companies, and the evidence from discussions with US and Irish education and training providers; and
- Chapter 7 concludes the report by summarising the key findings arising from the earlier chapters (including the gap analysis) and the key conclusions and recommendations arising from these findings.

2. The Global Digital Media Environment

2.1 Introduction

The purpose of this chapter is to provide some contextual background on the global Digital Media environment. The remainder of the chapter therefore includes four main sections:

- overview of the scale of the global Digital Media market;
- review of key industry trends and drivers-of-change in each of the sectors being reviewed;
- overview of the Digital Media "value chain" and where the companies interviewed during this study fit within the value chain; and
- summary of key chapter findings.

2.2 Overview of the Global Digital Media Market

Digital Media describes a phenomenon which has evolved over the past decade, whereby digital has transformed the Information and Communications Technologies and Media and Entertainment sectors. It has caused these sectors to increasingly converge, driving the creation of new products and services (such as mobile music and interactive television), which are delivered over new distribution channels (such as online and wireless).

A detailed description of the Digital Content market was set out in "A Digital Content Strategy for Ireland" (Forfás, 2002), and as such this overview of the market provides an updated description of the Digital Media market only. Our objective is to provide a background market context for the analysis of Digital Media skills requirements – particularly given the underlying recognition that digital (be it technology, content or services) is fuelling the knowledge-based society of the future.

Digital Media remains a nascent sector. However, despite a slowdown in the information and communications sectors in the early 2000s, many of its sub-sectors (such as mobile/wireless, Internet and games etc) are high growth, with rapid future development projected for over the next five years and beyond.

In terms of the market for Digital Media, given that it comprises the convergence of Information and Communications Technologies and Entertainment and Media, it is difficult to definitively state its size and growth. Market sectors that were previously separate (such as television and the Internet) are now overlapping (for example, through interactive television) and as such, are not yet measured.

However, data exists for a number of Digital Media sub-sectors, which when consolidated provide a reasonable indication of the scale of the industry. Based on the available data, indications are that the market size for Digital Media was worth at the very least $965 billion in 2004. Furthermore, estimates suggest that it will be worth at least $1.48 trillion by 2009, representing growth of more than 53% in the period, and that it will be a high value market. The data has been presented on the basis of the "Digital Content Framework", which was presented in the Digital Content Strategy for Ireland as referenced above – but it additionally includes Internet access and wireless, which provide an indication of the infrastructure component of Digital Media. This data is set out in Table 2.1 and provides an overview of the size and future growth of the Digital Media market – as noted, however, it does not represent the sector in its entirety.

Table 2.1: Global Digital Media Market Value

DIGITAL MEDIA SECTORS	CURRENT VALUE 2003/2004	FUTURE VALUE 2009/2010	
$ billion	Global Value	Global Value	Ave Ann Growth %
ENTERTAINMENT			
CG Animation & SFX	$28 billion	$34 billion[2]	4%
Games	$24.4 billion[3]	$55 billion	25%
E-music	$4.1 billion[4]	$25.6 billion	105%
Film (all, including digital)	$84.2 billion[5]	$119 billion	8.3%
TV (all, including digital and Interactive)	$298 billion[6]	$414 billion	7.8%
Digital Radio	-	-	-
EDUCATION			
Digital Libraries	-	-	-
E-Learning	$6.5 billion[7]	$24 billion[8]	67%
CONSUMER INFORMATION			
Online Publishing	-	-	-
Digital Publishing	-	-	-
Location-based Services (i.e. mobile / wireless content & services)	$388 billion[9]	$529 billion	5%
BUSINESS / PROFESSIONAL-RELATED CONTENT			
Corporate Communications	-	-	-
Business Publishing	-	-	-
Location Based Services	-	-	-
Non-Media Applications	-	-	-
Advertising (Online only)	$17.2 billion[10]	$33 billion	18.4%
INFRASTRUCTURE			
Internet Access (broadband and dial up)	$115 billion[11]	$254 billion	24%
TOTAL	**$965.4 BILLION**	**$1,488 BILLION**	**10%**

Note: '-' = statistics not available.

2 Roncarelli (2003).
3 Source PwC (2005), Excludes Hardware.
4 Source PwC (2005) Comprises digital and mobile music.
5 Source PwC (2005) Includes all film based on consumer not producer values.
6 Source PwC (2005) Includes expenditure on TV subscriptions, licence fees and advertising – market rather than production value.
7 IDC, 2002 value.
8 2006 value – 2009/2010 not available.
9 Source: "Wireless Communications" (Forfás, 2004). Includes mobile & fixed networks, hardware devices, middleware, software and market applications/services.
10 Source PwC (2005).
11 Source PwC (2005).

The key drivers of development of the Digital Media market are set out below. It should be noted that sector-specific drivers-of-change are set out in Section 2.3 of this report, for each of the key sectors included in the study:

- broadband supports the convergence of content, networks, platforms and devices. It enables the creation and delivery of rich media business and consumer applications across platforms such as the PC, television, personal devices (Palm Pilots, MP3 players etc), mobile phones and networked games consoles. Significant growth is expected in global broadband adoption, with PwC research projecting 321 million new broadband households to come on-stream over the next five years to 2009, resulting in a total of 448 million broadband households at that point;

- mobile/wireless has been a significant driver of growth in the Digital Media industry – again, supporting the delivery of data, voice and services over wireless/mobile devices. There are estimated to be 1.4 billion wireless subscribers globally (of which 400 million are in EMEA[12]). It is projected that there will be more than 133 million 3G mobile handsets by 2008 in Western Europe alone, with content revenues of more than €20 billion[13];

- accelerating deployment of new delivery technologies (such as mobile devices ranging from Blackberry and iPod to online games consoles) is a fundamental driver shaping the Digital Media industry. By the end of 2009, adoption of key delivery technologies is expected to attain levels necessary to significantly alter existing business models;

- allied to the above, the development of digital distribution provides opportunities for less expensive distribution models that can result in significant savings in manufacturing, shipping, and inventory management. With broadband penetration growing, digital distribution of video and audio is expected to become widespread; and

- while delivery deployment will be a vital driver of the Digital Media industry over the next few years, content and service innovation will play a significant – if not the most important – role. New types of content and new services must be developed in order to attract consumers to use the evolving digital distribution channels.

12 Europe, Middle East & Africa. Source PwC (2004).
13 Source Ovum, (2003).

2.3 Industry Trends and Key Drivers of Change

This section details some of the findings on key industry trends and drivers-of-change within relevant Digital Media sectors of Games, CGA and SFX, Digital Film, Digital Television, e-Music, Wireless and Mobile Services, and e-Learning.

Games: PwC estimates indicate that the global games market was worth over $25.4 billion in 2004[14]. This represented a rise of 11% on 2003. Growth was fuelled principally by the strong performance of console games (especially sequels to games or new games based on Hollywood films), while there was also strong growth in hand-held games and online/wireless games. Between 2005 and 2009, PwC estimates also suggest that the games market will further expand, at an annual compound rate of 16.5%, to $55 billion.

Consoles are the dominant platform in the games market, and the key driver of change in the sector is the ongoing development of console technology. Each upgrade in console technology and capability is therefore accompanied by a similar upgrade in the quality of games. In particular, the "virtual realism" of games and the overall games experience (from a user perspective) has improved dramatically, while new games console technology, which incorporates embedded online capabilities, will also fuel online games growth. Furthermore, improved mobile phone technology is further expanding the market for wireless and mobile games. The market for PC games, on the other hand, is expected to decline in the medium-term.

Table 2.2: Key Industry Trends and Drivers-of-Change for the Games Sector

- *The development of games consoles is the major driver of change, leading to five-year cycles where the technical complexity and capability of games can increase substantially. Indicators suggest that the XBox 360, for example, could be up to 15 times more powerful than its predecessor, while the PS3 could be up to 30 times more powerful than its predecessor.*
- *Growth in the online games market will expand considerably, by 550% over five years, as the embedded online capabilities of the next generation of consoles and the further expansion of broadband will have a positive effect on demand. The market for wireless and mobile games will also expand, by 650% over five years, as the games capability of mobile phones expands. The PC games market should decline, however.*
- *Market penetration for the games sector is also rising, the demographic for games players is broadening, and consumers are becoming more sophisticated.*
- *As games consoles develop their technical capability and as consumer tastes become more sophisticated, the games themselves therefore increasingly require more realism. The prevailing trend in games development is from 2D to 3D environments, and the plot, look, and feel of a game has become more important.*
- *The cost of games production has increased dramatically, but particularly for consoles. Games now need bigger teams to develop them over longer lead times. There are also less games being developed, and the sector has adopted a more "hits"-driven, Hollywood-type model. However, the explosion of games development across more 2D-based platforms provides less expensive opportunities for games development and enhances the attractiveness of developing games for online and mobile platforms.*

14 This excludes spending on hardware (e.g. consoles) and accessories used to play games.

CGA and SFX: The CGA and SFX sector is one of the most rapidly expanding areas of creativity and technical development. It is used extensively in television and film, animated simulation, computer games and digital environments.

Computer animation continues to grow as an increasingly important element of the overall film production process, particularly given the film industry's continuing focus on generating "blockbuster" film events as drivers of revenue. As the outputs of special effects and computer animation have become more sophisticated, the integration between production and post-production activity has also increased. As however, film production schedules and budgets are increasingly being squeezed, special effects and post-production schedules have in turn become tighter. From the industry perspective, this has resulted in two broad trends. Firstly, it may require effects and animation houses to increase the resources attributable to projects at any one time; and/or secondly, it leads to outsourcing of animation activities to other service providers. In tandem with this trend, the "commoditisation" of hardware and software has expanded the pool of competent artists and computer graphics specialists, leading to more competition but also greater potential for outsourcing.

According to the Roncarelli Animation Report[15], the expansion of the market and the application areas of computer animation are predicted to experience explosive growth well into this century. The global computer animation industry is forecasted to grow approximately to US$33 billion by 2008 and was estimated to be worth $28 billion in 2002 (i.e. a growth rate of 18% over six years). 3D production accounts for over 90% of total computer animation production, while 2D has very specific and limited uses. 3D computer animation represented approximately $26 billion in 2002.

Industry research points to the overall CGA and SFX industry being classified into 14 categories. Six-user categories fall under the "entertainment segment" while the other eight are in the "corporate/industrial segment". Although they are smaller in number, the overall importance of the six entertainment categories far outweighs the aggregate of the eight corporate and industrial categories.

During 2002, the entertainment segment for computer animation production accounted for almost 70% of the total production volumes, while the corporate and industrial segment accounted for the other 30%. In 2002, the share of animation in advertising declined from that in 2001. However, animation for film and television programme production remained constant, while in games, web animation, personal and business uses, it increased. Animation for educational uses remains strong.

15 The Roncarelli Report on the Computer Animation Industry, 2003.

Table 2.3: Key Industry Trends and Drivers-of-Change for CGA and SFX

- *The global computer animation industry is fragmented, and the total number of players runs in excess of 7,000 in over 80 countries worldwide. Many small and medium-sized players are located outside North America and execute outsourced animation projects. About 64% of all computer animation production companies do less than $1 million worth of business each year. Companies that generate more than $25 million represent about 1% of total companies.*
- *In the early 2000s, computer-generated imagery (CGI) became the dominant form of special effects, and it has now progressed to the point that it is difficult to distinguish CGI from live-action. Effects are becoming increasingly important to film-making. From 1995 to 2005, the average effects budget for a wide-release film increased to €40 million.*
- *Lead times for animation schedules are decreasing, which is leading either to a need to increase resources within individual effects and animation houses, or to greater sub-division of work among more service providers.*
- *Sluggish sales of DVDs of a number of animated blockbusters, in addition to a tremendous amount of product in the marketplace, is the result of a much more crowded industry. It is not known whether this will be a short-term issue or the beginning of a longer-term restructuring. From a global standpoint, it is believed that the current trend in geographic distribution will continue into the near future. The computer animation production shares represented by the UK, Europe and North and South America regions will continue to be slowly eroded as production increases in the Asia-Pacific region. Despite this, North America will continue to be responsible for almost half of all 3D-computer animation production volume for the foreseeable future. Some of the major studios are also in a growth phase, e.g. Disney and Sony, recruiting 600-700 each.*
- *The ongoing search for competitive advantage within the industry drives ongoing rounds of innovation in both tools and technologies to speed up, and reduce the cost of, the production process. Improvements in hardware and software are facilitating more "real time" activity, allowing artists to work simultaneously on digital assets rather than consecutively. Improvements are also resulting in greater "commoditisation" of activities, meaning that more people have access to vendor-based tools and are competent in doing basic special effects and animation activities. Technology is therefore much less of a barrier to entry than in the past. This rapid advancement of technology has resulted in CGI and SFX being one of the fastest growing sectors in the Digital Media industry.*
- *Due to the development of computing power and consequent reduction in costs, more and more of the global animation production output is taking place outside North America, with the resultant growing importance of the outsourced computer animation production market. A shift in animation production to the Asia-Pacific region is occurring due to the availability of low cost, powerful computer animation platforms and much lower labour rates in the region compared with Europe and North America. The bulk of outsourcing is now moving towards 3D animation activities with the "core assets" being created and modelled by a core team of creative and technical experts in North America. The cost of getting work done in countries such as Korea, Taiwan and China is said to be approximately 50% of work in developed countries. In countries such as India, the costs are even lower at 25%-30%. This cost competitiveness combined with the delivery of good international standards of animation by these studios has driven outsourcing to an even greater extent. A typical half-hour 3D CGI animation TV episode that would cost $170k to $250k to make in the US costs about $70k to $100k to make in India.*
- *The IRIX version of UNIX from SGI (Silicon Graphics) is completely relegated to support and maintenance only. Windows is continuing its dominance at the boutique level (less than 10 employees). Its dominance at the studio level has completely gone, however, and all the large studio pipelines are now based on some flavour of Linux. "Red Hat" used to be the flavour of choice, but since it adopted its "Enterprise Solution" of licensing it has been swiftly replaced by SUSE (Novell) and Fedora.*

Digital Film: Digital film is developing into an important aspect of the Digital Media industry, and digital processes have already had a substantial impact on traditional film-making processes. The global film entertainment sector, for example, was estimated to be worth $84.2 billion in 2004 (growing to $118.9 billion by 2009) – while there are no separate figures for the "value" of the digital component of film-making, there is a definite trends towards it becoming increasingly digitally-based.

Film-making techniques are increasingly influenced by the impact of digital technologies, particularly in ways that are designed to improve the productivity and efficiency of the film-making process. The post-production phase has increasingly become a digitally-based process to the extent that it is now almost fully digitised, for example, not just for generating special effects and animation aspects of a film but also for standard tasks such as film editing, colouring (telecine), sound production etc. Furthermore, film conceptualisation and pre-production processes have been improved by the introduction of electronic tools, while film production using digital camera technology is emerging to an ever greater extent. However, it is still likely to be some time before full digital distribution and projection of cinema product becomes the norm, and the rate of adoption of this standard is also likely to vary by territory.

Table 2.4: Key Industry Trends and Drivers-of-Change for the Digital Film and Television Sectors

- *Estimates for the value of the global film entertainment sector were $84.2 billion in 2004 – the value of the sector is also predicted to rise at a compound annual growth rate of 7.1% for the next five years, to $118.9 billion by 2009.*
- *There is increasing use of digital technology in film-making, and film-making processes generally are becoming more digitally-based. Post-production in particular has become almost completely digitised, for example, while the use of digital cameras and high-definition tape in film production is also becoming more common.*
- *Greater use of CGA and SFX in films is leading to an increasing overlap in terms of skills/trends between it and the digital film sector – this particularly applies to film post-production.*
- *Digital cinema has begun to emerge, but there is still likely to be a long lead-time before digital cinema and digital projection through theatres becomes mainstreamed on a global basis.*

Digital Television: Digital television is also an emerging Digital Media industry, and digital processes are, as with film-making, impacting on television-making processes. There are no separate estimates for the value of digital television activities. However, the overall television market is predicted to grow substantially in the coming years. The value of the market for television networks, for example, was estimated at $152 billion in 2004, and it is expected to grow at a compound annual growth of 6.0% to over $204 billion by 2009. The value of the market for television distribution, on the other hand, was estimated at $146 billion in 2004, and is expected to grow at a compound annual growth of 7.4% to $210 billion by 2009.

Digital television production activities are being impacted by digital technologies in similar ways to those found in the digital film sector. However, the emergence of digital television as a viewing option (e.g. in the form of interactive television or on-demand television) is an especially important development, which is fundamentally changing the way people consume television product. Digital television will also continue to expand as the availability of broadband increases and the cost of broadband decreases – and figures for both the US and Western Europe show this growing broadband access is an ongoing trend.

Table 2.5: Key Industry Trends and Drivers-of-Change for the Digital Television Sector

- *The value of the market for television networks was estimated at $152 billion in 2004, and it is expected to grow at a compound annual growth of 6.0% to over $204 billion by 2009.*
- *The value of the market for television distribution, on the other hand, was estimated at $146 billion in 2004, and is expected to grow at a compound annual growth of 7.4% to $210 billion by 2009.*
- *Broadband availability has increased and the cost of broadband to the consumer and the digital service provider has decreased. As a result, the number of households in the US with broadband access is expected to grow from 32.5 million in 2004 to 62.0 million in 2009, while the number of broadband subscribers in Western Europe is expected to grow from 29.9 million in 2004 to 93.5 million in 2009. High-definition television will expand in both the US and Europe, and digital television will expand worldwide, which will improve both the quality of television delivery and the level of interactivity for the consumer.*
- *On-demand television, in particular, is growing significantly (though from a low base). This offers consumers very high levels of flexibility in their television viewing and greatly expands their available levels of choice, e.g. it can allow consumers to watch whatever they want, whenever they want, for as long as they want etc. On-demand television is therefore evolving to such an extent that it is increasingly turning television into a menu of choices/viewing search facility.*

e-Music: The overall recorded music market was worth $37.8 billion in 2004 (based on PwC estimates), and the market is expected to grow to $56.3 billion (at an 8.3% compound annual rate) by 2009. However, traditional physical distribution of music (e.g. CDs, cassettes) is expected to decline in this period, from $33.6 billion to $30.9 billion (a decline of 8%), while the e-music component of recorded music spend will rise from $4.2 billion to $25.5 billion (a growth of over 500%). This e-music component will include licensed digital distribution services at $6.6 billion and mobile music services (e.g. ring tones) at $18.9 billion, both of which will have grown at strong exponential rates when compared to their current relatively low base.

The emergence of digital music has greatly expanded the ease of access to product and the level of choice available to consumers. This has led to changes in the way consumers listen to and purchase music. This includes, for example, more retailing of individual songs in digital format (a contrast to the sustained decline in the physical distribution of CD- and cassette-based singles).

There are a number of key factors that are driving the anticipated growth in both digital and mobile music – these include the ongoing expansion of Internet and broadband penetration worldwide and the continued strong growth in the adoption of portable digital music devices (e.g. Apple's iPod, Creative's Zen). In addition, mobile phones are generating strong demand by providing an alternative MP3 device and by creating a huge market for the sale of ring tones.

Table 2.6: Key Industry Trends and Drivers-of-Change for the e-Music Sector

- *Rapidly expanding interest in digital and mobile music will drive recorded music spending across the globe. By 2009, digital distribution of music is expected to be worth nearly $6.6 billion, while music/music products distributed via mobile phones will be worth nearly $18.9 billion.*
- *This is partly driven by ongoing increases in both Internet and broadband penetration, which are further expanding the market opportunity for licensed digital distribution services for music.*
- *It is also driven by the emergence of portable digital music devices and the convergence of wireless devices as entertainment media, as well as their growing use by consumers as both music players and as avenues for sale of ancillary music products (e.g. ring tones).*
- *Digital distribution is driving changes in how the consumer listens to and consumes music – the ease of access to, and relative low cost of digitally distributed songs, for example, are producing more "impulse buying" and the re-emergence of the purchase of individual songs rather than albums.*
- *In addition, digital distribution is offering greater opportunity for e-music suppliers (wholesale and retail) to develop ancillary sales opportunities side-by-side with music sales, e.g. sales of DVDs, sales of ring tones, sales of Amazon-type other suggested listening. The number of potential consumer offers through e-music services has therefore mushroomed.*
- *Digital distribution is also offering more opportunity for "bundling" of music packages in ways other than the traditional album format.*
- *Piracy remains a problem, impacting legitimate sales of physical music, e.g. unauthorised music downloads and illegal duplication of CDs*

Wireless and Mobile Services: Wireless and mobile services are another area of very strong growth within the Digital Content industry. A recent Forfás study of the sector[16], for example, indicates that total service revenues in the sector are expected to grow from $388 billion in 2003 to $529 billion in 2010. It will be data services, and not voice services, however, where the strongest growth will lie – data revenues alone being projected to grow from $55 billion in 2003 to $235 billion in 2010. The wireless/mobile industry comprises mobile networks (2G, 3G, 4G, WLAN etc.), fixed and broadcasting networks, hardware devices, middleware, software and services etc.

This substantial expansion in wireless and mobile services is being made possible by continuing advances in wireless and mobile technologies. For example, increasingly, the trend in mobile phone technology is towards smaller phones but also more powerful phones, to the extent that many mobile phones are now becoming "mini-computers". This in turn is leading to an explosion of non-voice based revenue streams, covering such activities as e-mail, Internet, picture and video messaging, music, photography and games.

Alternative wireless technologies are growing (e.g. Wimax, Bluetooth, WLAN etc), with key opportunities believed to lie in providing wireless and mobile data and other services and content.

16 Wireless Communications: An Area of Opportunity for Ireland, Forfás, 2004

Table 2.7: Key Industry Trends and Drivers of Change for the Wireless and Mobile Services Sector

- *The rapidly expanding capability of wireless technologies and mobile phones is the key driver of services development. Mobile phones are increasingly developing into multi-purpose devices that incorporate Internet services, photographic capability, music capability, video capability, games capability, e-mailing and messaging capability etc, and this will be further enhanced by the expansion of 3G wireless technology that facilitates broadband wireless transmissions.*
- *Global subscriber growth for wireless and mobile services remains strong, though data revenues rather than voice revenues are likely to be the key source of future growth – overall service revenue is expected to increase from $388 billion in 2003 to $529 billion in 2010, with data revenue alone increasing from $55 billion in 2003 to $235 billion in 2010.*

e-Learning: In 2002, the global e-Learning market was estimated to be worth more than $6.5 billion, according to the International Data Corporation. By 2006, it is anticipated that this market will have grown to nearly $24 billion, which represents very substantial growth of over 250% for the period, but which is also considerably below the original IDC estimate of $34 billion. This means that e-Learning growth has been substantial, but not as fast as was originally anticipated at the start of the decade.

A significant trend in the sector has been towards more customisation of e-learning packages and programmes to suit the needs of individual clients, and this is driving the need for more interaction between the client and the e-learning provider as well as the need for more high quality e-learning solutions and innovation on the part of the e-learning provider.

Table 2.8: Key Industry Trends and Drivers of Change for the e-Learning Sector

- *Analysts IDC have estimated that the worldwide e-Learning market is expected to be worth $23.7 billion in 2006, which would represent growth of 260% from the 2002 level of $6.6 billion. At the same time, the IDC estimate for 2006 has been downgraded from its original estimate of $34 billion.*
- *The recent development of e-Learning packages and programmes has been noticeable for a shift in focus to the learner, and the importance of the effective transfer of knowledge to that learner. Global pressures on organisations to re-tool and re-skill people more quickly to meet the needs of ever-changing markets are at the same time driving the need for courseware and content that is customised more for the client.*
- *The shift towards more customised e-Learning for clients will in turn also drive the need for high quality and innovative responses to client needs from e-Learning providers.*
- *New technologies may continue to impact on e-Learning in future – this might include the roll-out of broadband facilitating more use of video and audio in e-Learning, more use of simulation-based e-Learning, e-Learning using portable/mobile devices (m-Learning), "smart suites" that embed e-Learning within a user's work context, and more "on-demand" e-Learning tools.*

2.4 The Global Digital Media "Value Chain"

The Digital Media value chain describes the range of value-added activities that occur across each of the Digital Media sectors, and which are involved in bringing products/services to each of the sector's markets. It comprises ten core activities as defined below, which include:

- Digital Media enablers (enabling technologies) – enabling technologies are the core technologies/software that are developed to enable the production, management and distribution of Digital Media. They can loosely be defined as "foundation" technologies/software;
- content design – this includes concept development and the creation of content in digital format (data, audio, video etc);
- content authoring – content authoring is an integral aspect of content design. It involves building the necessary functionality for establishing the content access, navigation system, edit and file management options for the content;
- content conversion/packaging – content conversion is defined as the conversion of analogue content into a digital format, i.e. content digitisation. Content packaging is the manipulation (customisation and aggregation) of original content into suitable formats, e.g. CD-ROM production, video coding for transmission purposes;
- content management – content management is defined as cataloguing, tracking and managing of assets for re-purpose, re-use and distribution across multiple channels from one single source. Content management applications let diverse types of users aggregate, organise, manage, create access to and deliver all types of content, including documents, text, images, application data and streaming content. Content must be collected and managed across the entire content lifecycle (creation to distribution);
- content storage – content storage covers all forms of devices and services used to store data. Devices include DVD and CD-ROM right through to high-end enterprise storage systems. Storage services can include storage of servers/data itself, high-performance data transfer, protection against data loss ("redundancy") and data back-up[17];
- content publishing – this incorporates digital rights management and describes securities, permission, and rules for delivering, viewing, disseminating and accessing content along with ownership rights etc. Content is also priced and packaged for sale at this stage;
- content marketing – activities connected with the advertising and marketing of Digital Media;
- content distribution – content distribution involves the process of preparing content in a format suitable for distribution, e.g. preparing content for streaming. For the Internet, this would also include management of the services covering Internet access service, web traffic management and analysis; and
- infrastructure/access provision – infrastructure provision covers the implementation and maintenance of the platforms over which Digital Media is distributed or accessed. These include broadband and narrowband telephony networks, satellite, cable and wireless. Access provision also incorporates media access devices such as PC, TV, consoles and set-top boxes, among others.

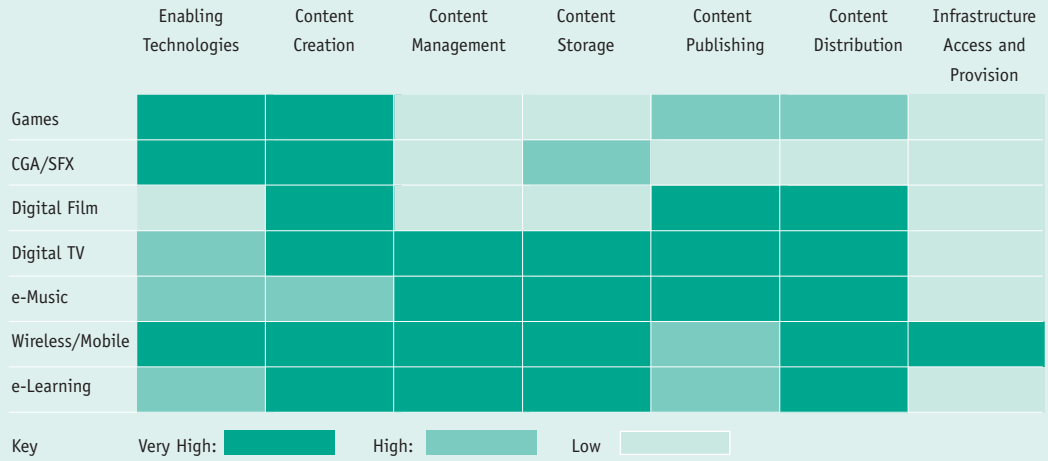
These elements can be further sub-divided into: enabling technologies; content creation (including content design and content authoring); content management (including content conversion/packaging and content management); content storage; content publishing; content distribution (including content marketing and content distribution); and infrastructure access/provision.

17 Rich Media Asset Management (RMAM) systems – also referred to as Digital Asset Management (DAM) systems – track and manage digital assets: audio, image, text, animation, 3-D graphics, and video files. RMAM and content management systems span the functions of managing as well as storing content, and as such can be categorised into either content management or content storage. This is similarly the case for many digital content technologies, as the boundaries of the links in the value chains are not definitive. Content management, web content management and document management are categorised in content management, as their functions are more directly related to the management of content. DAM and RMAM have a stronger focus on storage (especially since rich media data volume becomes so large), and as such are categorised under content storage.

Table 2.9 shows how the companies interviewed during this study "fit" with the Digital Media value chain. Areas heavily shaded indicate parts of the value chain where there is a strong emphasis on activity, with areas shaded lighter indicating parts of the value chain where there is some emphasis on activity. By sector, it shows that:

- for the games sector, the main emphasis of company activity has been on (a) creating games content and (b) developing software and technologies that assist in enabling the creation of games content. One of the games companies interviewed is also a major publisher and distributor of games;
- for CGA and SFX, the main emphasis of activity is again on creating animation and special effects content and on developing technologies that assist in creating animation and special effects. One of the companies interviewed also acts as a conduit for clients, however, which includes storing and organising, not only in-house content created for the client, but also content created for the client by other animation and effects houses;
- for digital film, the main foci of activity for companies interviewed were content creation (from conceptualisation through to post-production), content publishing and content distribution;
- activities across the value chain were important for companies interviewed in the digital television sector – particularly content creation, content management and storage (as content management systems are important), content publishing and content distribution (e.g. interactive television and on-demand television). To some extent, digital television companies are also involved in building enabling technologies (e.g. building content management systems);
- for the e-music sector, there is a similar spread of activity across the value chain, but activities involving content management, storage, publishing and distribution are particularly important (e.g. incorporating e-music retail websites with back-up content management systems and other support systems). Digitising music content is obviously also carried out, though it is a fairly commoditised activity at this stage, while involvement in developing enabling technologies mainly involves the development of customer-facing retail applications (i.e. websites) and content management systems;
- content management, storage and distribution are again major areas of activity within the wireless and mobile sector. There is some involvement in creating and publishing original content, however sourcing external content is also a major contributor to what companies offer the client/consumer. Involvement in developing enabling technologies mainly includes the development of web-based applications (including for mobile phones), content management systems etc; and
- for e-learning, the main emphasis of activity is on content creation, management, storage and distribution, with enabling technologies development again based largely on web applications and "learning management systems"/content management systems.

Table 2.9: Target Companies "Fit" with the Global Digital Media Value Chain



2.5 Summary of Chapter Findings

- Predicted strong growth is a common feature across Digital Media sectors: the global games market, for example, is predicted to grow from $25 billion in 2004 to $55 billion in 2009; CGA and SFX is expected to grow from $28 billion in 2002 to $33 billion in 2008 (albeit a significantly lower growth rate than other sectors reviewed); digital technologies will increasingly impact strongly on the film sector, which is predicted to grow from $84 billion in 2004 to $119 billion[18] in 2009; similarly, digital technologies will impact strongly on the digital television sector, which is expected to grow from about $300 billion in 2004 to nearly $415 billion in 2009; the e-music component of the recorded music market is predicted to grow from $4 billion in 2004 to $25 billion in 2009; global wireless and mobile data services are expected to grow from $55 billion in 2003 to $235 billion in 2010; and the global e-learning market is predicted to grow from over $6 billion in 2002 to nearly $24 billion in 2006.

- Continued developments and advances in technology lie at the heart of this anticipated growth. This includes: advances in console and mobile technology for games; ongoing rounds of innovation in technology for CGA and SFX (including the development of in-house proprietary technologies); the development of new mobile phone technology, portable digital music devices etc; and the increased roll-out of broadband technology, which is facilitating the emergence of interactive/on-demand television, e-music, and wireless and mobile services.

- Other notable Digital Media industry trends include: the expansion of project size and costs in the games sector, and the resulting increased focus on delivering "hits"; the "commoditisation" of basic skills and tools for CGA and SFX, which has produced a growth in outsourcing for lower-end activities (especially to Asia-Pacific territories); changes in the way that consumers listen to and purchase music (e.g. more retailing of individual songs in digital format) as result of the options that the e-music market provides; and the growing customisation of e-learning packages and programmes.

- Companies interviewed as part of the study demonstrate involvement in a range of activities that cover the full spectrum of the value chain, covering enabling technologies, content creation, content management, content storage, content publishing and content distribution.

18 Film and Television figures are for all – not just digital and interactive.

3. Digital Media Skills – International Demand

3.1 Introduction

The purpose of this chapter is to provide an analysis of the international demand for Digital Media skills, based on the evidence provided by the leading-edge Digital Media companies interviewed in the various sectors covered. The rest of the chapter covers the following areas:

- a review of the core skills profile evident from companies in each of the seven sectors covered, namely Games, CGA and SFX, Digital Film, Digital Television, e-Music, Wireless and Mobile Services, and e-Learning, including: the core skills profile by broad occupational group; an overview of the balance of skills needed (technical, specialist technical and non-technical); and company views on future skills needs;
- evidence from the companies on how they source skills and how they deal with employee training and development; and
- a summary of the main chapter findings.

Appendix B provides a summary of the core skills profiles presented in this chapter.

3.2 Skills Profile in the Games Sector

As noted earlier, the companies interviewed were primarily games developers, while one was also a major games publisher as well as a games developer. None of the companies interviewed were involved in other games-related activities such as tools development for games (e.g. middleware developers) or games localisation.

The core skills for the companies interviewed can be classified into five key occupations. These are: management/project management; design; artistic/creative; programming; and quality assurance. Each of these occupational groups, including the various roles involved and the indicative skills/experience required, is now described in more detail.

Management/Project Management: Management and project management roles include the general/senior management roles that are typical to any company (e.g. Chief Executive, Finance, Human Resources etc) as well as the specific project management roles that are more directly tied to individual games development projects. These project management roles are ultimately responsible for co-ordinating resources, agreeing milestones, monitoring progress, presenting product, and accounting for resources and expenditure, and the different roles involved may include the following:

- the Executive Producer, who is a senior manager with the ultimate overall responsibility for the delivery of a games project in time and on budget;
- the Project Manager, who is responsible for the day-to-day administration and scheduling of a games project;
- the Technical Director, a role that is emerging in some companies, who operates alongside the Project Manager but who is more responsible for overseeing the technical development of a games project; and
- the Discipline Leads, who are people with management responsibility for delivery of the design, artistic/creative, programming and quality assurance elements of a games project. Under these Discipline Leads, there may also be people with responsibility for sub-elements of design, artistic/creative or programming, e.g. animation leads within the artistic/creative group.

Traditionally, project management has come from a technical background, with managers working their way up through a company (or companies) from the design, artistic/creative or programming areas. Project management needs for games companies are becoming a lot more complex, however, because the size of games projects (in terms of budgets, staff resources and timeframe) has increased substantially, while the industry's new focus on delivering "hits" has placed an even greater emphasis on delivering quality games[19]. Senior management and project management staff therefore increasingly need more conventional business and marketing skills. In this regard, one company interviewed suggested that the emergence of project managers with non-technical business management backgrounds has become more common.

Design: Designers are responsible for producing ideas and concepts for games (storylines, characters, settings) and for delivering detailed design specifications (including technical specifications) for game content, game mechanics, game modelling, game texturing, game interface design etc.

There appears to be less specialisms within the design occupations than there are for other occupational groups. A role that has increasingly begun to emerge, however, is that of Level Designer, i.e. designers who have specific responsibility for the design of individual levels (i.e. levels of gameplay difficulty) within a particular game. This is probably a response to the increasing complexity of games, as consumers demand more levels that provide increasingly more challenging gameplay. Another specific design role evident in some of the companies interviewed is that of Scripter Designer, responsible for designing and scripting sophisticated games characters and their behaviours.

Designers are typically educated to Degree level in areas such as Games Development, Computer Science, Fine Arts, Film or Architecture. They usually have prior experience of working in the games sector, including completed experience of working on a number of published games. Creativity is a highly important trait for designers, since they are the prime source of ideas for games and their accompanying look and feel. However, they also have to have excellent communication and writing skills because they (a) produce documents that "pitch" games ideas, both internally and externally, (b) provide the detailed design specification documents that artists and programmers will subsequently follow, and (c) have to liaise extensively with artists/programmers etc to refine design, deal with any design problems/issues etc[20].

19 The emergence of Technical Director roles alongside Project Managers is also a symptom of the increased size and complexity of games projects.

20 Technical Artists, for example, are typically technical graduates (e.g. Computer Science, Engineering) who are proficient in the technical aspects of artistic tools and who play a liaison role between artists and programmers.

In terms of technical skills, designers need to be able to use standard desk-top publishing tools for documentation purposes (e.g. MS Word, MS Excel, Adobe). However, designers today have to be knowledgeable in all aspects of game production, and skills in using 3D design tools such as Maya and 3D Studio Max are commonly sought. Even familiarity with programming languages (such as C++) and scripting languages has become highly desirable in candidates for design positions.

Artistic/Creative: Artists represent a very important skill set within the games sector, and their importance to the games development process has increased exponentially in recent years as the development of games console technology has facilitated improved graphical power and graphical capability. This has in turn driven demand for more visually appealing games experiences, and the need for more artistic resources within the games development process has grown accordingly. At this stage, artists therefore account for a significant proportion of the numbers employed by games developers.

Artists working in the games sector also fill more specialist roles compared to, say, designers or programmers, and this is again partly driven by the progression towards a more "virtual reality" standard of games experience. Indicative specialisms within artistic roles include:

- Concept Artists, who create original artwork including character idea and design, environment idea and design, and component idea and design;
- Animators, or artists who create images that show characters/objects in motion or that illustrate a process;
- Modellers, who visualise and model characters, structures, interiors, external environments etc;
- Texture Artists, who specialise in adding texture elements to artistic creations;
- 2D Artists/Pixel Artists and 3D Artists, who work on either two-dimensional (e.g. for hand-held games) or three-dimensional art (e.g. for consoles);
- VFX Artists, who create high quality effects to augment other artists' environments and visuals; and
- Character Artists and Environmental/Background Artists, who specialise in the creation of character images and environment/background images respectively.

For all artist positions, traditional creative and artistic skills are a necessity, depending on the area of expertise, e.g. drawing, animating, modelling, texturing. For other technical skills, however, artists are mainly users of software rather than developers of tools or technology. For example, artists working in 3D environments need to be proficient in using software packages such as XSI, Maya and 3D Studio Max, while artists working in 2D environments need to be proficient is using tools like Adobe Photoshop, Adobe Illustrator and Pro Motion.

As the games production process has become more complex, however, the need for artists to be more familiar with the entire games production process pipeline has also become more important. At a basic level, this means an appreciation and understanding of what happens at other stages of the process, however this can be enhanced where artists have skills related to these other stages, e.g. artist's contribution to the programming process can be enhanced if they have skills in the use of scripting languages.

Programming: Programmers are responsible for developing non-vendor based software and related tools that are used in developing games. This is again a core skill set within the occupational groups for games development, and programmers make up a large proportion of the staff employed by games developers. A number of programming roles are identifiable among the companies interviewed, including:

Tools Programmer; Software Engineer; Graphics Engineer; 3D Software Engineer; Network Engineer; Console Programmer; Technology Programmer etc. Most programmers do not appear to enter the games sector as specialists, however, and programmers generally tend to be graduates with degrees in Computer Science, Engineering or a related area.

Programmers generally need to be proficient in the industry standard programming languages, which vary by platform, and the growth of online and mobile/wireless games means that programmer experience across platforms is highly valued – the most commonly used programming language for console and PC-based games is C++, for example, while Java is more commonly used for mobile games programming. Knowledge of scripting languages, which develop less complex programming code to improve functions within vendor tools for example, is also common.

Proficiency in using programming languages well is also highly valued, however. This is because the increasing complexity of games requires well constructed, fast running code that allows games to perform at a high standard. This usually comes with games sector experience rather than being taught, though a strong background and competency in mathematics/physics has been cited by companies as an indicator of good programming skills.

In addition, some specialisms within programming are emerging as the complexity of the games production process increases, though again these tend to be developed through industry experience rather than being gained through formal qualification. Programmers in the games sector, for example, have developed specialisms in physics programming, computer graphics programming, artificial intelligence, shading, gameplay, visual effects, audio techniques, and networking/Internet technologies (for online, multi-player games). Some of these areas also have specialist programming tools, such as Havok (a middleware programming tool for physics), AI Implant and Cg (a specialist programming language for computer graphics).

As with artists, programmers also need to have a better understanding of what happens at all stages of the games production process, and programmers who have skills in other areas (e.g. animation packages such as Maya) are better equipped to contribute to improving the process in these areas.

Quality Assurance: Quality assurance personnel are responsible for testing games to see how they work in practice and to feed back any problems emerging to the designers, artists and programmers. Games companies typically employ a small number of people in this area, and traditionally the key experience and skill required was an active interest in, and enthusiasm for, playing electronic games. This requires people who are PC literate and are good at tracking "bugs" in electronic games. Quality assurance personnel also need the necessary reporting skills to be able to feed back their findings into the games development process, however.

While these positions have in the past only required a fairly minimal level of educational qualifications (e.g. second-level standard), they are now increasingly being filled by more technically competent people, e.g. graduates with Computer Science degrees. This higher level of qualification is very useful, given the increasing complexity of games development, as it helps to give games testers a better understanding of the other elements of the games development process.

Balance of Skills: Table B.2 presents an overview of the balance of core skills needed across the games sector, based on the evidence of the companies interviewed. For each occupational group, it highlights the mix of technical skills, specialist technical skills and non-technical skills (rated as "very important", "important" or "less important") as well as commenting on the optimum balance of skills within each group. Generally, Table B.2 suggests that the games sector requires a strong mix of technical, specialist technical and non-technical skills, with the following balances evident across each occupational group:

- for management and project management roles, technical competency is commonly found (and it is essential for Technical Directors and Discipline Leads). However, good business and project management skills are becoming increasingly necessary as the size of games development teams expands and the cost of games development projects increases;
- for games designers, technical competency is again a useful trait, however the key skills lie in being able to (a) create games ideas and (b) communicate these ideas in an effective manner. An exception to this is the Technical Artist, who as a link between the designers and the artists needs to be more technically skilled but also have very good project management skills;
- artistic and creative personnel need a very strong mix of skills that incorporate a high level of technical competency in terms of animation and effects tools, a range of technical specialisms in different kinds of artistic/creative work, but also highly developed traditional non-technical artistic and creative skills;
- for programmers, the core skill required is very strong programming ability – however, as noted earlier, more specialist programming roles are also emerging while the growing size and complexity of games development projects also makes interpersonal skills and project management skills more highly valued; and for quality assurance staff, people have to be able to play games well above all other things. At the same time, technical competency is emerging as a common trait found in such staff.

Underlying this skills balance are a number of emerging key summary findings on the skills profile required for success in the games sector:

- the increased complexity of games is driving the need for more specialist skills within occupations. Artistic/creative needs in particular have become more complex as the potential to develop games to a virtual reality standard has increased and as software packages have improved accordingly. In addition, games programmers are increasingly developing programming specialisms in addition to their core expertise in areas such as physics, computer graphics, artificial intelligence and gameplay etc;
- programming needs are becoming more complex, and companies increasingly look for skilled programmers that are experts at writing well constructed, fast-running code. Often, good programmers have a strong background in areas such as mathematics or physics in combination with expertise in key programming languages such as C, C++ and Java amongst others;
- the growth of mobile/wireless and online networked games is driving the need for specific areas of expertise including: programmers with networking skills; C++ and Java expertise; knowledge of Internet technologies such as HTML and XML; and experience in the area of wireless devices/technologies such as hand-held devices, 3G mobiles etc;
- creativity and innovation is highly important. This is particularly the case for design and artistic staff, although companies' definitions of creativity also apply to how artists/programmers use the tools at their disposal in creative and innovative ways. Generally, however, creativity is viewed by companies as being something that is innate to the individual, i.e. it cannot be taught;

- technical awareness across all games occupational areas is growing, with positions increasingly filled by candidates with technical skills in programming or software. Knowledge of all aspects of game production is also more important, leading to some artist and design positions that value knowledge of programming or scripting languages, for example; and
- general project management skills are becoming more important as the size of games development teams increases and as the complexity of the games development process grows. This applies not only at the project management level but also for senior roles within the specialist occupations. Furthermore, given the increased interaction within bigger teams, communication and interpersonal skills are now highly valued.

Future Skills Needs: Generally, the games companies interviewed expect future skills needs to continue to reflect the recent trends evident in existing skills profiles (e.g. increased specialisation of artistic and R&D roles). Some key points to note, however, include the following:

- the need to recruit high quality programmers will continue to be highly important. While the depth and range of artistic skills involved in developing games has also increased, these skills are more easily available either through formal recruitment or through outsourcing;
- technology will continue to improve and develop, including the further development of areas such as artificial intelligence or the continued development of more sophisticated programming languages, and the sector's skills will need to be continually updated in line with this. The continued growth of online and wireless/mobile games will also have a similar effect on skills needs, requiring more people with the requisite skills in dealing with these technologies;
- the skills needed in content design and content creation will continue to adapt and increase as the technical complexity of games development increases and as the focus on developing "hits" becomes increasingly pronounced;
- business and interpersonal skills will continue to become more important, ranging from at least basic awareness at the very technical levels through to well-developed skills at project management levels;
- staff will also continue to become more adaptable in future, working on different types of games and for different types of platforms; and
- in terms of university and college course development, companies' preferences would seem to suggest a shift towards more specialised games modules within generic courses rather than having too many dedicated games development courses, though this is not common to all companies interviewed.

3.3 Skills Profile in Computer Generated Animation and Special Effects

The skills profile for the sector can be sub-divided into four broad categories: management; creative (art/story development); computer animation/graphics; and R&D. Each of these occupational groups, including the various roles involved and the indicative skills/experience required, is described in more detail below.

Management/Project Management: As with the games sector, management roles include the normal general/senior management roles that are typical to any company (e.g. Chief Executive, Finance, Human Resources etc) as well as specific project management roles that are more directly tied to CGA and SFX activities. Examples of such roles include Technical Director, CG Supervisor and Art Director, and they are responsible for providing the overall technical direction for their area, co-ordinating resources, agreeing milestones, monitoring progress, presenting product, and accounting for resources and expenditure. Traditionally, project management has come from a technical and animation/special effects background.

Creative (Art/Storyboarding): The creative occupational group forms a crucial initial input into the CGA and SFX process. The skills involved are largely non-technical in nature, however, and they are not as heavily influenced by skills in using digital technologies as the computer animation/graphics and R&D occupational groups. Indicative roles in this area include:

- conventional Artist roles, which create the concept art (up to 2D);
- Character Designers and Prop/Set Designers, who interpret themes, concepts and story ideas into character and prop/set designs;
- Modellers, who will produce physical models of both organic and inorganic objects that help to guide and inform the creation of similar digital assets;
- Storyboard Artists, responsible for conventional storyboarding activities; and
- Editors, who turn the storyboards into video-based "story reels" (including basic "scratch" audio), which are used to guide the subsequent animation process.

Generally, the key skills requirements here are non-digitally based artistic and creative skills, i.e. skills such as artists, designers, sculptors/modellers. Writing skills are also highly important for storyboarding. People working in these areas usually come from a relevant artistic or film-related educational background (e.g. degrees in Film or Fine Art), have a strong aesthetic eye and a good knowledge of traditional artistic/animation principles.

Editorial roles are somewhat more technically proficient in the use of digital technologies, and skills in the use of editing systems such as FinalCut or Avid are important here.

Computer Animation/Graphics: The animation and computer graphics occupational group is a very technical and very specialist group, where the use of digital technologies plays a particularly strong role. Some of the indicative specialist roles in the animation and computer graphics group, for example, as is evident from the companies reviewed, include the following:

- Character Animators, who create the motion and personality of computer graphics characters;
- Computer Graphics Modellers, who design and build the geometry of organic and inorganic computer graphics models;
- Riggers/Chainers, who are responsible for putting "digital bones" and skeletal structures into a computer generated model;

- Creature Developers, who are responsible for ensuring that models maintain an anatomically correct and sculpturally detailed form while moving through animated motions by connecting the rendered surfaces of models to animation controls and by creating procedurally animated simulations of hair, cloth, muscles and flesh etc;
- Digital Matte Artists, who create digital set extensions and virtual environments (e.g. vistas, cityscapes, backdrops);
- Layout Artists, who create sequences of shots using traditional film-making principles in computer graphics environments;
- Matchmovers, who create motion files matching original background plate photography and converting the plates into various formats for use with in-house software, i.e. matching real film sequences with CGA and SFX asset creations;
- Motion Capture Technicians, who record actual performances from real-life actors and apply their performances to digital characters;
- Digital Plate Restoration Technicians, who work with paint software to clean frames and remove dirt, scratches etc;
- Compositors, who seamlessly integrate all the layers or elements of a shot, including live-action and computer graphics elements;
- Rotoscope Artists, who work with compositors to modify and remove isolated elements for digitally composited sequences;
- Lighting Directors, who establish direct and reflected lighting and shadows effects to realise the look and style of a shot; and
- Computer Graphics Technical Assistants, who support all areas of production and who have particular responsibility for working with visual effects and computer graphics supervisors to create the look of computer generated objects and scenes – including lighting, shading, rendering etc.

The types of qualifications required for such positions vary. For many positions, incumbents are educated to Degree level in areas such as Film, Fine Art or Animation, particularly where technical skills are important but artistic skills are crucial. Examples include Character Animators, Matchmovers, Rotoscope Artists, Lighting Directors and Layout Artists. Computer Science graduates are typically sought for positions such as Creature Developers, Motion Capture Technicians and Technical Directors/Assistants, while qualifications in Industrial Design and Architecture are also useful for work as a Digital Matte Artist or a Lighting Director. Photography qualifications and skills, meanwhile, are considered useful for Compositors, Digital Matte Artists and Matchmovers.

Required technology and software skills can also vary, with the most common requirement being knowledge of, and proficiency in, 3D animation packages such as Soft Image XSI, Maya, 3D Studio Max, Electric Image, LightWave and Form Z[21]. Typically, skills using such packages are required and/or desirable for Creature Developers, Character Animators, Matchmovers, Digital Matte Artists, Layout Artists, Motion Capture Technicians and Technical Directors/Assistants. Skills requirements for other technologies and software, however, include the following:

- need for a knowledge of Linux and UNIX operating systems across a range of occupation types, including Creature Developers, Compositors, Digital Plate Restoration Technicians, Motion Capture Technicians, Rotoscope Artists, Lighting Directors and Technical Directors/Technical Assistants;

21 Maya is the industry standard. However, XSI is now the biggest challenger to Maya's dominance.

- need for C++ and Java programming skills for Technical Directors/Assistants and to a lesser extent for Compositors and Lighting Directors (e.g. basic knowledge of C++ or ability to use Shell scripting languages);
- knowledge of specialist software for Compositors (e.g. Discreet compositing products), Matchmovers (e.g. RealViz Matchmover, 3D Equalizer) and Rotoscope Artists (e.g. XSI Matador, Digital Magic, Elastic Reality); and
- knowledge of rendering software (e.g. Renderman, Mental Ray) is also an important requirement across a number of positions.

While technical skills are very necessary for a lot of animation and computer graphics positions, it is important to note that artistic skill is often regarded as an equally crucial if not more crucial requirement in employee skill sets. From this perspective, therefore, people working in animation and computer graphics often possess a unique blend of both digital and non-digital art skills, including a well-developed understanding of both the creative and technical processes involved in producing computer generated assets. Artistic and creative talent is particularly important in the sector at present, given that a lot of the animation and computer graphics software and tools have become "commoditised". This means that there are more people who are technically competent in using the packages, so competitive advantage therefore lies more in creative talent in using such tools rather than in technological capacity. Furthermore, artistic and creative talent does not solely mean drawing and related skills – acting/performance skills, for example, were also cited as useful for some positions, such as Character Animators.

R&D: The R&D/programming group are the people within the CGA and SFX sector who create proprietary technology tools that leading-edge companies in the sector will use either in tandem with, or to enhance, vendor-based tools (such as Soft Image XSI, Maya and 3D Studio Max) for various animation and computer graphics activities. Indicative roles in these areas, as is evident from companies reviewed in the sector, include:

- Tools Programmers, who develop tools and applications to assist productions and computer graphics resources in managing resource processes and computer graphics assets;
- Systems Developers, who are responsible for the design, prototype and construction of complex computer and data storage systems needed to create cutting edge graphical images;
- Database Applications Developers, who create data storage and management infrastructure and related applications and systems;
- R&D Engineers, who create software systems and techniques for creating visual effects in a number of specialist areas;
- Interaction Designers, who are responsible for designing software behaviours and logical, consistent preparation of functions within software environments;
- User Interface Prototype Developers, who are responsible for building functional prototypes of complex interactions and testing alternate designs in response to user feedback; and
- Quality Assurance Engineers, Automation Engineers and Technical Writers, who perform various quality assurance roles.

As noted above, R&D Engineers can also operate in a number of specialist areas or work on quite specific R&D activities. For example, some of the specialist R&D positions evident from the research include positions in: 2D (systems and techniques for painting, rotoscoping, compositing and image viewing); Animation (systems and techniques for animation, procedural animation or motion capture); Computer Vision and Data Capture (systems and techniques that emphasise tracking, matchmove, 3D reconstruction); Core Architecture (architecture and frameworks for graphical applications); Dynamics Simulation (systems and techniques for developing structural phenomena such as cloth, hair, flesh etc); Effects Simulation (systems and techniques for developing natural phenomena such as water, fire and smoke); and Rendering (systems and techniques for developing rendering).

A common basic requirement for all positions in this occupational group appears to be a Degree in Computer Science, Engineering or some other related discipline. Usually, a strong background in maths, engineering or physics is underlying this. Knowledge of programming skills using C/C++ is also required for most positions, with some positions valuing expertise in Java programming (e.g. Systems Developers, Quality Assurance Engineers) and scripting languages such as Shell, Python, TCL or Perl (e.g. Tools Programmers, Quality Assurance Engineers). For positions involving some data storage and management roles (e.g. Systems Developers, Tools Programmers, Database Applications Developers), knowledge of database programming languages such as Oracle, SQL or PLSQL is needed. In addition, knowledge of Linux and UNIX operating systems is commonly sought across most positions.

Although not considered a necessity, a working knowledge of, and familiarity with, 3D computer graphics packages and media production processes is another valuable trait that companies like to see in people working in R&D, e.g. programmers who have a working knowledge of how to create animation and computer graphics using Maya, Soft Image XSI, 3D Studio Max etc.

Balance of Skills: Table B.4 provides an overview of the balance of skills needed for the various occupational groups in the CGA and SFX sector. As with the games sector, it shows that a complex mix of technical, specialist technical and non-technical skills are needed. For each occupational group, for example, the following mix of skills is evident:

- while management in the CGA and SFX sector often comes from technical backgrounds, the key skills requirement here is good project management skills – though some roles, such as Computer Graphics Supervisors and Technical Directors/Art Directors, also need the strong technical competency as a key job requirement;
- for creatives, the key skills required are traditional, non-technical artistic and creative skills, though editing staff need artistic/creative skills but also technical editing skills;
- computer animation and graphics staff, on the other hand, typically need a very complex mix of core skills that incorporates traditional artistic and creative skills, general technical skills in animation and computer graphics, but also specialist technical skills depending on their role; and
- R&D staff typically have to be very technically competent in computer programming, however some also fill specialist programming roles. Project management and communication skills are also increasingly important as the process for making CGA and SFX becomes more complex.

Key findings on the skills profile needed for success in the CGA and SFX sector include the following:

- computer animation requires a unique blend of digital and analogue art skills, requiring an understanding of both the creative and the technical processes involved;
- both artistic/computer graphics positions and R&D/programming positions feature a high or increasing level of speciality. Traditionally, staff have either come in with, or have adopted, specialist roles and thereafter have deepened their specialism in these areas;
- the level of technical proficiency in the sector is generally very high. Typically, programmers have to be highly competent in using the main programming languages (C/C++, Java), while computer graphics and modelling specialists need strong knowledge of the main animation software (Maya, Soft Image XSI, 3D Studio Max etc.);
- in addition, general technical awareness of both programming and software techniques is valued – i.e. having programmers with computer graphics experience or having conventional and computer graphics artists with programming and scripting skills;
- proficiency in maths/engineering/physics is required for specialist animation roles such as 3D computer modelling and "rigging/chaining", and it is typically also found among high quality programming staff;
- aesthetic and artistic skills are highly important in the art and computer graphics area, as is an overall understanding of the film-making and post-production processes;
- adaptability, particularly for new or changing technologies, is very important. This is because companies in the sector are highly skilled at developing proprietary tools, which can change on a highly regular basis, in addition to using new tools produced by third party software developers – in order to drive competitive and cost advantages; and
- communication and project management skills are becoming increasingly important as the scale and complexity of special effects and animation activity grows and as more work within the production house is shared amongst a number of service providers.

Future Skills Needs: Discussions with special effects and animation companies have elicited a number of interesting insights on future skills needs, including the following:

- while many working in the sector have tended to develop deeply specialist skills in a single area, there is a trend among some of the main players in the sector to cross-train their staff and make them more competent across a broader range of areas, and thereby make them more capable of delivering digital "assets" (e.g. a creature, an animated object) in their entirety. A smaller number of activities (e.g. character animation) will continue to remain deeply specialist;
- high-end skills are the most likely skills to remain in-house among the main players in the sector (e.g. character animation, tools development), while much of the execution of activities will have more potential to be re-located to lower cost locations; and
- software packages and other development tools will continue to evolve. Discussions with some of the companies interviewed, for example, would suggest that XSI is overtaking Maya as the industry standard software for 3D computer graphics and animation. However, this is not likely to change the core skill sets involved.

3.4 Skills Profile in the Digital Film Sector

This section provides an outline of the core skills profile for the digital film sector. Core skills are in the following broad areas: management; content creation; pre-production; production; post-production; and other relevant roles.

Management: Management roles in the digital film sector can be broadly split into two areas – general management roles that are familiar to most types of companies/sectors and management roles that are more specific to the film/television sectors. General management roles include the normal senior management positions as well as management in roles such as finance, human resources etc. As with other sectors, general business skills and qualifications are important here, while experience in the film industry or other related media industries is also common.

More specific film related management roles involve Producers and related roles, however. These are usually people with significant previous experience of working in the film sector or in a related area, and they are the people who typically make film projects happen. As such, they therefore have to bring a unique mix of finance/fund raising, legal/negotiational and general deal-making skills as well as strong management, organisational, budgeting and scheduling skills. How these roles are filled is also a function of the size of the company, as many of these roles can be freelancers/outsourced.

Generally, the role of the Producer and other related positions has changed little as a result of the increased digitisation of film production. Increasingly, however, incumbents in such roles (where they have embraced digital technology as part of film-making) also have a strong knowledge of how digital technologies and activities affect the film-making process, e.g. familiarity with how digital tools assist activities such as video and sound production, editing etc[22].

Content Creation: As with the role of the Producer, the key roles underlying the creation of film ideas and concepts (which ultimately become feature films) have changed little as a result of the emergence of digital technologies. The core roles here remain those of Directors, Scriptwriters and Storyboard Artists, and the core requirement for these roles remains creative talent and ability. Creative educational backgrounds in film, television or some other related area are common among such people, together with a strong creative/conceptual/visual ability and a broad knowledge of film production techniques. Directors are also very much "managers", however, who work closely with Producers – Directors therefore need to have strong business and project management related skills (e.g. budgeting, scheduling) as well as the ability to envisage a scene and instruct actors to deliver on that vision.

Digital technologies are having an impact on how these roles are performed, however, and specialist software packages have emerged as an aid to writing and storyboarding in particular. Increasingly, for example, writers are familiar with how to use script creation software for writing and organising scripts (such as Drakkon Script, Dreamascript, SceneWriter, Scriptware and Storybase), while storyboard artists are proficient in using electronic storyboarding packages that incorporate character sketching, photography import and sound capture (such as Storyboard Quick, Storyboard Artist and Storyboard Pro).

Pre-production: Pre-production roles include Set Development, Location Management, Casting, Costume Design and Make-up. As with those working in content creation for digital film, people working in these roles are increasingly influenced and aided by digital and related technologies. The nature of the roles themselves largely remains the same as in the pre-digital environment.

22 As regards digital film-making, at this stage film-making is in a state of transition, with some Producers, Directors, Directors of Photography etc embracing the technology while others are slow to accept/adopt it.

Generally, people working in pre-production come from artistic, film, television or other creative backgrounds, and the nature of their roles require good creative and visual ability. Many of the roles now benefit from emerging software and technology, however, which principally help to more efficiently deliver pre-production roles by increasing productivity, improving information flows and producing cost savings. This includes tools now available for set development and pre-visualisation (e.g. Avid Film Composer, Antics Pre-viz, IKTRIX Impulse, 5D Android), costume design (Personal Patterns 4 Deluxe, PatternMaker, Expert Vision) and make-up (eImagePro, MAGGI Mirror), while location management professionals also now have access to location management databases and websites when scouting for sites.

Production: Film production (i.e. live action shoot activities) is also increasingly influenced by the use of digital technologies. This has had most impact on camera professionals, with the emergence of digital high-definition (HD) cameras for film-making, but digital technologies have also emerged in other areas. The main examples where digital technologies affect live action production are as follows:

- HD cameras, which provide comparable quality to traditional film but which again provide productivity and cost saving advantages, e.g. by simplifying the production process, removing the need to transfer film from an analogue to a digital format for editing. Among the main HD camera formats and ranges that are popularly in use for digital film are Sony's SRW (including the current generation F950), Panasonic's DVCPro-HD (including the current generation VariCam) and Thompson's Viper Filmstream Camera;

- the emergence of computerised motion control systems, which provide for computer-assisted cameras and rigs, with multiple moving axes allowing high precision, repeatable camera moves. These systems typically provide integrated hardware and software packages that can plan complex camera move generation and manipulation (using 2D and 3D graphic displays). An example of such a system is the FLAIR (Version 4) Motion Control Computer System; and

- production of electronic film dailies, which have again raised the value and efficiency of the traditional review system for daily film shoots. In particular, they offer increased functionality over tape-based systems (e.g. sorting dailies by scene or by take, creating playlists of scenes/takes, adding and removing scenes/takes). Examples of such tools include facilities such as Quantel iQ, MESoft and Technique. CineShare is a proprietary Sony software system in this area, and some other studios also produce their own tools.

Typically, these tasks are carried out by traditional film production professionals who would have acquired the ability to use such devices on-the-job rather than having specialist qualifications in the use of these techniques. Increasingly, however, skills in these areas are likely to be incorporated into course curricula for digital film courses. Furthermore, the availability of digital technologies does not diminish the need for good creative and visual flair for camera work etc.

Post-production: Post-production roles in the digital film sector cover a number of activities, including the following:

- telecine, which is the process of transferring motion picture film to a digital environment (including colour correction);

- non-linear video editing, which includes digital film and audio transfer, video compression and storage, dailies synching and projection, splicing, extracting, trimming etc;

- image manipulation activities, which include CGA and SFX, compositing, "wire removal" (i.e. removal of objects and scratches from images), pixel manipulation etc; and
- sound design and mixing. This includes activities such as: automated dialogue replacement (ADR), which involves re-recording of dialogue that cannot be salvaged from production tracks; and foley, which matches live sound effects with the action of a picture.

In addition, many of the activities described for the CGA and SFX sector can also be considered part of the post-production phase on film productions needing these enhancements.

Incumbents in these roles usually have some form of related qualification – this may include general degrees in film or a related media area, more targeted qualifications in film post-production or sound post-production, or other artistic/creative qualifications. Formal qualifications are not necessarily a pre-requisite, however, but creative skills and a good eye/ear for visual and audio look, feel and sound are very important. Knowledge of appropriate hardware and software devices and packages are also crucial, including: Discreet software such as Smoke and Flame, or Adobe After Effects (for visual effects); editing and compositing software produced by companies such as Avid or Pinnacle; telecine software and hardware tools, such as Spirit; and digital audio console/software systems such as Digidesign Pro Tools and Lightworks Touch.

Furthermore, post-production activities are often carried out by independent post-production companies, who are stand-alone and dedicated to post-production activities only. Discussions with companies in the digital film, digital television and computer generated animation/special effects sectors suggest that competition in this area has increased substantially. As a result, some companies in this space indicated that better business and project management skills (across the board) are increasingly highly valued.

Other Roles: Other important roles in the digital film sector include (a) marketing and distribution roles and (b) legal roles pertaining to rights negotiation and protection. Marketing and distribution roles are usually filled by people with business/marketing degrees or by people with other educational qualifications but with relevant marketing experience. Traditional marketing skills are required here, however the role is also developing with the emergence of new marketing channels. Online marketing in particular has had an impact on film marketing and distribution, principally through the development of film-specific websites, the distribution of film trailers for download/streaming over the Internet etc (obviously, making this type of marketing activity happen also needs web designers with appropriate skills).

As with other media and entertainment sectors, legal expertise in rights negotiation and protection is also particularly important. While such a role has been long established in several entertainment sectors, it has become especially important in a digital environment, where the threat of product becoming available in illegal or unlicensed ways has increased.

In other areas, digital sound systems have become an integral part of feature film exhibition and presentation. These systems are typically provided through external providers, however (e.g. Dolby, Sony). Similarly, companies are emerging that will provide digital projection systems, though the extent of digital projection for feature films is not yet widespread.

Balance of Skills: Table B.6 provides an overview of the balance of skills required for the various occupational groups in the digital film sector. While digital technologies are certainly having an impact on the skills profile needed for film-making generally, Table B.6 shows that non-technical skills generally continue to be the core skills required across most occupational groups:

- the core skill needs for management, for example, are commercial, project management, and financial/budgeting skills rather than technical skills in film-making (though people in these role may also have such a background);
- similarly, content creation requires a strong creative, conceptual, scriptwriting and visual ability, while some technical aptitude using appropriate software serves as an aid to this process;
- pre-production is in turn similar to content creation, as traditional pre-production skills are augmented by some technical aptitude in using related tools;
- for production and post-production, on the other hand, strong technical competency in using digital camera systems and a range of post-production tools is highly important, however incumbents in these roles typically also show creative and visual flair; and
- there are some other crucial roles in digital film, such as marketing/distribution and rights negotiation/protection, which are essentially non-technical in nature.

Key findings on the skills profile needed for success in the digital film sector include the following:

- the people who are key drivers of any film project, digital or otherwise, continue to be the producers, directors and scriptwriters. With the increasing importance of digital technology, however, people in these roles are likely to have a more knowledgeable understanding of what digital activities bring to film projects;
- many of the less technical areas of the traditional film-making process (e.g. storyboarding, location management etc) are now aided by computer software, making knowledge of such tools increasingly important;
- the unique selling point for digital film, however, continues to lie in the talent and creativity of its people rather than the technology at its disposal. Creativity therefore lies at the heart of what most successful leading-edge firms in the sector do; and
- business and project management skills are becoming more crucial, both in terms of more discrete business and project management structures and greater business awareness on the part of staff generally.

Future Skills Needs: Companies interviewed in the digital film sector do not see any fundamental shifts in their skills needs going forward. However, some points of note in this regard are as follows:

- the use of digital intermediary processes in film will certainly increase in future, including the use of more computer graphics and computer animation, use of artificial intelligence, photo-reality etc. A general shift towards greater employee knowledge of digital and computer-based systems is therefore likely;
- creative skills and resources will continue to be of the utmost importance throughout the film production process, however, irrespective of the input of digital technologies;

- the need for business skills (finance, funding, legal and negotiation skills) and project management skills will continue to become more crucial given the costs of film production, including the need for more staff to be "business aware"; and
- marketing and distribution skills will continue to need to evolve with emerging new ways of marketing and distributing product. Digital distribution will become particularly important, which will require more skills and technologies in digital asset management (storage, image compression/decompression, encryption/decryption), digital projection and e-cinema etc.

3.5 Skills Profile in the Digital Television Sector

This section provides an outline of the core skills profile for the digital television sector. Skills in the digital television sector can be sub-divided into a number of different categories. These include: management; content creation; pre-production, production and post-production; systems development; and marketing and distribution/other roles.

Management: As with digital film, management roles in the digital television sector can be broadly split into the two areas of general management roles that are familiar to most types of companies/sectors, and management roles that are more specific to the television sector. Again, general management roles include the traditional senior management positions as well as management in roles such as finance, human resources etc, where general business skills and qualifications are important here, but where experience in the television industry or other related media industries is common. How these roles are filled is also a function of the size of the company, as many of these roles can be freelancers/outsourced.

Producers and similar roles in the television sector share a similar background to that found in the film sector, i.e. they are people with significant previous experience of working in the television sector or in a related area, and they are the people who typically make television projects happen. As per the film sector, they need the same mix of finance/fund raising, legal/negotiational and general deal-making skills as well as strong management, organisational, budgeting and scheduling skills.

Similarly, the role has not been significantly affected in any direct way by digital technologies, though a knowledge among Producers of how digital technologies and activities affect the television production process is more common.

Content Creation: Content creation for television again involves much the same skills as content creation for film, and the key roles for creating television programming have changed little as a result of the emergence of digital technologies. Therefore, creative talent and ability lies at the heart of what Directors, Writers and Storyboard Artists in television do. This requires creative educational backgrounds in film, television or some other related area, strong creative/conceptual/visual ability, and a broad knowledge of television production techniques.

Similarly, digital technologies are having an impact on how these roles are performed, and specialist software packages have emerged as an aid to writing and storyboarding in particular. This includes script creation software for writing and organising scripts (as outlined above) and electronic storyboarding packages that incorporate character sketching, photography import and sound capture (also outlined above).

Pre-production and Production: Pre-production and production roles, as with digital film, include Set Development, Casting, Costume Design, Make-up, Digital Camera, Digital Lighting, Digital Sound etc. As is evident from the review of digital film activities, people working in pre-production and production roles are increasingly influenced and aided by digital and related technologies. Pre-production and production roles themselves largely remain the same as in the pre-digital environment, and where relevant most incumbents in pre-production and production roles would have acquired on-the-job skills in moving from analogue to digital technologies (e.g. camera, lighting, sound).

Generally, people working in pre-production and production come from artistic, film, television or other media-related backgrounds, and the nature of their roles also require good creative and visual ability. Increasingly, however, cameramen and lighting/sound technicians are proficient in using digital camera/lighting/sound equipment and techniques, while even people like set designers, costume designers and make-up artists are aided by software tools that are specifically provided to enhance their activities.

An additional element of digital television production is the production of ancillary content for programming offered on interactive television, e.g. text, graphics or audio/video based content that interactive television users can access while watching a documentary, for example. This kind of production role is typically more technical than other roles, incorporating skills that range from basic writing and journalistic skills (e.g. for text-based content) through to the types of animation and graphics skills that are found in the CGA and SFX sector. At this stage, even (relatively simple) games can be developed for use in interactive television content.

Post-production: Post-production activities for the digital television sector are now heavily influenced by digital technologies. Roles in this area include Video Post-production, Digital Video and Audio Editing, and Compositing. Other CGA and SFX roles, and digital film post-production roles (as described earlier), can also be used in digital television post-production, however.

For the types of roles listed above, incumbents typically have qualifications in a film, television or other media related area. Previous film and television post-production experience also tends to be sought, though trainees can be brought in at a junior level or for internships. In addition to this, such people are usually proficient in some of the major video effects, compositing or video editing packages, such as Discreet Smoke, Discreet Flame, Adobe After Effects, Pinnacle Commotion, Avid Symphony and Avid Xpress, and Apple Final Cut Pro. For non-linear audio editing, workstation systems such as DVora Pro, Amiga ProStationAudio and Pro Tools 5 are often used.

Systems Development: People working in systems development roles have become increasingly important in digital television, but particularly with the emergence of more interactive television formats – these are the people who not only develop internal computer-based systems but who also develop consumer- and client-facing applications as well as content management and storage systems. Typical roles in this area include Designers, Internet Architects, Software Engineers and Systems Developers.

As with several other Digital Media sectors, Software Engineers, Systems Developers and related occupations usually have degrees in Computer Science or Engineering – in this case, prior experience in developing consumer-facing applications and content management systems is valued. Programming skills in Java/J2EE/JavaScript, Internet technologies/protocols like UML, HTML, XML, Weblogic and TCP/IP, and database languages like Oracle and SQL are also commonly sought as well as experience with operating systems like Sun, UNIX, Solaris or Linux. In addition, given that digital television allows content to be delivered across multiple platforms (e.g. online, mobile, portable devices), experience with these platforms is common.

Designers and Internet Architects are more directly involved in creating the look and feel of interactive applications. Such people commonly have some kind of design/web design qualification as well as strong conceptual, visual design and web design skills. Knowledge of packages such as Photoshop, Visio and Illustrator is also often sought.

Marketing and Distribution/Other Roles: Other key roles relate mainly to marketing and distribution, programme planning and rights negotiation and protection. For marketing and distribution, experience in online or interactive marketing environments is becoming more important as television spreads to other platforms and becomes more "on-demand". Programme planners, on the other hand, are more likely to come from a related media background and have a good feel for consumer tastes. As with other sectors, specific expertise in rights negotiation and protection is often sought to deal with piracy and copyright issues arising from digital distribution.

Balance of Skills: Table B.8 provides an overview of the balance of skills required for the various occupational groups in the digital television sector. For each group, the mix of skills required is summarised below:

- as with the core management roles for digital film, commercial, project management, and financial/budgeting skills rather than technical skills are highly important;
- similarly, content creation and pre-production require a strong creative, conceptual and visual ability, while some technical aptitude using appropriate software serves as an aid to this process;
- production and post-production, on the other hand, are more technically skilled while also having good creative abilities;
- systems developers need to be very technically competent as computer scientists and engineers, however they do not need the same creative background as some of the other occupational groups; and
- roles in marketing/distribution, legal rights negotiation/protection etc are highly important but largely non-technical in nature.

Key findings on the skills profile needed for success in the digital television sector include the following:

- as with digital film, the people who are key drivers of a television project continue to be the producers, directors and scriptwriters;
- despite the aids provided by computer software, talent and artistic/creative skills remain at the core of television production and concept creation as well;
- as per CGA and SFX, for digital production and post-production activities there has been some move towards "commoditisation" of technologies and software, meaning that an increasing number of people/firms have access to the tools needed to operate in the sectors, so innate talent and creativity is increasingly important in this area;
- people working in these sectors come from a mix of educational backgrounds, although media-related qualifications are common and more technical positions require computing/audio-visual related backgrounds and expertise, e.g. film and television production, broadcast engineering. Digital television qualifications and courses have now also appeared in the UK;

- where television production targets the interactive standard in the digital world market, specific skills are required including: programming/computing; ability to use/develop content for broadband technologies; skills for "multi-platforms" such as TV, broadband, PC and wireless devices; digital television design and development software; and I-TV middleware platforms such as OpenTV, Liberate etc;
- experience of the media industry also seems to be important, as it is not always easy to introduce graduates directly into the business; and
- business and project management skills are becoming more crucial, both in terms of more discrete business and project management structures and greater business awareness on the part of staff generally.

Future Skills Needs: Companies interviewed in the digital television sector would suggest that important emerging future skills needs will be influenced by the ongoing emergence of interactive and on-demand television. However, some points of note in this regard are as follows:

- interactive television will increase as broadband adoption grows and as digital television becomes more popular. This will have implications for skills needs for developing interactive television tools, e.g. programming of systems, design of consumer interface tools and environments. Design and planning skills in particular will need to be enhanced as a result as well as more expertise in the use of menu-based/navigation systems and content management systems;
- companies expect to need more and more creative resources. However, these are likely to come from a mix of backgrounds rather than any specific area of education/training;
- project management, communication and interpersonal skills will become more important in the future, as digital television will require more interaction between people along the production and distribution process e.g. interaction between creatives and post-production regarding the look and feel of television product after digital processing, interaction between systems development and marketing/distribution regarding the design and operation of on-demand television systems; and
- marketing and distribution skills will continue to need to evolve with emerging new ways of marketing and distributing product. This will require people who can follow and quickly understand new ways of marketing and distributing product.

3.6 Skills Profile in the e-Music Sector

This section provides an outline of the core skills profile for the e-music sector. Core skills can be sub-divided into four key occupational groups: R&D; operations/technical support; marketing and distribution; and management/other roles.

R&D: e-Music employees in the R&D occupational group are the people who develop digital technology initiatives in the sector, including label/retailer/artist websites, content management systems, mobile/wireless technologies, other technologies that support marketing and distribution, reporting/internal management systems (e.g. royalty management) and secure payment systems. These people are typically either applications developers, systems developers, computer programmers or web designers.

R&D within the e-music sector does not involve the same degree of specialisation as is found in some other Digital Media sectors. Typically, R&D employees in the companies reviewed are graduates in Computer Science or a related discipline, who have programming skills in a mixture of languages, such as C++, C-Sharp and Visual Basic.Net, as well as skills in using database languages such as RPG ILE, SQL, COBOL and Oracle. Web design and user interface programming skills are highly valued, and experience in developing e-commerce or other consumer-facing applications is also very important – this does not necessarily have to be experience in developing music-based applications, but rather experience in developing applications that handle both a large volume of transactions and also complex transactions (e.g. transactions that facilitate a "shopping basket" of music and ancillary sales).

Operations/Technical Support: Operations and technical support employees are typically the people who monitor the operation of e-music business applications and systems and deal with any problems/issues arising (including customer support). Indicative examples of the types of roles found in the companies reviewed include the following:

- Technical Support, who investigate any infrastructural problems arising in the systems and applications;
- Infrastructure Support, whose job is to optimise and enhance the available capacity of the systems and applications;
- Customer Support, the people who provide classic front-line support services to the consumer (such as private individuals accessing digital music through licensed distribution services); and
- Business-to-Business Support, the people who provide classic front-line support services to business customers (e.g. music labels that are distributing digital music through third party "e-tailers", music-related businesses that are provided with web hosting services).

Also aligned to this group are employees who input data into the content management systems – these are the people who populate the content management system with: the "media data" that is being made available for purchase (e.g. music, video, images etc); the "meta data" that can accompany the product offering (e.g. artist name and details, album name and details, track listings, genre classification, biographies, discographies, related music reviews etc); and the "offer data" for the product offering (e.g. where the product can be sold, when the product can be sold, how much the product can be sold for etc).

Technical Support and Infrastructure Support are roles that require a reasonably high degree of technical competency. Consequently, people with a Degree in Computer Science or a related discipline are usually sought. Experience in a technology sector is a requirement, particularly experience in using networking or server technologies (e.g. TCP/IP networking protocols, Microsoft IAS web servers), while familiarity with the main online media technologies is also welcomed (e.g. Windows Media Player, Real Player). Technical Support and Infrastructure Support require the same broad skill set, however, Infrastructure Support personnel usually have more years of relevant experience behind them.

Customer Support and Business-to-Business Support roles, as noted above, are classic front-line service support functions. Having a technical background in Internet and media technologies is helpful for these roles, however it is not a necessity, as much of the required technical knowledge can be learned" on-the-job". Language skills, on the other hand, are a crucial requirement for these roles given that e-music services from a single source are generally traded on a global basis.

There are no specialist or technical skills required for inputting data to content management systems, and this task is usually carried out by people who have basic clerical and computing skills. This job is typically done by people on a part-time basis (e.g. using student employment).

Marketing and Distribution: As is the case with physical music product, marketing and distribution is a highly important part of the e-music value chain. This is especially evident in some of the major music labels, for example, which have now developed separate marketing and distribution functions for both physical music and e-music. Some of the indicative marketing and distribution roles found in an e-music context are:

- Content Planning, which includes the people who are responsible for advising and recommending on the type of music that should be marketed, i.e. the mix of artists that should be featured, the mix of genres that should be featured, geographical variations in content planning etc;
- A&R[23], which includes finding the right talent (to sign up on music labels). While A&R is important in finding creative talent across the music industry, it will also become important in a specific e-music context through the emergence of "e-labels" (e.g. which promote music that is made available solely in a digital format);
- Content Procurement, which involves negotiating/acquiring licences to get access to appropriate product (for e-music retail websites);
- Product Marketing, which involves defining what products should be sold, what the detailed specification for the product should be (e.g. the appropriate product "bundling"), and what market segments should be targeted;
- Consumer Marketing, which involves marketing targeted at individual consumers; and
- Business-to-Business Sales/Marketing, which (from an e-music retailer perspective) involves selling wholesale and retail services to potential suppliers of e-music (e.g. promoting the retailer's website as a distribution channel for music labels, offering all-in web hosting services for that provide labels and other music-related companies with their own branded retail website).

23 Artist and Repertoire.

Employees working in these areas usually have a marketing/commerce/business degree, though this is not always necessary – skills for A&R and Content Planning positions, for example, are primarily based on having an excellent knowledge of and feel for music tastes, trends and talent. Traditional marketing and sales skills are also key, and music industry experience is useful, though experience working in other online and mobile marketing environments is increasingly important. For business-to-business activities, sales and marketing experience drawn from selling other high transaction software applications provides valuable skills in trying to sell web retail and web hosting services.

Management, Executive and Other Roles: Management, executive and other roles in the e-music sector include the normal management and administration roles that are found in most sectors, including general management, finance, human resources, public relations and general administration. People who fill these positions usually have business degrees or qualifications in the relevant activities, though record industry experience (irrespective of qualifications) is still common among management. Experience in other e-commerce sectors is also useful for managers who are directly involved in e-music related activities, however.

e-Music businesses also need general legal expertise and skills in the same way that other businesses do. Of particular importance within e-music, however, is the need for specific legal expertise in the area of negotiating and protecting digital music rights – this is especially crucial given the difficulties with music piracy in the e-music sector. To fill this role, e-music companies need people who not only have the appropriate legal qualifications but who also have strong experience of the music industry, including a detailed and intimate knowledge of music law.

Balance of Skills: Table B.10 provides an overview of the balance of skills required for the various occupational groups in the e-music sector. In summary, it shows a mix of technical and non-technical skills being required, with some limited specialisation of technical skills in some areas:

- R&D staff typically need to be very technically competent, with backgrounds in C++ programming but also with additional specialisms in areas such as database programming and user interface programming;
- technical support staff incorporate a mix of people who are technically competent in monitoring and maintaining systems on the one hand (Technical Support and Infrastructure Support) and people whose core skills lie in traditional customer support and language skills on the other (Customer Support and Business-to-Business Support);
- marketing and distribution is crucially important to the e-music sector, and above all this requires traditional business and marketing skills, with experience in the music industry and/or online marketing environments being helpful; and
- there is also a range of general management and other specialist roles (rights negotiation and protection, royalty management) that are non-technical in nature but crucially important.

Key findings on the skills profile needed for success in the e-music sector include the following:

- while the actual conversion of music from a physical to a digital format is now a fairly commoditised task using widely available tools (e.g. Apple's iTunes), technical skills in the e-music sector are highly important in the building, monitoring and maintenance of content management systems, distribution systems, client-facing applications and retail platforms;
- there are a number of non-technical skills that are highly important in the e-music sector, however, particularly in the areas of customer/client support and marketing and distribution; and
- prior work experience is also much sought after. This does not necessarily have to be music industry experience (although content planners need to have a good feel for what current musical tastes and trends are). Experience in other e-commerce and consumer-facing application environments, for example, is equally highly valued.

Future Skills Needs: For the e-music sector, companies interviewed to date again do not foresee any significant shifts in their core skills requirements over the coming 3-5 years. Key points noted by companies, however, were as follows:

- existing skills will continue to have to move with improvements in available technologies and device types for e-music. In particular, more specialist skills in technical/design roles will be needed across the different platforms that are emerging as e-music opportunities (e.g. wireless and mobile);
- the explosion of potential consumer offerings and consumer choice through e-music may have implications for skills development on the sales and marketing side, e.g. continued development of online sales and marketing skills and capacity, development of sales and marketing for converged e-music/other entertainment offerings; and
- for business-to-business sales, people with experience in software/technical sales will become more valuable in future relative to people with previous music industry experience. This will be driven by the continued emergence of telecommunications companies and mobile phone operators as customers and providers of e-music services and capability.

3.7 Skills Profile in the Wireless and Mobile Services Sector

This section provides an outline of the core skills profile for the wireless and mobile sector, based on the evidence of discussions with companies operating in this sector. Core skills can be sub-divided into four key occupational groups: management; technical/R&D; content development; and sales and marketing.

Management: Management, executive and other roles in the wireless and mobile sector include the normal management and administration roles that are found in most sectors, including general management, finance, human resources, public relations and general administration. People who fill these positions usually have business degrees or qualifications in the relevant activities, though relevant industry experience in the wireless and mobile sector or in a technology or entertainment sphere would be common.

As with some of the other sectors reviewed, management in the wireless and mobile sector will also include more technically-oriented management roles (examples given above include Mobile Technology Manager and Project Manager) – such roles will typically be filled by people with Computer Science or related degrees who have skills in programming, web design etc. However, the core of their role within a wireless and mobile services company remains being responsible for project management and related responsibilities.

Technical/R&D: The technical/R&D occupational group for the wireless and mobile sector is similar to other sectors in terms of its high level of technical proficiency and expertise. It is responsible for developing software and user interfaces for wireless and mobile applications as well as developing content management systems (which have to accommodate vast libraries of wireless and mobile content) and back-end systems for billing, payments etc. In addition, mobile phone and related hardware manufacturers hire technical/R&D staff to carry out these roles.

Generally, people working in this area have an educational background in Computer Science, Engineering or a related area – the best programming talent would also most likely have good mathematics and related skills as well. For programmers, however, developing user-facing wireless and mobile applications requires greater use of Java/J2EE/Javascript than C++, for example, though on the hardware side skills in C++ are very important. Proficiency in the use of database languages (e.g. Oracle) is also important for developing content management systems, while operating system experience which is sought typically includes Linux, UNIX, Windows, Sun, Solaris or Open Source.

Web designers, as expected, require very strong web design skills and knowledge of working with Internet technologies such as HTML, XML and WML. Skills in using graphics tools such as Adobe Photoshop, Adobe Imageready and Quark Xpress, while Macromedia Flash is also particularly popular for specific web design graphics applications.

On the hardware side, programmers typically need experience across a variety of wireless and mobile technologies, including radio frequency engineering (RF), digital signal processing (DSP), application specific integrated circuits (ASIC) as well as knowledge of wireless and mobile standards such as Advanced Mobile Phone System (AMPS), Time Division Multiple Access (TDMA), Global System for Mobile Communications (GSM), General Packet Radio (GPRS), Enhanced Data for GSM Evolution (EDGE) and Universal Mobile Telecommunications Service (UMTS, the European standard for 3G).

Previous experience of developing applications for wireless and mobile purposes also appears to be very important – this is because working on wireless and mobile applications can be quite different to working on PC applications, for example, as can working with Java programming as opposed to C++. Again as with other sectors, better project management, communication and interpersonal skills are also seen as an important requirement in technical/R&D staff.

Content Development: Content development roles involve the people who provide the content that is delivered by wireless and mobile services companies. The type of content that such people provide has expanded in recent years, and will continue to expand with developments in wireless and mobile technology (such as 3G) – to a large extent, content development has also become a tool for mobile device personalisation for consumers. Content therefore includes ring tones, wallpapers, screensavers, logos, SMS and MMS text alerts and information services, video (for download and streaming), digital music, and mobile games.

Where this content is being developed from scratch, the skills and qualifications needed are typically traditional creative skills in music, writing and art. For example, freelance journalists are commonly used for developing SMS text alert products, musicians and performers are used for developing ring tones, and artists are used for developing wallpapers, screensavers etc. These roles may not involve very technical skills, however artistic skills can incorporate skills in the kinds of (lower end) graphics and animation packages referred to for the games sector or for CGA and SFX. In addition, people working in web design roles might also be involved in developing artwork that is used for mobile content.

Games for mobile phones also are a huge growth area at present. Some wireless and mobile services companies are involved in developing such games directly themselves, and in such cases companies need some of the range of skills described for the games sector (see Section 3.2 above).

A lot of content provided by wireless and mobile services companies is sourced externally rather than developed internally, however, and to do this companies need people who can source content, negotiate deals on content (with film, TV and entertainment companies, music labels etc), license content and aggregate content. Again, this does not require a technical background per se, and people who fill these roles are more likely to come with a business or marketing related qualification and experience – together with having appropriate skills in identifying the right kinds of content, making and negotiating deals to license content, and packaging content in ways that are attractive to the customer (whether business or consumer).

Sales and Marketing: Sales and marketing staff play a very important role in the wireless and mobile sector. Typically, people in these roles have business, marketing or related degrees, though qualifications in this area are not a pre-requisite. What such people need to be able to do, however, includes the following:

- establish short- and long-term sales strategies;
- build strategic partnerships with mobile operators and distributors;
- co-ordinate marketing promotions;
- provide feedback to the product line regarding content attributes etc; and
- identify and recommend opportunities for product improvement etc.

Prior experience in the wireless and mobile sector is highly valued, and this might be typically gained through working for wireless and mobile telecommunications operators or for related sectors (e.g. the mobile games sector). Strong negotiation skills are important, as is the ability to understand the main wireless and mobile content technologies and keep abreast of developments in this space. In addition, very well-developed communication and interpersonal skills are a pre-requisite.

Balance of Skills: Table B.12 provides an overview of the balance of skills required in wireless and mobile sector occupational groups, broken down according to the mix of technical skills, specialist technical skills and non-technical skills required. It shows that both technical and non-technical skills lie at the core of skills needs for wireless and mobile services:

- management roles incorporate a mix of traditional, non-technical business and management roles as well as more technically-related roles that are still at their core project management positions;
- technical/R&D roles are very technically skilled, involving specialist skills in programming, web design, content management systems etc. At the same time, non-technical project and interpersonal skills are becoming more important as part of the skills mix;
- content development roles are more creative, though an ability to identify and source good content is also valued; and
- sales and marketing requires traditional high quality skills in this area, and excellent relevant experience is a major advantage.

Key findings on the skills profile needed for success in the wireless and mobile sector include the following:

- technical proficiency makes up a core component of the skills set, especially for technical/R&D roles, but particularly in Java for applications, C++/System C for hardware, and related technologies (Internet technologies such as HTML and XML, wireless and mobile technologies such as 3G/UMTS, GPRS, GSM, EDGE, TDMA);
- creative skills are crucial for content development, however, and they are probably likely to continue to become more important as the potential for more sophisticated wireless and mobile and content develops; and
- project management skills, interpersonal skills and related skills are becoming more prominently sought across the wireless and mobile sector.

Future Skills Needs: Interviews with companies operating in the wireless and mobile sector do not suggest that there will be any very significant shifts in core skills requirements over the coming 3-5 years. However, regular shifts in the wireless and mobile sector (with, for example, key developments being 3G, Wi-Fi/Wimax etc) will have implications for skills. Some salient points to note regarding future skills requirements include the following:

- skills will generally have to adapt to changes in mobile phone technology – at the heart of this is a recognition that "mobile phone" is now something of a misnomer, and that "mobile devices" more accurately describes what is being provided for (particularly given the emergence of 3G capabilities). This includes their use as cameras, MP3s, streaming and download tools for audio and video, transaction providers, and messaging and e-mail providers; and
- implications of this might include: the need for continued skills in Java programming (for example, where existing software and applications for music, video etc are re-developed for wireless and mobile format); the need for other R&D/programming skills (e.g. for embedding software and technologies within mobile phone hardware); the need for more extensive and more varied content development skills as content itself becomes more sophisticated (e.g. games, video); and the need for more skills in developing graphical user interfaces and operator portals generally.

3.8 Skills Profile in the e-Learning Sector

This section provides an outline of the core skills profile for the e-learning sector. Core skills can be sub-divided into four key occupational groups: management/business roles; technical/R&D; content authoring and design; and technical support.

Management/Business Roles: Management and business roles in the e-learning sector include general management and other typical management functions (e.g. finance, HR, sales) as well as management roles that are more specific to the e-learning sector (e.g. Project Manager, Lead Designer).

For general management related roles, the skills and experience required are typical of the kind of business management skills found in other sectors. For sales and marketing related roles, however, experience in selling consultancy or technology solutions is an advantage.

Project Managers or Lead Designers, on the other hand, are more likely to come from an e-learning specific background or from a similar sector. Project management skills and other business related skills are becoming increasingly crucial for such management positions, however – this includes skills in managing timescales, budgets, people, quality etc as well as skills in managing clients and their needs (e.g. understanding their requirements, analysing their requirements and developing strategies and products to respond to these).

For all management, an understanding of e-learning developments in the wider market is increasingly important.

Technical/R&D: The technical/R&D group includes the people who create the (often web-based) training software programmes for e-learning activities. Generally, staff in this area includes programmers and web designers – indicative job titles include Web Developer, Lead Developer, Systems Developer, Interactive Designer and Software Engineer.

Typically, staff in these roles have a graduate qualification in Computer Science, Engineering or a related area. Where programming skills are required, they mainly relate to programming for development of Internet and web-based technologies as well as for "learning management systems"/content management systems – therefore, programming skills are mainly sought in Java and Javascript, Internet technologies and protocols (including HTML, DHTML, XML, XSLT, CSS, Cold Fusion and ASP), and database languages (e.g. Oracle, SQL) etc. For web design, good user interface design and interactive design skills are important together with previous experience of working on websites that incorporate significant database and content management system elements.

An understanding of e-learning technology developments and industry standards also appears to be important. This includes SCORM (Shared Courseware Object Reference Model), for example, which enables developers of web-based learning management systems and learning content authoring tools to find, import, share, re-use and export learning content in a standardised way. The Institute of Electrical and Electronics Engineers (IEEE), meanwhile, also develops technical standards, recommended practices and guides for computer implementation of education and training systems.

As with other occupational groups in other Digital Media sectors, good project management skills are also often cited as a common requirement for people working in technical/R&D roles. This includes skills in managing timescales and costings as well as client management skills – such skills are also likely to become increasingly important as client-specific bespoke learning becomes more important and as e-learning solutions continue to develop a blending of traditional classroom and interactive e-learning methods. This is because such solutions will most likely require increased collaboration, both between the various occupational groups that are contributing to developing solutions and with the clients that are seeking the solutions.

Content Authoring and Design: Content authoring and design includes staff who develop the actual content for e-learning packages and programmes as well as those who contribute to develop the look, feel and design of these packages and programmes. This includes roles such as: Content Author (people who write content); Art Director (people who set the overall "look and feel" for e-learning material and tools); Graphic Designer (people who conceptualise an e-learning programme with a view to making it as clear and stimulating as possible for the user – thinking visually and considering how content should be structured); and Instructional Designer (people who ensure that instruction is designed, developed and produced in a systematic manner that produces efficient and effective learning).

Good creative abilities in art, writing and graphic design typically underpin most of these roles, and experience of working in web design or other interface design environments is also useful. Knowledge of some of the well known graphics design software packages is also sought. For content authoring, specific subject matter expertise can be required depending on the topic under study, though this expertise can often be contracted in for particular projects if it is not held in-house.

The role of the Instructional Designer is somewhat more technical compared to other roles in this area. At its core the role involves planning the structure of an e-learning package so that it maximises the learning experience. It is also in many ways a project management or liaison role, however, and to carry out the role the Instructional Designer must understand the needs and wants of the client, the objective of and audience for the finished product, and the capabilities of the team (e.g. programmers, artists) and tools that will develop the product. In addition, Instructional Designers must have a strong interactive understanding and the ability to design in a non-linear, user-oriented way. The role therefore often requires people who have a relevant educational background (e.g. in education, training or some other qualification involving learning theory), but who also have the skills to: develop content; develop and understand graphics; keep abreast of relevant technologies and any changes emerging; and ensure that the final product meets client business requirements.

Project management skills and good communication skills have become more important in these roles as well. By their nature, content authoring and content design roles are the types of occupations that need very good oral, written and interpersonal skills. However, the emergence of more client-customised e-learning packages and solutions also means that there is a lot more interaction between the e-learning provider and the client, and such interaction is obviously crucial at a content authoring and design stage.

Technical Support: Technical support roles include people involved in quality assurance and people involved in systems administration technical support roles. Quality assurance roles involve testing of both the quality of the content and the software that is used to present content – for both of these types of roles, highly technical skills are not a necessity, and more important skills are a good eye for detail, an ability to think logically and methodically, and an ability to try to understand the typical behaviour of the end user for an e-learning package or programme. However software testers are more likely to have a computing background.

Systems Administrators oversee the well-being of systems, networks and servers in an e-learning company, fixing things/anticipating potential problems, and implementing new equipment. Such positions usually require a qualification in Computer Science or Engineering, of Diploma level or higher, together with an understanding of how systems, networks and servers operate. Problem solving skills are also very important for such roles.

Balance of Skills: Table B.14 provides an overview of the balance of skills required in the e-learning occupational groups, broken down according to the mix of technical skills, specialist technical skills and non-technical skills required:

- management and business roles include the normal non-technical business and management skill required in most companies, while at the same time there are some management roles that are more technically proficient but still highly dependent on good project management skills;
- as with other sectors, technical/R&D roles in e-learning, involve skills in programming, web design, content management systems, database design, interactive design etc. Non-technical project and interpersonal skills are becoming increasingly important;
- content authoring and design roles are more creative in nature than other roles; pedagogical skills are very important, although some technical skills are also important for these roles; and
- technical support roles typically involve a mix of technical and non-technical skills and competencies, with an ability to identify problems particularly important.

Key findings on the skills profile needed for success in the e-learning sector include the following:

- as with other sectors, e-learning involves a mix of traditional creative skills and more modern day technical skills (e.g. programming, web design), both of which make core inputs into developing e-learning packages and programmes;
- strong interactive design skills will be a key requirement in future as interactivity will be a key success factor for future e-learning packages and programmes; and
- project management and interpersonal skills appear to have become increasingly important across a lot of roles in e-learning, particularly as client-customised packages and programmes have led to more and more interaction with the client.

Future Skills Needs: Key points emerging on likely future skills needs within the e-learning sector are as follows:

- simulation, gaming and interactivity will enrich e-learning experiences in future, which means that e-learning skills sets may increasingly incorporate skills that are evident in other Digital Media sectors (e.g. games, CGA and SFX);
- e-learning packages and programmes will increasingly have requirements for value-added services such as needs assessments, customised curriculum design, online mentoring and performance assessment/support, and reporting, tracking and "hosting" of e-learning services. This move towards a service model for e-learning may therefore also increase the demand for more customer-facing skills;
- the emergence of e-learning "suites" – incorporating learning management systems that become part of a wider knowledge management approach within large corporates, may have implications for skills in terms of greater database, software, products and process knowledge etc; and
- broadband roll-out may open up the need for more skills in areas such as video and sound as part of e-learning packages.

3.9 Source of Skills

Table 3.1 provides a summary of evidence on how companies interviewed in each of the relevant Digital Media sectors source their skills. The key trend emerging across companies is that prior experience appears to be very important, with a lot of companies hiring people who already have industry experience or experience in related areas. There is evidence, however, that new graduate hire or even non-graduate hire does occur – examples include graduate hires among larger games developers and animation companies and the use of internships in digital television companies and digital film post-production companies.

Table 3.2 provides evidence on company attitudes and approaches to training and development. In this regard, approaches to training and development seem to vary by company size rather than sector – for example, larger and more established players in the games and CGA and SFX sectors are more likely to adopt a structured approach to training and development (incorporating classroom-type training, online tutoring, mentoring etc, and even in-house "universities" in some larger companies), while training in other companies tends to less structured and only used as required.

At the same time, a lot of emphasis is placed on "on-the-job" learning across all sectors, even where there is a structured training and development process. In addition, a lot of training is focused on keeping up-to-date with new technologies – this includes either new vendor-based technologies and updates of existing vendor-based technologies or changes to proprietary in-house technologies and tool sets.

Table 3.1: Evidence on Source of Skills for Digital Media Sectors

Sector	Source of Skills
Games	Evidence from the companies interviewed suggests sources of new hires can vary by company size. Smaller games developers interviewed, for example, appear to look more for experienced staff when hiring, while larger games developers appear to hire more graduates directly from college and allow them more time to develop. Graduates also appear to be increasingly hired from specialist Digital Media courses where they exist. For short-term pressures on demand, outsourcing is typically used more for artistic skills than programming skills – good artistic skills are to be found in more plentiful supply, but good programmers are harder to find.
CGA and SFX	Companies interviewed in the CGA and SFX sectors typically hire the majority of their people with previous experience rather than straight from college. However, any new graduates who are hired come with degrees in Animation/Computer Graphics or with qualifications in related areas.
Digital Film	Evidence from companies interviewed highlights a number of points on how companies in the digital film sector source skills. For production companies, a lot of the skills and resources used come from experienced people hired as freelancers on a project-by-project basis – actual in-house production staff numbers can therefore be quite small. For distribution companies, film or media-related experience appears to be important. Post-production houses, on the other hand, retain larger in-house resources on an ongoing basis and usually source their employees from Media/Fine Art/Film degree backgrounds – these people can be a mix of experienced staff and new graduates, depending on the seniority of the positions being filled, while both graduates and non-graduates can be considered for junior traineeship positions (e.g. as interns/"runners"). Digital Television Most people hired in the digital television sector have college degrees in media-related areas or are qualified for specific roles (e.g. Computer Science/Engineering, normal business-related functional areas) – however, most people who are hired by the digital television companies interviewed will come with previous experience. Relatively few graduates are hired straight from college, though the use of internships to provide experience and to see if people "sink or swim" seems popular.
e-Music	A majority of staff in the e-music sector are experienced people sourced from within the industry, based on the evidence of the companies interviewed. People with experience of working in other online retail environments is increasingly common, however. While a large proportion of staff are graduates, it is less common for people to be hired directly from college.
Wireless and Mobile Services	Staff working in developing the wireless and mobile sector typically come with some experience rather than straight from college. This is not universal, however, and some companies seek to hire the very best talent (for programming in particular) from leading applied academic and research schools.
e-Learning	While only one e-learning company was reviewed as part of the study, evidence from this company and from a review of job specifications in other e-learning companies suggests that staff in the sector typically come with experience rather than straight from college.

Table 3.2: Evidence on Training and Development for Digital Media Sectors

Sector	Training and Development
Games	Smaller games developers interviewed did not have any structured training or development programmes, rather people tend to learn "on-the-job" with possibly some form of mentoring. On the other hand, a larger games developer interviewed adopts a more structured approach to training that includes 3-5 days of classroom-type training (particularly for new technologies, tools and processes), structured processes for career development and career development plans for individual employees.
CGA and SFX	The CGA and SFX companies interviewed tended to have dedicated training departments within their organisations, though this may be a factor of their relative size and importance. Training provided includes online tutoring programmes, internal courses of up to 2-6 weeks duration, mentoring etc. A lot of this training includes teaching people in the use of proprietary tool sets, and cross-training to encourage people to develop new skills to accompany their core competencies.
Digital Film	Evidence from the companies interviewed does not suggest that structured training and development programmes are widely used, rather training and development tends to be based "on-the-job". Post-production houses appear to hire junior staff as trainees, however, but the nature of this training is also mainly work-based.
Digital Television	Training and development in digital television companies interviewed is focused mainly on keeping up-to-date with new technologies etc as they emerge – some of this training may be externally provided vendor-based training rather than internal training. Other training that is provided is concentrated mainly on management or leadership development-type training, or on trying to broaden people's skills base (e.g. better project management skills for technologists).
e-Music	Training in the e-music sector, based on the companies interviewed, is focused mainly on providing training to keep up-to-date with new and existing technologies as they emerge/update. This training would tend to happen as required rather than following a regular, structured programme.
Wireless and Mobile Services	Evidence of training and development activities among wireless and mobile companies includes a mix of organised training courses and on-the-job development. While a lot of activity occurs on-the-job, some large companies have structured training programmes (involving 4-8 weeks training per annum), with the focus of training on both technical and non-technical skills (e.g. providing better project management skills for engineers).
e-Learning	One e-learning company was reviewed during the study, and its training and development activities incorporate a significant amount of formal processes and procedures. This includes formal training courses for sales personnel, a formal design mentoring programme for design staff, and a formal curriculum of open training events for all staff covering all aspects of its business.

3.10 Summary of Chapter Findings

- The skills mix required across Digital Media sectors consists of an often complex balance of technical, specialist technical and non-technical skills – both across occupational groups and within occupational groups. Very often, required skills sets in Digital Media sectors can require a strong mix of technical, specialist technical and non-technical skills.

- For systems development and R&D type roles, high quality programming skills appear to be a crucial requirement that is needed in most Digital Media sectors. At basic level this requires strong programming skills in C++, however programming needs across different platforms can vary and will require skills in the use of Java (e.g. for wireless and mobile), database languages (e.g. Oracle), and Internet technologies and protocols among other. Experience across different operating systems can also be crucial.

- Outside of systems development/R&D, the need for technical proficiency across Digital Media sectors is also generally increasing. In particular, content creation and production roles are becoming more and more technical across sectors, ranging from technology as an aid to the process (e.g. film and television pre-production and production), to technology being at the core of the process (e.g. artistic and creative roles in games, animation/computer graphics roles in CGA and SFX, post-production in digital film and television).

- In addition, Digital Media roles are becoming increasingly specialised – this is most evident in the high levels of specialisation in artistic roles for games/CGA and SFX and the growing level of specialisation in programming.

- Basic traditional creative skills remain crucial to most sectors, however, regardless of advances in technology, and the "commoditisation" of technologies and software makes competitive advantage based on talent even more crucial. Key areas where traditional creative skills remain paramount are: games designers and artists; creatives and animation/computer graphics staff working in CGA and SFX; and staff across the range of content creation, pre-production, production and post-production for digital film and television etc.

- There is also a trend towards a more widespread need for non-technical skills across Digital Media sectors in areas such as project management, communication and interpersonal skills. This is evident in the continued key role played by producers in the digital film and digital television sectors, the increased importance of project management skills in games (games development projects expand and as games development content becomes more complex) and the importance of specialist sales, marketing and distribution skills in e-music (including online marketing). Furthermore, a better understanding by all employees of the entire "pipeline"/production process is increasingly important.

- Adaptability is becoming more and more highly valued in Digital Media employees – this incorporates the ability to adapt to different types of works, changes in technologies, and work across different platforms (e.g. programming expertise for console, online and mobile in games).

4. Review of Leading-Edge Digital Media Skills Providers

4.1 Introduction

This section describes the provision of Digital Media education and training by the "leading" Digital Content skills providers in the US. The objective is to obtain an understanding of the scope, quality, technical and non-technical aspects of these digital media tertiary education and training providers, as a basis for comparison for Irish courses. Of key importance is also to understand the mechanisms used by leading US Colleges/Universities to synchronise their courses with Digital Media industry developments.

Four education providers where reviewed as part of this study, namely Carnegie Mellon, Florida State University (FSU), Full Sail, and University of California Los Angeles (UCLA). The four colleges were selected on the basis of providing a good overview of Digital Media education in a broad range of college/university "types", i.e. a well established/leading university with a good Digital Media programme (i.e. UCLA and Carnegie Mellon); a private/commercial "further education" college dedicated to Digital Media/Media (i.e. Full Sail); and a relatively newer university, again with a good media programme (i.e. FSU).

Table 4.1 presents a brief overview of each US College/University reviewed.

Table 4.1: Profile of Leading US Digital Media Education and Training

College	Profile
Carnegie Mellon, Pittsburgh	Approximately 8,000 undergraduate and graduate students; Campuses in Pittsburgh, California and the Arabian Gulf nation of Qatar; Seven professional schools and colleges - three deliver Digital Media courses, i.e., College of Fine Art; The School of Computer Science, and the David A. Tepper School of Business.
FSU, Florida	Approximately 38,000 undergraduate and graduate students; 94 undergraduate programmes and 200 postgraduate programmes; 17 professional Schools or Colleges – five deliver Digital Media related courses, i.e., School of Motion Picture, Television and Recording Arts; College of Business; College of Information; College of Engineering; and College of Arts and Sciences.
Full Sail, Florida	Private dedicated Digital Media college, established in 1979; Approximately 5,500 students; New class starts and graduates every month and courses are taught on an accelerated learning basis (i.e. BSc Degree delivered in 21 months, Associate of Science Degree in an average of 12 months); Not structured around faculties, instead each course is a faculty in itself. 5 out 7 courses are directly related to Digital Media (i.e. BSc Game Design and Development; Associate of Science Computer Animation; Associate of Science in Film; Associate of Science Recording Arts).
UCLA, Los Angeles	Approximately 38,500 students; 118 undergraduate, and 200 graduate programmes; Library ranked among the top 10 in the US; 11 professional schools - three deliver Digital Media/Media courses, e.g. School of the Arts and Architecture, School of Engineering and Applied Science, and School of Theatre, Film and Television.

Tables 4.2 to 4.5 inclusive, present a more detailed overview of each University/College's "position" in Digital Media. This is indicated by their number and type of Digital Media programmes or related/relevant courses and their Digital Media research centres/facilities.

Table 4.2: Summary of Digital Media Courses and Research in Carnegie Mellon

College	Digital Media Courses '05/'06	Undergraduate Vs Postgraduate	D. M. Research Centres/Facilities	Faculty	Media/ Digital Media Related Courses	Qualification	Duration
Carnegie Mellon	21	10 UG 11 PG	Studio for Creative Enquiry	College of Fine Arts/College of Humanities & Social Sciences	Humanities and Arts	BHA	n/a
			Centre for Building Innovation	College of Fine Arts/ College of Science	Science and Arts	BHA	n/a
			Entertainment Technology Centre	College of Fine Arts	Communication Design	BFA	n/a
					Industrial Design	BFA	n/a
					Interaction Design	BFA	
					Design	PhD	n/a
			Centre for Technology Transfer		Art	BFA	n/a
					Production Technology and Management	Undergraduate	n/a
					Production Technology and Management	Postgraduate	n/a
					Music	BFA	n/a
				Carnegie Institute of Technology	Electrical and Computer Engineering	BEng	n/a
					Electrical and Computer Engineering	MSc/ PhD	n/a
				Tepper School of Business			
					Business	Undergraduate	n/a
				School of Computer Science	Computer Science	BSc	n/a
					Computer Science	MSc	n/a
					Computer Science	PhD	n/a
					Entertainment Technology	MA	2 years
					Software Engineering	MA	n/a
					Software Engineering	PhD	n/a
					eBusiness Technology	MSIT	n/a
					Robotics Institute	MSIT	n/a

Table 4.3: Summary of Digital Media Courses and Research in Florida State University

College	Digital Media Courses '05/'06	Undergraduate Vs Postgraduate	D. M. Research Centres/Facilities	Faculty	Media/ Digital Media Related Courses	Qualification	Duration
FSU	13	7 UG 6 PG	Electronic Materials and Devices Lab	College of Arts and Sciences	Computer Science	BA	4 years
			High-performance Computing and Simulation Research Lab		Computer Science	BSc	n/a
					Computer Science	MSc	n/a
					Computer Science	PhD	n/a
				School of Motion Picture, Television and Recording Arts	Film	BFA	4 years
					Film	MFA	2 years
				College of Business	Management Information Systems	Undergraduate	4 years
					Management Information Systems	PhD in Business	4 years
				College of Electrical Engineering	Electrical Engineering	BSc	4 years
					Computer Engineering	BSc	4 years
				College of Information	Information Technology	BSc	4 years
					Information Technology	MA	n/a
					Information Technology	MSc	n/a

Table 4.4: Summary of Digital Media Courses and Research in Full Sail

College	Digital Media Courses '05/'06	Undergraduate Vs Postgraduate	D. M. Research Centres/Facilities	Faculty	Media/ Digital Media Related Courses	Qualification	Duration
Full Sail	5	5 UG 0 PG	0	n/a	Computer Animation	Associate of Science	14 months
					Digital Media	Associate of Science	13 months
					Film	Associate of Science	12 months
					Recording Arts	Associate of Science	12 months
					Game Design and Development	BSc	21 months

Table 4.5: Summary of Digital Media Courses and Research in UCLA

College	Digital Media Courses '05/'06	Undergraduate Vs Postgraduate	D. M. Research Centres/Facilities	Faculty	Media/ Digital Media Related Courses	Qualification	Duration
UCLA	15	5 PG 10PG	Centre for Research in, Engineering, Media and Performance. WINMEC (Wireless/Mobile Research Centre)	School of Theatre, Film and Television	Film and Television	BA	4 years
					Film and Television	MA	2 years
					Animation	MFA	3 years
					Production/ Directing	MFA	3 years
					Screenwriting	MFA	2 years
					Producers Programme	MFA	2 years
					Theatre	BA	4 years
					Theatre	MA	2 years
					Theatre	MFA	2 years
				School of the Arts and Architecture	Design/ Media Arts	BA	4 years
					Design/ Media Arts	MFA	2 years
				School of Engineering and Applied Science	Computer Science and Engineering	BSc	n/a
					Computer Science	BSc	n/a
					Computer Science/ Management	MSc/ MBA	3 years
					Computer Science	PhD	n/a

To review the provision of Digital Media education and training by the Digital Content skills providers in the US and Ireland, a key step comprised development of a "framework" for evaluation of education and training. The framework comprises four key criteria to assess Digital Media education and training, namely:

- Course Scope;
- Course Positioning;
- Course Development and Update; and
- Digital Media Industry Linkages.

Each area of the framework, in turn comprises several sub-criteria under which Digital Media skills providers are reviewed. A high-level description of this framework is provided in Table C.1.

4.2 Summary of Key Findings

1. The scope of Digital Media education and training provided in the US is quite diverse, particularly in terms of the relatively high level of sector specialisation (e.g. the games, animation or film industry etc.) within courses or course modules. While it should be recognised that this is partly a function of scale (i.e. the US has a much larger and more diverse economy, with a large population that can support a more varied course scope), it is of interest from the perspective of the sheer scope of its Digital Media education and training provision.

2. The level of technology specialisation within courses is also significant. Through a combination of specialist modules and related projects, students typically specialise in specific Digital Media technologies including areas such as: C++ and Java programming; real-time 3D programming; artificial intelligence; software such as Maya, DirectX and OpenGL for games; and training in digital cinematography, technical labs, remote multi-camera production, film & television programming; and animation design tools and software.

3. The ability of US colleges to update course content with speed and flexibility appears to be high, vitally important, given the needs of a fast-changing industry such as Digital Media. Courses are typically reviewed at regular intervals (ranging from formal reviews every six months to every five years, combined with informal annual reviews) with course modifications implemented thereafter.

4. Mechanisms to ensure courses remain up-to-date with industry developments include: structured industry involvement in course review, design and delivery through Advisory Boards, Review Panels, Technology Committees, Dean's Council of Alumni, ongoing fostering of informal industry linkages and participation in "Education Summits" etc. Industry input from leading entertainment and media companies is recognised as being vital to ensuring graduates are equipped with the latest industry requirements.

5. Benchmarking of courses is undertaken by each of the colleges reviewed albeit, the frequency, focus and level of formality varies between College/University. A number are ranked nationally or internationally amongst the leading Digital Media colleges by US publications. Benchmarking is viewed as being key to ensuring courses are considered leading-edge and remain up to date with industry developments.

6. Industry linkages in the US colleges, both in terms of course design/delivery and course development/update, are well-developed, with evidence of structured industry input through mechanisms such as those described above, in addition to structured guest lecturer programmes, software company "testing" relationships with colleges and their students, and extensive joint industry research etc.

4.3 Course Scope

To determine the scope of the US Digital Media education and training reviewed, the programmes were reviewed against four criteria, namely: Digital Media sector specific courses/course value chain specialisation; course technology specialisation; and, course access and availability. Each is described in full in the following sections.

4.3.1 Number of Digital Media Courses

In relation to the number of Digital Media courses provided by the leading US Digital Media skills providers, a number of key findings emerged from the research.

- The four Colleges/Universities reviewed offer a total of 54 courses which are either related to, or core, Digital Media courses (an average of 14 courses per College/University);
- Just under half of these courses, with 26 programmes, are "generic" or broad courses such as computer science and engineering, e.g. BEng in Electrical and Computer Engineering in Carnegie Mellon and BSc in Information Technology in FSU;
- The remaining 28 programmes are core media or Digital Media courses covering areas such as design, film & TV, as well as animation and production; and
- Responsibility for delivering Digital Media-related courses is shared across three or more Faculties in Carnegie Mellon, FSU and UCLA, ranging from Arts and Engineering to Film and Theatre. Full Sail is structured differently –around courses, with each course considered a "faculty" in itself.

4.3.2 Sector Specific Courses/Value Chain Specialisation

In relation to the delivery of Digital Media sector specific courses and the value chain specialisation of the Digital Media courses, a number of key insights emerged from consultations with the leading US Digital Media education providers:

- Across the US Colleges/Universities reviewed, a small number of courses are dedicated to specific Digital Media sectors with ten courses out of a total of 54 being sector specific, including: BSc Game Design and Development, Associate of Science in Computer Animation, Film, and in Recording Arts (Full Sail); BA/MA in Film and Television, and MFA in Animation (UCLA); BFA Music (Carnegie Mellon); and the BFA/MFA in Film (FSU);
- Typically a very small number of Digital Media courses in each College/University are sector specific. However, four out of the five courses in Full Sail are dedicated sector programmes, namely games, digital film, animation and recording arts;
- Rather than providing students with specialist sector skills, the broader courses such as computer science, engineering and information technology typically provide skills which are applicable to all Digital Media sectors, i.e. programming skills including C/C++, and Java, as well as some specialist sector specific skills such artificial intelligence;
- Importantly, there is substantial potential for sector specialisation within some of the broader Digital Media courses. For example, the BHA Degree programme in Carnegie Mellon and the BA Design/ Media Arts in UCLA, offer inter-related modules and projects that deliver skills specific to key Digital Media sectors, i.e. games, animation, digital TV and digital film modules; and
- Across the Colleges/Universities reviewed, most courses typically do not specialise in one or more specific areas of the Digital Media value chain (e.g. content production, content distribution, content management etc.). Rather most areas are included in each course. For example, the BA in Film & Television in UCLA covers film production and post production, and the Associate of Science in Digital Media in Full Sail delivers modules on Digital Media production and publishing as well as IP management.

4.3.3 Technology Specialisation

In relation to the level of technology specialisation provided by leading US Digital Media education and training providers, the consultations highlighted a number of key insights.

- Across the Colleges/Universities reviewed, a high degree of technology specialisation is typically provided by most Digital Media courses reviewed;
- In the Digital Media courses reviewed, first year typically provides students with knowledge of general technologies. However, through choosing a combination of specialist modules and/or related projects, students can typically specialise in particular Digital Media technologies/areas by final year;
- Examples of the potential specialisms include: training in C++ programming, real time 3D programming, artificial intelligence, Maya, DirectX and OpenGL for games; and training in digital cinematography, technical labs, remote multi-camera production, film and television programming, and animation design for film and television; and

  Furthermore, courses involving programming typically include a strong element of algebra, maths, trigonometry, calculus, physics and linear algebra.

4.3.4 Course Access and Availability

The consultations with the leading US education and training providers point towards some key issues in relation to the access and availability of Digital Media courses:

- Full Sail provides a very interesting example of a dedicated Digital Media College. Although the only entry requirement is a high school education, graduation requirements are more difficult – a minimum of 70% grade average and 90% attendance;
- Courses are taught on an accelerated learning basis, and are delivered for eight hours a day, five days a week. As a result, two-year Associate Degree programmes are condensed into 12 months and three-year Bachelor Degree programmes delivered over 21 months;
- A new class for each course starts and graduates every month;
- Courses are expensive, i.e. $40,000 for an Associate Degree and $65,000 for a Bachelor Degree – high course fees may limit demand; and
- The MA in Film in FSU is also delivered on an accelerated learning basis, with the three year Masters Programme taught over two years. The curriculum combines intensive technology training with a high level of practical course work, for six continuous semesters delivered over two years.

4.4 Course Positioning

To determine the "positioning" of US Digital Media education and training, the courses were reviewed against three criteria, namely: digital media course benchmarking/national and international recognition; graduate demand by leading digital media companies; and accreditation/certification level. Each is described in full in the following sections.

4.4.1 Digital Media Course Benchmarking/National and International Recognition

To review the positioning of US Digital Media education and training, the national and international recognition of Digital Media courses, in addition to course benchmarking were considered. The review highlighted a number of key findings.

- Benchmarking to compare courses against leading Digital Media education is undertaken by each of the Colleges/Universities reviewed; however frequency and focus (national versus international courses) varies across the Colleges/Universities;
- Formal benchmarking processes are in place in Full Sail and UCLA. The Programme Director of each Digital Media course in Full Sail must conduct a formal benchmarking review against national (and some international) leading courses on an annual basis. During the five year formal course review in UCLA, the review panel formally benchmarks each course against the leading US education providers;
- More informal benchmarking is occasionally undertaken by Programme Directors or lecturers – particularly in UCLA and Carnegie Mellon, whereby courses are benchmarked an ad hoc basis against criteria such as choice/ flexibility of modules, technology specialisation, and staff/ technology resources; and

- Many of the Colleges/Universities are ranked nationally and/or internationally among the leading education providers in Digital Media by US magazines and publications such as Shift Magazine and Electronic Gaming Monthly. Both Full Sail and Carnegie Mellon, for example, have been ranked very highly in a number of published lists of Digital Media and related education and training providers.

4.4.2 Graduate Demand by Leading Digital Media Companies

In terms of the demand for Digital Media graduates by leading companies in the Colleges/Universities reviewed, the review of leading US education and training highlights a number of key insights.

- It appears that many graduates from the Colleges/Universities reviewed, progress to work for leading-edge companies in Digital Media sectors;
- In Full Sail, approximately 80% of graduates are employed in their chosen field within two years of graduation – graduates are generally employed in all the leading Digital Media companies across the US, although many graduates start their careers by joining the many smaller Digital Media companies located in the Florida area;
- The Film School in FSU report that 94% of all graduates in the MA in Film, since its introduction in 1989, are working in Film and TV. Additionally, almost 100% of graduates from the MA and BA in Film in the last 5 years are working in Film and TV, within 12 months of graduation, with students typically working for leading companies such as Disney, DreamWorks, Sony and Pixar; and
- Carnegie Mellon reports a very high demand for its Digital Media students. Its Entertainment Technology Centre has several written-agreements with major entertainment companies to provide them with graduates from its MA in Entertainment Technology.

4.4.3 Accreditation/Certification Level

In terms of the level to which Digital Media education and training is certified in the US Colleges/Universities reviewed, the research provided a number of key insights as follows:

- The courses offered across the leading US Colleges/Universities are primarily accredited as undergraduate Bachelor Degree and Masters Programmes, as well as a small number of PhD and Associate of Science courses. Specifically, 27 courses are Masters and PhD programmes, 23 Bachelor Degree courses and the remaining four are certified as Associate of Science Degrees. However, an important point is that Further Education Colleges, which typically offer a greater number of non-Bachelor Degree type courses, were not reviewed in the study; and
- The Associate of Science programmes in Computer Animation, Film, Recording Arts and Digital Media are currently delivered by Full Sail. However, to provide a more comprehensive training programme, Full Sail expects to change three of these courses to Bachelor of Science Degrees in 2005/2006, specifically the Computer Animation, Film and Digital Arts & Design (formerly Digital Media) courses – the BSc programmes will offer a more comprehensive training programme with an upgraded roster of courses and broader practical applications.

4.5 Course Development and Update

To establish the processes involved in the development and update of US Digital Media education and training courses, four criteria were used to assess this. These were: flexibility of course modules; frequency of course/module update; industry synchronisation mechanisms; and cross faculty co-ordination. The rationale was to obtain an in-depth understanding of the course synchronisation mechanisms – to ensure they remain appropriate/relevant in a fast-changing industry. Each are described in full in the following sections.

4.5.1 Flexibility of Course Modules

In terms of the US education provider's flexibility to change course modules, or introduce new courses, the consultations highlighted several trends as follows:

- The ability to quickly change/update course modules appears to be very high across most of the Colleges/Universities reviewed. Changes to course content are typically made in a relatively short timeframe, i.e. from a few days to a few months;
- Carnegie Mellon and Full Sail have a particularly high level of flexibility when updating courses/modules. Full Sail's model is especially flexible, allowing the college to change up to 25% of programme content without prior approval, therefore technology/module changes can be introduced in a very short timeframe. Furthermore, in Carnegie Mellon, rather than answering to a Faculty Dean or Faculty Board, each Department reports directly to the University Provost, thus allowing Departments to quickly and continually modify course content if needed;
- In FSU, frequency of course update varies across each Faculty. The Film School is particularly flexible, with a review of course content undertaken every semester (i.e. every 3/4 months). Furthermore, course descriptions/guidelines for the BA and MA in Film are deliberately broad –this enables small changes to be made to course content during the semester if needed; and
- In terms of introducing a new course, it can typically take up to one to two years. However, it appears new courses are not regularly offered by the Colleges/Universities. More-often, new modules or programme streams are created within an existing course.

4.5.2 Frequency of Course/Module Update

In relation to the frequency of course or module update across the Colleges/Universities reviewed, consultation with the US education and training providers pointed to the following findings:

- The Colleges/Universities reviewed typically undertake a formal review of all courses at regular intervals, in addition to continuous informal reviews of individual course modules throughout the academic year. However, the formal reviews vary significantly in terms of timeframe, from six months to five years; and
- Full Sail provides very useful examples of leading-edge practice, with twice-yearly conferences organised in order to drive joint academic/industry review of, and recommendations on, future course direction/design for the following six months. Furthermore, each programme is regularly reviewed on an informal basis by the Programme Director and staff on each course against the latest industry and technology developments.

4.5.3 Industry Synchronisation Mechanisms

In relation to US education and training providers updating courses in line with industry trends and developments, the consultations identify a number of key processes to achieve this, as follows:

- Across the Colleges/Universities reviewed, each uses a range of informal and formal mechanisms to synchronise course content with industry developments, including: Advisory/Review Boards established to keep courses/technology resources in line with industry developments; and informal meetings/ discussions with industry;
- Each of the Colleges/Universities includes on a structured basis, industry experts as members of their Advisory Boards during formal course reviews. In Full Sail for example, during the six month course review, the review panel consists entirely of industry experts;
- Formal Boards are also established to keep courses/technology resources in line with industry developments. For example, Technology Committees in Carnegie Mellon regularly review technology both across the college and within courses, against students/staff technology requirements and industry developments. In UCLA, each School has its own External Advisory Board comprising Alumni and Industry experts who are at the top of their profession. The External Advisory Board for the School of Theatre, Film and Television for example, is chaired by a senior person from Sony Pictures and keeps the School informed of the latest developments in the entertainment industry; and
- Full Sail informally reviews its programmes via other industry linkages, including liaison with other education providers and software vendors through "Education Summits", trade shows and conferences. Furthermore in UCLA and Carnegie Mellon, interaction with industry through the sponsorship of technology and/or research provides insights into industry skills requirements, e.g. Disney, Warner Brothers, Sony Pictures, Apple, Adobe and Microsoft in UCLA, and Microsoft, Alias, Intel and Apple in Carnegie Mellon.

4.5.4 Cross-Faculty Co-ordination

The consultations with leading US education and training providers offer insights into the level of cross faculty co-ordination in the design and delivery of Digital Media courses.

- The Colleges/Universities reviewed, with some exceptions, typically have a low level of formal cross-faculty co-ordination, even where courses are spread across several faculties. Faculties in each College/University are quite autonomous and self contained, with interaction limited to informal discussions/linkages between members of staff; informal sharing of resources; and meetings between Faculty Deans or Department Heads;
- For example, in Carnegie Mellon and UCLA, staff occasionally deliver classes to students outside their own faculty, this is typically an informal arrangement co-ordinated between faculty administrators; and
- However, interfaculty meetings between Faculty Deans or Department Heads are held regularly across the Colleges/Universities reviewed. Although such meetings are not centred around/arranged to discuss Digital Media, discussions between senior faculty members regarding Digital Media education and training occur as part of the process.

4.6 Digital Media Industry Linkages

Finally, to identify the linkages US Digital Media education and training providers have established with industry, the Colleges/Universities were reviewed against a number of key criteria, namely: industry design of course content; industry delivery of course content; joint research programmes; and other evidence of industry participation. Details of each are provided in the following sections.

4.6.1 Industry Design of Course Content

In terms of industry input into the design of Digital Media programmes within the colleges reviewed, the consultations with the selected leading US education and training providers highlight a number of key issues as follows:

- To ensure structured and formal input into course design, industry is included as members of Advisory/Review Panels. A less formal alternative is for Colleges/Universities to receive general advice and guidance on course content from industry by holding informal discussions/meetings with key industry representatives
- For example, Carnegie Mellon and UCLA ensure that industry comprises a large percentage of Board membership during their formal five year course review. Furthermore, as described in Section 4.4.3, each School in UCLA has an External Advisory Board involving leading industry professionals, who advise on industry requirements and developments; and
- In addition, informal discussions/ meetings are held with industry for their input into course design. For example, Full Sail liaises with other education providers and industry at Education Summits hosted by software vendors, and Digital Media related trade shows and conferences. Furthermore both UCLA and Carnegie Mellon leverage their industry linkages established for feedback on skills requirements – linkages include research partnerships and sponsorship and technology provision.

4.6.2 Industry Delivery of Course Content

Consultations with US Digital Media education providers identified that industry involvement in the delivery of course content is typically in the form of guest lecturers.

- Frequency of the use of guest lecturers varies across the Colleges/Universities reviewed, from occasional input into course delivery, to being a core mechanism for delivery of certain course elements/modules;
- For example Full Sail has developed a regular guest lecturer programme across all courses, whereby each module is required to have a minimum of 10 guest lecturers a year; and
- Unlike Full Sail, there is no minimum requirement for the involvement of guest lecturers in Carnegie Mellon and UCLA. However, both colleges try to engage guest lecturers to as great an extent as possible. Interestingly, the Department of Theatre in UCLA run a series of Disney classes which are co-ordinated by the Vice-President for R&D at Imagineering in Disney and frequently include Disney staff as lecturers.

4.6.3 Joint Research Programmes

In relation to joint research programmes between industry and education, the US education and training review highlights a number of key findings:

- Industry involvement in the Colleges/Universities includes sponsoring technology resources, undertaking joint industry research projects and other research programmes, as well as the development of start-up business supported through incubation centres;
- For example, Carnegie Mellon has secured large amounts of funding from industry, including Microsoft, Alias (producers of the Maya software) and Intel, for its Digital Media research centres, namely the Studio for Creative Enquiry and the Centre for Building Innovation. Oftentimes, to involve/make students aware of research undertaken in Digital Media research centres, lecturers incorporate research findings/projects into the course content of Masters and/or undergraduate programmes; and
- Further industry linkages have been established through the College/University incubation centres. The Centre for Technology Transfer in Carnegie Mellon for example, offers incubation support to established companies and start-up firms that are interested in licensing Carnegie Mellon's innovations.

4.6.4 Other Industry Participation

Consultations with leading US education and training providers indicate that each college has developed further industry linkages beyond research/technology linkages, industry delivery of course content and designing/providing input into course design.

- For example, in Full Sail software vendors regularly deliver demonstrations on new technology and allow students to test the latest software technology before it has been released onto the market;
- Some of the courses in FSU, Carnegie Mellon and UCLA offer students an opportunity to complete industry internships; and
- The Entertainment Technology Centre in Carnegie Mellon in particular, has developed a strong set of linkages with leading entertainment companies, namely Walt Disney, DreamWorks and Pixar.

5. Review of Irish Digital Media Skills Providers

5.1 Introduction

This section presents an overview of a number of key providers of Digital Media education and training in Ireland. The objective is to provide a qualitative overview of the scope, quality, technical and non-technical aspects of the key Irish Digital Media tertiary education and training courses. Of key importance is also to understand how Digital Media courses are synchronised with Digital Media industry developments. Furthermore, this section builds on the research and analysis undertaken in Phase I of this study (i.e. Skills Requirements of the Digital Content Industry in Ireland: Phase I). The Phase I study provided an in-depth quantitative profile of the key Digital Content training and education providers in Ireland, and as such this review of Irish Digital Media education and training should not be considered in isolation.

Eight education providers were reviewed as part of the study, namely Trinity College Dublin (TCD), University College Dublin (UCD), Dublin City University (DCU), University of Limerick (UL), National College of Art and Design (NCAD), Dublin Institute of Technology (DIT), Galway Mayo Institute of Technology (GMIT) and Dun Laoghaire Institute of Art, Design and Technology (IADT). To provide a good overview of tertiary level Digital Media education and training in Ireland a broad range of colleges were selected for the review, namely: well established/leading Universities with Digital Media/media programmes (UCD, TCD, DCU, UL); dedicated art, design and technology Colleges (IADT, NCAD); and a small selection of the Institutes of Technology with Digital Media/media programmes (DIT, GMIT). Colleges of Further Education and industry/training were not included in the review (e.g. Ballyfermot College, Screen Training Ireland and FÁS etc) as they were covered in the Phase I study.

The Digital Media education and training, delivered by the eight Colleges/Universities, is reviewed under four key areas: course scope; course positioning; course development and update; and Digital Media industry linkages, namely the same framework on which the review of US education and training was based. The section is set out as follows:

- 5.2 Summary of Key Chapter Findings;
- 5.3 Course Scope;
- 5.4 Course Positioning;
- 5.5 Course Development and Update;
- 5.6 Digital Media Industry Linkages.

It should be noted that the analysis of the Irish Digital Content skills providers, presented in Sections 5.2 to 5.5 is subdivided into two categories, namely “Universities” and “Institutes/Other”. “Universities” represent four of the education providers reviewed, namely UCD, DCU, UL and TCD, with the remaining colleges, DIT, GMIT, NCAD and IADT categorised as “Institutes/Other”.

5.2 Summary of Chapter Findings

1. The scope of Digital Media education and training is quite diverse in Irish Universities/Colleges, ranging from "broader" computer science and engineering courses which contain elements of Digital Media education (specifically on the technology side), to dedicated courses for the Digital Media industry. However, the range of courses dedicated to specific Digital Media sectors (such as games, mobile/wireless, animation and film & TV) is relatively low with less than 10% of courses reviewed being sector-specific. Interestingly, a small number of more general Digital Media courses, also deliver modules which are specific to a range of sectors. For example, mobile communications, 3D modelling, 3D model animation etc.

2. The level of technology focus/specialisation within courses varies. Courses in engineering and computer science typically provide programming skills relevant to all Digital Media sectors. In addition, many offer specialisms such as artificial intelligence, virtual reality and image processing etc. Digital Media courses also provide specific technology education such as 3D computer graphics, digital sound processing, image/video compression, special effects techniques etc. However, it was noted that in specific areas, the technologies may not be industry standard. For example, Maya is not being taught in the games courses. In addition, key programming skills appear to be taught on computer science etc, rather than on Digital Media courses. Finally, the level of technology focus in some Film and TV courses is relatively low.

3. There is greater flexibility for Irish Universities/Colleges to update course content/course modules rather than introduce new courses. Modifying course content or modules however, can still take anything up to one year.

4. Mechanisms to ensure courses remain up-to-date with industry developments include processes such as: Programme Boards to review and input into the design of course content, typically comprising industry experts; ongoing fostering of informal industry linkages etc., and industry-funded joint research projects. While industry input from leading entertainment and media companies is recognised as being vital to ensuring graduates are equipped with the latest industry requirements and that courses keep up-to-date with all industry trends and developments, Universities/Colleges cited the challenges and difficulties associated with ensuring industry engages effectively in this activity.

5. Benchmarking of Digital Media courses does not involve, for the most part within the Colleges/Universities reviewed, a structured/prescribed approach. In addition, no formal process is in place to assess how courses rank nationally or internationally, for example, vis-à-vis leading international Digital Media courses in the USA or UK.

6. Industry linkages in the Irish Universities/Colleges comprise: industry input into course design and delivery; joint research programmes; and other linkages such as internships/work placements etc. For the most part, industry input into course design and delivery is informal – secured through industry contacts, guest lecturers (in some Universities/Colleges, there are both structured and ad hoc guest lecturer programmes) and where established, Programme Boards. The review points to relatively well-developed industry research linkages as well as start-up business incubation centres. Again however, Universities/Colleges cited the challenges and difficulties associated with ensuring industry engages effectively in these activities, and expressed objectives to achieve an uplift in joint industry activity.

5.3 Course Scope

To determine the scope of Irish Digital Media education and training, the Digital Media courses are reviewed against four criteria, namely: the number of digital media related courses; sector specific courses/value chain specialisation; technology specialisation; and course access and availability. Each is described in full in the following sections.

5.3.1 Number of Digital Media Courses

In relation to the number of Digital Media courses delivered by the Irish education providers, the consultations highlight a number of key findings.

- A large number of courses that are either specific to, or relevant for, Digital Media are delivered across the colleges/universities reviewed. A total of 108 courses are available, with an average of 14 courses per college/university and an average of five core media or Digital Media courses per college/university. 65 Digital Media related programmes are delivered by the universities, with the colleges reviewed offering 43;
- The majority of digital media related programmes (68 courses or 63%), are broader courses such as computer science and engineering;
- The remaining 40 courses are "core" media or Digital Media programmes covering areas such as games development, multimedia systems, animation, and film & TV. A greater number of specific media or Digital Media courses, 25 out of 40, are delivered by the colleges; and
- Responsibility for delivering Digital Media-related courses is typically shared across two or more Faculties/Schools. For example, Faculties representing Engineering, Computer Science, Film, Arts and Humanities and Design each provide courses related to Digital Media.

5.3.2 Sector Specific Courses/"Value Chain" Specialisation

In relation to the delivery of sector specific courses and the value chain specialisation of the Digital Media courses, a number of key insights emerged from consultations with Irish education and training providers.

- Across the Colleges/Universities reviewed, the number of courses dedicated to specific Digital Media sectors is relatively low – with nine courses or just 8% being sector specific.
- The majority of sector specific courses (four of the nine programmes), are focused on the Film and Television sector, with only one or two programmes for the Animation, Games, Music and e-Learning sectors. Furthermore, a course specifically for the mobile and wireless industry is not delivered across the Colleges/Universities reviewed;
- Despite the low level of sector dedicated programmes, many of the non-sector specific courses (including "broader" and core media/Digital Media courses) typically provide students with skills that are applicable to most Digital Media sectors, for example, key programming skills such as Java and C++ are taught in many of the computer and engineering courses, with skills such as computer modelling, special effects, digital editing tools and tools for interactive media design delivered by the core media/Digital Media courses. It is recognised however, that on completion of such courses which are not sector specific, students may require further study to acquire more specialist sector-related skills;

- Interestingly, a small number of the non-sector specific courses deliver modules which are specific to Digital Media sectors, e.g., mobile communications in BA (Mod) Information & Communications Technology (TCD); 3D Modelling and advanced computing skills for web and mobile applications in BSc Computing in Multimedia Programming (IADT); and 3D model animation and computer generated models/animation in BA Design in Modelmaking for Film and Media (IADT); and
- In terms of "value chain specialisation", the majority of courses across the Colleges/Universities reviewed, provide students with a grounding in many areas of the Digital Media value chain, e.g., Computing in Multimedia Programming and Computing in Multimedia Systems in IADT focus on elements of the value chain such as production, storage, and distribution; and the MSc in Multimedia in DCU focuses on design, authoring, production and the distribution of information.

5.3.3 Technology Specialisation

In relation to the level of technology specialisation provided by Irish Digital Media education and training providers, the review highlights a number of key issues.

- Generally, the consultations revealed that the level of technology specialisation/focus varies across the Digital Media related courses reviewed;
- Courses in engineering and computer science, typically offer programming skills such as C++ and Java, which are relevant to many Digital Media sectors. In addition, some of these courses also offer specialisms for Digital Media such as artificial intelligence, virtual reality and image processing;
- Core media and Digital Media courses would appear to provide some Digital Media specific technology education and training such as 3D computer graphics, digital sound processing, image, video compression, post-production, special effects techniques, digital imaging and digital editing;
- However, it was noted that in specific areas, the technologies may not be industry standard. For example, Maya is not commonly being taught in the games courses;
- Key programming skills – critical for Digital Media sectors - such as C++ and Java, appear to be taught on the broader computing and engineering courses, and some multimedia courses, rather than specifically on Digital Media courses; and
- The level of technology specialisation in film and TV courses in the Universities reviewed is quite low, with the focus on areas including: theory and practice of film making; film history and theory; distribution and exhibition; and screenwriting.

5.3.4 Course Access and Availability

The consultations with the Irish education and training providers point towards some key issues in relation to the access and availability of Digital Media courses.

- Across the Colleges/Universities reviewed, annual student intake for the Digital Media related undergraduate and postgraduate programmes varies across the courses; however classes are typically quite small with an average of 15 to 30 students accepted each year; and
- Undergraduate courses are three to four years long, with postgraduate courses generally taught over one to two years. The lengthy timeframe to produce graduates (approximately three to six years) combined with the relatively low intake of students into Digital Media courses each year means that the numbers of graduates entering the marketplace annually is not substantial

5.4 Course Positioning

To determine the "positioning" of Irish Digital Media education and training, courses are reviewed against three criteria, specifically: digital media course benchmarking/national and international recognition; graduate demand by leading digital media companies; and accreditation/certification level. Each is described in the following sections.

5.4.1 Digital Media Course Benchmarking/National and International Recognition

To review the positioning of Irish digital media related courses, the national and international recognition of Digital Media courses, in addition to course benchmarking were considered. A number of key trends surfaced from the review:

- Course benchmarking, which is important in keeping courses up-to-date with industry/education developments, is typically carried out occasionally and/or is informal in nature across the Colleges/Universities reviewed;
- For example, existing benchmarking processes include: external examiners providing insights into competing courses and potential course improvements; Erasmus students offering feedback on international courses; and lecturers/programme directors occasionally reviewing courses against leading international courses/Universities/Colleges. Apart from one college, these do not involve a structured or formal format for course benchmarking with the key driver for benchmarking appearing to be individual lecturers or Programme Directors who leverage industry connections for insights into competing/leading courses; and
- Furthermore the Colleges/Universities reviewed do not have any formal process in place to assess how courses are ranked nationally or internationally. For an indication of how Digital Media courses rank nationally, many of the Irish Colleges/Universities rely on the CAO course application levels, and/or employment rates as an indication of their popularity.

5.4.2 Graduate Demand by Leading Digital Media Companies

The Colleges/Universities reviewed do not report on graduate take-up by leading Digital Media companies.

The Universities reviewed typically stated that graduates and their places of employment were formally tracked. However, official or up-to-date figures were not provided by any of the universities.

The Colleges typically affirmed that they were aware of the success of past graduates in relation to employment. However, up-to-date or official data was not available. Alternatively, some of the colleges reviewed, were not aware of demand by leading companies for their Digital Media students.

5.4.3 Accreditation/Certification Level

In terms of the accreditation or certification level of Irish Digital Media education and training, the review provides a number of insights into the Colleges/Universities reviewed.

- Of the Digital Media programmes reviewed, the majority (75 courses), are accredited as undergraduate courses, with the remaining 33 courses accounting for postgraduate programmes;
- The Universities reviewed offer a greater number of Digital Media related postgraduate courses than the Colleges - Universities deliver 29 postgraduate programmes, whereas four are available in the colleges. However in relation to undergraduate courses, the Universities and Colleges roughly deliver an equal number with 36 and 39 courses each respectively;
- Each undergraduate course delivered by the Universities is accredited to an Honours Bachelor Degree; the Colleges on the other hand, in addition to Honours Degrees, have six courses certified to an Ordinary Degree or Higher Certificate level (refer to table for further detail); and
- Of the core media/Digital Media programmes, the majority of undergraduate courses are delivered by the Colleges (22 programmes), with the Universities delivering only three undergraduate programmes. 12 of the 15 core Digital Media courses in the Universities are delivered at postgraduate level.

5.5 Course Development and Update

To establish the processes involved in the development and update of Irish Digital Media education and training courses, four criteria were used to assess this. These were: flexibility of course modules; frequency of course/module update; industry synchronisation mechanisms; and cross faculty co-ordination. Each are described in 5.5.1 to 5.5.4 inclusive.

5.5.1 Flexibility of Course Modules/Courses

In terms of Irish education provider's flexibility to change course modules, or introduce new courses, the consultations highlighted several trends as follows:

- Across the Colleges/Universities reviewed, modifying course content can typically take a year or more to implement. However there are some exceptions, for example, new modules are designed on a yearly basis in response to the latest industry developments in TCD's MSc in Multimedia Systems;
- Changing course content may involve incremental change or may incorporate the introduction of new course modules. For most Colleges/Universities, there is less flexibility to undertake more substantial change to course content in a short timeframe;
- New modules/modification of module content are usually introduced in the last two years of an undergraduate degree or at postgraduate level, with the first one to two years providing a more general grounding and therefore considered to require less modification; and
- Across the Colleges/Universities reviewed, there would appear to be relative flexibility with regards to the introduction of new modules. The introduction of new courses on the other hand, is a more complex and lengthy process. The development and accreditation process for a new course generally involves a formal process, requiring approval from several Councils or Boards, which can take anything from one to three years.

The current legislative framework for the institutes requires them to obtain approval from the Department of Education and Science for new courses. The Institutes of Technology Act 2006 gives greater autonomy to the institutes.

5.5.2 Frequency of Course/Module Update

In relation to the frequency of course or module update across the Colleges/Universities reviewed, consultations with the Irish education providers pointed to the following findings.

- Across the Universities and the Colleges, there appears to be three primary processes to update and review courses, namely: formal review at medium-term intervals combined with a formal annual review; formal review at medium-term intervals combined with an informal annual review; or just an annual review of all course content;
- A review process evident in both the Colleges and the Universities involves formal College/University-wide review of all courses by a panel of academia and/or industry, at regular medium-term intervals, every 3-5 years, in addition to an informal annual review of course content, which is typically an internal Faculty or specific course review;
- The second process also involves a formal College/University wide review at regular medium-term intervals (approximately every 5 years). However, this is combined with a formal annual review, which is typically a review conducted internally by each Faculty. This process is distinct to the colleges, in particular DIT; and

- Alternatively, the final process involves reviewing/updating course content on an annual basis, with a formal University-wide review at medium-term intervals not included as part of this process. The process, which is distinct to a small number of the Universities, typically involves an internal faculty review or a course review whereby new modules or changes to module content are made in response to staff research projects and/or industry trends.

Finally, in the last College reviewed, it formally reviews each course every five years- however this not is a College wide review. Instead each Department is in charge of implementing its own review process. In addition, incremental course changes are made during the year, with more substantial changes introduced on a yearly basis. The Programme Boards for each course, which meet two to three times a semester, are responsible for assessing the course content during the academic year.

5.5.3 Industry Synchronisation Mechanisms

In relation to Irish education providers updating courses in line with industry trends and developments, the consultations identify a number of key processes to achieve this as follows:

- Typically, the mechanisms for synchronising courses with industry developments are informal in nature both for Universities and Colleges - albeit a small number of them employ formal mechanisms for ensuring courses remain relevant to industry/keep up-to-date with industry developments;
- Informal mechanisms common across the Colleges/Universities typically include: informal meetings and discussions with industry; linkages with industry through joint industry and industry funded research projects; and staff linkages with industry; and
- To a lesser extent, evidence of formal mechanisms to keep courses updated with industry developments and trends was found in three of the eight Colleges/Universities reviewed. They include industry representatives on Course/Programme Boards, thus receiving direct input from industry in the design of course content.

5.5.4 Cross - Faculty Co-ordination

The consultations with Irish education and training providers offer insights into the level of cross faculty co-ordination in the design and the delivery of Digital Media courses.

- Universities and Colleges, with some exceptions, typically have a relatively low level of structured cross-faculty co-ordination, based around formal interfaculty processes, even where courses are spread across several faculties. Informal contacts between faculties are more commonplace and regular;
- Informal co-ordination between faculties primarily consists of regular discussions between members of staff or senior faculty members such as Faculty Deans or Department Heads, and the sharing of resources and staff across faculties; and
- Although not as common, evidence of formal mechanisms to encourage cross-faculty co-ordination was found in three of the eight Colleges/Universities reviewed. In one for example, interfaculty collaboration is formally encouraged through an interdisciplinary strategic research and planning group comprising expertise from the arts, engineering and computing faculties. Furthermore in another, the Programme Boards ensure input from across the college into course design and development, and include staff from each faculty as members of the Board.

5.6 Digital Media Industry Linkages

Finally, to identify the linkages Irish Digital Media education has established with industry, the Colleges/Universities were reviewed against a number of key criteria, namely: industry design of course content; industry delivery of course content; joint research programmes; and other evidence of industry participation. Details of each are provided in the following sections.

5.6.1 Industry Design of Course Content

In terms of industry input into the design of Digital Media programmes within the Colleges/Universities reviewed, the consultations with Irish education and training providers highlight a number of key issues.

- Industry involvement in the design of course content is largely informal – input is primarily in the form of informal discussions and meetings between industry and college staff;
- Industry meetings are held by staff at every level of the College/University, from Course Directors and Faculty Deans to lecturers, however, the level or frequency of communication is generally driven by individual staff members;
- Personal industry contacts, as well as contacts established through work placements, guest lecturer programmes and industry funded research projects are leveraged by the colleges; and
- A more limited number of formal mechanisms exist to include industry in the design of course content. Three out of the eight Colleges/Universities reviewed, include industry representatives as members of Course/Programme Boards, which are responsible for the design and future development of course content.

5.6.2 Industry Delivery of Course Content

Consultations with Irish Digital Media education providers identified that industry involvement in the delivery of course content is primarily in the form of guest lectures.

- Each of the Colleges/Universities engage industry as guest lecturers to some extent however, frequency can vary from occasional input into course delivery, to being a core mechanism for delivery of course elements/modules;
- It appears that two of eight Colleges/Universities reviewed include a guest lecturer series as part of their Digital Media courses, with other Colleges/Universities typically using guest lecturers on a regular basis across the Digital Media related courses. For example, in IADT creative courses in media-related areas involve one guest lecturer per week who are typically well established industry professionals; and
- The remaining five colleges/universities, appear to engage guest lecturers in the delivery of course content occasionally during the year – oftentimes, the level/frequency of guest lecturers depends on individual staff members.

5.6.3 Joint Research Programmes

In relation to joint research programmes between industry and education, the education review highlights a number of key findings.

- Across the Universities reviewed, there is evidence of industry funding for research projects and technology, industry involvement in joint industry research programmes and start-up businesses supported through University incubation centres.
- Although industry involvement in research is not as extensive as the Universities, there is some evidence of industry funding/sponsorship for research projects and technology as well as involvement in business incubation centres, across the Colleges reviewed.

5.6.4 Other Industry Participation

Consultations with Irish education providers indicate that many of Colleges/Universities reviewed have developed further linkages with industry though student internships and work placements.

- Inclusion of work placements in the Digital Media courses varies across the Colleges/Universities reviewed. Some consider it an essential element of the course curriculum and offer students a placement ranging from six months to a year; alternatively, other education providers do not offer students work placements or alternatively require students to organise placement themselves.

6. Digital Media Skills and Enterprise Clustering

6.1 Introduction

The purpose of this chapter is to examine the evidence available for the link between education, research and skills and Digital Media enterprise clustering. This evidence has been examined under a number of research streams, each of which is discussed in the remaining sections of the chapter. Specifically, these sections include:

- a discussion of the definition of clustering and the key factors typically underlying cluster development;
- review of the evidence available from the literature review on clustering policy and strategy in the UK and the US;
- evidence available from discussions with leading-edge Digital Media companies;
- evidence available from discussions with both the leading US education and training providers and the Irish education and training providers; and
- a summary of the key chapter findings.

More detailed material on the literature review elements of this review are provided in the appendix to the report.

6.2 Definition of Clustering

There is no universally accepted definition of what constitutes a cluster. Almost all attempts to define clustering, however, share a common view that clustering incorporates proximity (e.g. of location), networking (e.g. between public sector, private sector, and academia) and specialisation (e.g. by industry/sector). Michael Porter, for example, has described clusters as "geographically close groups of interconnected companies and associated institutions in a particular field, linked by common technologies and skills". He also goes on to emphasise that clusters "normally exist within a geographic area where ease of communication, logistics and personal interaction is possible". While he states that clusters can range from being of an urban area scale to being a group of countries, they are "normally concentrated in regions and sometimes in a single town".

A recent World Bank research paper has also identified a number of key success factors that are essential in cultivating successful and creative clusters[24]. Having an appropriate base of knowledge and skills, and having an outstanding university research base and associated commercial linkages, are identified among these key factors. However, there are also five other factors that are considered crucial, these being:

- availability of venture capital (as a key source of finance for high growth start-up companies);
- accessibility of anchor firms (that stimulate the growth of others) and mediating organisations (that facilitate exchange of information and promote joint actions);

24 Weiping WU, "Dynamic Cities and Creative Clusters", World Bank Policy Research Paper 3509, February 2005.

- targeted public policies (e.g. in terms of appropriate educational programmes, financial support for business start-up, initiatives to improve business infrastructure);
- good quality services and infrastructure; and
- diversity and quality of place (i.e. an attractive place to both live and work).

These latter five factors, while crucial, are not the focus of our research, which is more specifically investigating the link between education, research and skills and Digital Media enterprise clustering.

In the context of Digital Media, the industry can be defined as including both the Digital Media (creative) and software applications (technology) industries. Therefore, it spans the creative industries and the ICT sector. As a result, Digital Media policy or strategy to achieve enterprise clustering may not be an isolated, well defined set of initiatives/objectives. Some countries/regions have created a clear strategy focused on developing Digital Media clusters. Other cases may not be so clear, with some countries/regions developing clustering strategies for one of/both the ICT and the creative sectors. Therefore the following findings encompass evidence of ICT, creative industries and Digital Media clustering.

It should also be noted that it is widely accepted that clusters generally emerge spontaneously. It is therefore practically impossible for Governments or other agencies to create clusters artificially. What Governments and agencies can do, as noted above, is promote policy measures to enhance cluster benefits and effects by encouraging collaboration among stakeholders where an actual or potential cluster exists.

This is recognised in the European Commission's "Final Report of the Expert Group in Enterprise Clusters and Networks," which identifies how EU member states, candidate countries, EFTA/EEA members and the European Commission itself can incorporate clusters and networks into their national, regional, local and EU policies. This report states that a policy on clusters should "… provide a framework for dialogue and inter-firm co-operation as well as co-operation between small enterprises, higher education and research institutes, public and non-public organisations at local, national and European and international level". The distinct role of EU, national and regional authorities in this context includes:

- being a catalyst – i.e. supporting synergies between actors, or enhancing the sharing of information, technology, and practices between European regions and clusters at an EU level;
- developing framework conditions – best practice here appears to involve national authorities establishing the overall framework conditions, with regional authorities responsible for implementing and managing clusters;
- exchanging information – national authorities should support initiatives for gathering and disseminating strategic information for regions and clusters, while regional and local authorities are best placed to organise and foster internal exchange of information between local actors;
- financial support – while the issue of financial support is controversial, it is recognised that Government aid is often needed to finance restructuring and infrastructure, development of co-operation, research and education, knowledge transfer, cluster animation etc; and
- raising awareness – i.e. the importance of fostering collaboration between stakeholders. This can be used as a stage to raise awareness among enterprises of the potential offered by clusters and networks, thus contributing to the long-term success and growth of the cluster.

6.3 Evidence from the UK Literature Review

In the UK, the Department of Trade and Industry (DTI) set up a Cluster Policy Steering Group in 2000, which had the objective of identifying (a) existing cluster strengths in the UK and (b) the barriers to the successful development of clusters. As a result of this group's work, responsibility for strategic development of clusters was devolved to a Regional Development Authority (RDA) level in England. Responsibility for implementing clusters therefore lies with:

- North-West Development Agency;
- Yorkshire Forward;
- One North-East;
- Advantage West Midlands (AWM);
- East Midlands Development Agency;
- East of England Development Agency;
- South-East England Development Agency;
- South-West of England Regional Development Agency (SWERDA); and
- London Development Agency.

RDA activities in these areas were kick-started in 2000-01 by a £15 million Innovative Clusters Fund (ICF), which was a pioneer funding stream to RDAs to promote cluster development and business incubation in the regions. Out of nine RDAs in England, two have been involved in developing and supporting Digital Media or related clusters – these are the ICT clustering strategy adopted by AVM and the Digital Media strategy adopted by SWERDA. In both cases, there is also evidence that education, research and skills play an important role in the respective clustering strategies.

AWM: Under the AWM strategy, ICT is identified as one of 10 priority clusters considered vital to the development of the region's economy, output and employment, as it accounts for 6% of regional output and also supports almost all other sectors of the economy through the development of enabling technologies. Therefore, AWM set up a Clusters Opportunities Group (COG) to oversee and direct the delivery of the ICT cluster strategy – this group is majority private sector led (and supported by public sector partners), and is responsible for drawing up an annual strategy for the ICT cluster.

Under the AWM strategy, skills and education is identified as one of three key "strategic enablers" (along with hard/soft infrastructure and data/intelligence), while research and innovation is one of three key "strategic directions" (along with developing networks and growing sub-clusters"). Activities to date have included:

- the development of "OpenAdvantage", the West Midlands Open Source Solutions Centre, which is a collaboration between the University of Central England, the National Business-to-Business Centre at Warwick University and the National Computing Centre to encourage the take-up of Open Source software. OpenAdvantage provides free consultancy and knowledge to industry through seminars and training workshops about Open Source software and best practices;

- the development of a Centre of Excellence for Research in Computational Intelligence and Applications (CERCIA) at Birmingham University. CERCIA organises courses and workshops and gives technology reviews and briefings to business. Additionally, it provides consultancy services and contract R&D work to external organisations and looks to form partnerships with industry and businesses in joint R&D work, which may lead to joint ventures in the future;
- the development of university-based consultancy, training and support for ICT-based SMEs at the IT Futures Centre at Wolverhampton University. IT Futures offers: advice and practical assistance on the evaluation of the latest technologies for use in business; advice on bespoke and off-the-shelf solutions; access to staff training; and website development services to industry[25];
- a proposal to develop the "West Midlands Mobile and Wireless" initiative, a consortium of five universities in the region working together to promote the exploitation of wireless and mobile technologies and thereby promote a new sub-cluster in the region.

SWERDA: In the SWERDA area, the RDA has identified five economically important sectors and three emerging sectors that it regards as crucial for increasing economic growth – creative industries is one of the emerging sectors, with one of the established sectors being ICT. A number of strong industry clusters have been developed, as well as a strong network of incubation centres and science parks, and the creation of partnerships between industry, education and digital related bodies.

In 2004, the RDA produced its first strategy report focused specifically on the Digital Media industry in the South-West of England. The "Digital Content Strategy" was developed by South-West Screen, which is the film, television and Digital Media agency for the South-West of England. It sets out a clear action plan for developing the Digital Media industry in the South-West, particularly through fostering a culture of integration and collaboration between industry stakeholders. The action plan incorporates recommendations under five strategic objectives, which are listed below.

Objective A: Sector Profiling

- Recognise the different structures, networks, cultures and commissioning patterns in Digital Media, which are quite distinct from traditional, established media.
- Support the six key venues across the South-West, for example the Watershed, which act as hubs of activity and expertise in Digital Media and nodes of energy.
- Identify, brand and profile emerging "digital quarters" in key South-West cities, centred on these key venues in partnerships with local bodies.
- Encourage collaboration between those venues and the digital arms of the existing media/interactive clusters and innovative local digital companies.
- Support existing talent showcasing and incubation programmes.
- Develop a strategic presence for the South-West Digital Media industry, both at a regional/UK level and internationally.

25 Five days free consultancy can be provided to SMEs if they meet a range of criteria: they employ less than 250 people; they operate in the West Midlands; and they are involved in creative industries, engineering design, tourism and leisure, medical technology, and/or food and drink.

Objective B: Know How Development

- Support knowledge transfer between and among SMEs, corporates and universities providing opportunities to engage in UK wide networks like the Creative Entrepreneurs Club.
- Support cutting-edge academic institutes in the region, which engage and serve the digital community, and associated placements, shadowing schemes and mentoring opportunities.
- Look at how skill development initiatives can be pulled together to maximise their strategic impact, possibly clustering them together under one umbrella.

Objective C: Innovation and Commercialisation Support

- Engage the industry with leading-edge applied academic research, particularly enabling SME engagement.
- Investigate the creation of an investment fund for Digital Media or, more widely, the creative industries.

Objective D: R&D Programme

- Encourage major platform operators, media companies and university R&D departments to form new collaborations to pitch for new funding streams for innovative digital work, in particular to access UK and EU level funds.
- Seek funding for a feasibility study for a Digital Media Service to support the South-West Digital Media community.
- Seek active participation in UK-funded initiatives, i.e. the UK Film Council Digital Screen Network programme to research new audiences and business models in cinematic distribution based on digital technology.
- Explore the potential for partnership with the South-East region.

Objective E: Expertise SW

- Business expertise should be made available to the Digital Media sector, which may be part of the creative industries as a whole.
- Provide access to a single source of intellectual property advice.
- Provide support and advice on enterprise development – entrepreneurship from successful entrepreneurs, possibly through a managed mentoring system.
- Encourage trade international support for SME participation in international festivals, markets and showcases.
- Provide a distillation of market intelligence and access to a respected analyst.

There are six Digital Media related industry clusters or networks in the South-West region. These are Bristol Interactive Cluster (BRIC); Digital Peninsula Network (DPN); Gloucestershire Media Group; InterACTIVE; Plymouth Media Partnership; and Wessex Media Group. Each cluster's objective is to create a focus for the growth and development of the media/creative industries within that particular sub-region. Different industry architectures, regional specialisms, sources of funding and partnerships have led to different emphases in each cluster. However, three clusters in particular have developed links/partnerships with training and education providers in their region:

- Wessex Media Group – Wessex Media Group is a collective group of producers, directors, camera people, sound recordists, writers, designers, animators, music composers, and others in the screen-based media industries, including training providers from the region. One of the key aims of the group is support education and training to strengthen the regions skills base – to facilitate this, the Group has strong links with most of the higher education institutions in the region running Digital Media courses, including: Bournemouth University; Salisbury College; Weymouth College; Bournemouth and Poole College of Further Education; and the Learning and Skills Council for Bournemouth, Dorset and Poole;

- Plymouth Media Partnership – the objective of PMP is to develop a networking forum to foster and develop links and commercial partnerships among creative industries in and around the Greater Plymouth area. It supports a broad range of sectors including: television, film and radio; facilities houses; interactive media; animation; web design; marketing design; and music composers. One of its key aims is to collaborate with the local academic and training organisations to provide guidance on the quality and relevance of courses as well as building networks and relationships across the South-West with all stakeholders; and

- InterACTIVE – InterACTIVE represents local Digital Media companies and the converging media cluster. It is a University of Bath initiative, which includes members ranging from web and Internet developers to interactive content producers and digital technology companies.

In addition, SWERDA has also developed a number of incubation facilities and science parks in the region, each having strong links with the training and education in the South-West. For example:

- the new Enterprise Pavilion at Bournemouth University's Arts Institute provides high quality business incubation with accommodation and business support services with industry standard equipment including post-production facilities for Digital Media;

- the University of West England's eMedia at the Watershed, Bristol's Digital Media Centre, provides hi-tech managed office space in prime locations in the heart of Bristol's creative district; and

- DShed, a partnership initiative led by the Watershed, with support from other bodies including South-West Screen and BRIC, which aims to create a focus for Digital Media development (encompassing publishing, distribution, production, training and research) by actively encouraging networking and knowledge/skills transfer between the media industry, R&D, education providers and the creative community.

Scotland: In the late 1990s Scottish Enterprise, Scotland's main economic development agency, identified a number of industries as possible components of a meaningful cluster, which acquired the name "creative industries". The industries which conform to this "creativity" model are: games; radio and television; new media (including multimedia and Internet); film; music production; design (including fashion design and crafts); publishing; architecture; advertising; arts; and cultural industries. An "action phase" for the development of a creative industries cluster was launched in April 2001, with resources of £25 million allocated to a programme that would run over a 3-5 year period.

An early stage of the initiative involved identifying a set of opportunities or objectives for the digital "creative" cluster. From the very beginning, the focus of the cluster has been on Digital Media and the ability of these industries to fully utilise its benefits. Furthermore, four main objectives/opportunities for development of creative industries were identified:

- generating a more "creative-friendly" and supportive business infrastructure in Scotland;
- establishing more effective means of identifying and nurturing creative talent;
- a greater international reputation for Scotland as a creative sector; and
- greater interaction between Scotland's creative industries and the research community.

A five year action plan was also developed with specific growth targets established for the end of the five year period, including: cluster growth of 10%-20% each year; creation of 2,000 new jobs; and increased export trading to 15% of cluster turnover.

The creative industries cluster was primarily run by the national office of Scottish Enterprise, but with extensive consultation and collaboration with industry representatives. In some cases, component sectors of the creative industries cluster are co-ordinated from a local office, in line with regional strengths. In general, support and activity are also delivered through existing structures and bodies such as Local Enterprise Companies, industry associations and partners such as the Scottish Arts Council.

To date Scottish Enterprise has succeeded in introducing a number of initiatives to foster growth of the creative industries cluster in Scotland. These include:

- the development of a Proof of Concept Fund, which supports the pre-commercialisation of leading-edge technologies emerging from Scotland's universities, research institutes and NHS Boards. Since 2001, some 13 new projects in the Digital Media and creative industries sector were funded by a £2 million investment from this fund;
- on the infrastructural side, a world class Digital Media centre, earmarked as a "Digital Media Campus" and business park is being developed in Glasgow, with a second Digital Media park under construction in Dundee, which will see a £50 million injection into the area over the next 10 years;
- a number of support/development agencies have been set up to provide assistance to the creative industries sector and enhance partnership between academia and industry. For example, Interactive Tayside is a partnership between public, private and academic sectors to develop and promote Tayside's Digital Media industry. The body aims to: build the Digital Media industry in the Tayside area; develop new commercial opportunities; promote the high-quality skills and talents of the area's Digital Media practitioners to a wide audience; and encourage higher levels of collaboration between businesses and with academia. Interactive Tayside can offer a range of business support services, all geared towards the development of the Digital Media industries in this area. These services for large and small businesses include: advice and funding; help with PR and promotion; R&D; and training and skills; and
- in addition, the Research Centre for Television and Interactivity in Glasgow provides practical help to independent production companies. Set up in 1998, a partnership between Scottish Enterprise Glasgow and Channel 4, its work focuses on: supporting and developing business growth among content producers; encouraging R&D within the industry; and enhancing the quality of ideas and the commercialisation of content across all platforms.

6.4 Evidence from the US Literature Review

The US provides evidence of a number of clusters involving Digital Media sectors and related areas. US States where relevant clustering activity is in place include Boston, Florida, Texas and California. Of these, Boston and Florida provide the best evidence of activities linking education, research and skills to Digital Media enterprise clustering.

Boston: Research conducted at universities in Massachusetts has had a major impact on the growth of sectors such as computing and IT. The State's eight research universities, for example, are large beneficiaries of federal research funding and the authors of a considerable number of new patents. This serves to attract large national and international companies to locate in the area – some such companies include Cisco and Sun Microsystems.

Licensing of technologies to commercial enterprises is perhaps the most direct way in which academic research can be translated into industrial growth. To facilitate this, the Boston research universities have created technology transfer offices. Support offered through these offices includes:

- seed money for further work on inventions;
- assistance in business planning;
- introduction to venture capitalists;
- assistance with recruitment; and
- incubator space.

Boston's "Research Row" is made up of MIT, Harvard and a number of other local universities as well as a concentration of industrial labs, which together offer a superior technical labour pool. MIT is also well known for its institutional culture which encourages faculty entrepreneurship with many companies having been founded by university alumni. For software firms the computer culture in Boston, which is formed around MIT (dubbed "Technology Square"), helps explain clustering there.

In addition, the research universities in Boston have worked to design their teaching and training programmes to meet the needs of the regional labour force. The universities also contribute to the quality of life in the region through the provision of affordable housing programmes, community improvement programmes, and programmes to help deliver health services.

Florida: A number of Digital Media and IT clusters have emerged in Florida as a result of increased co-operation between research institutions and enterprise. Principal drivers for this development include the following:

- Florida has a number of key IT products and information service companies including: Citrix Systems; Electronic Data Systems (EDS); Hewlett-Packard; IBM Global Services; and Intel;
- Florida is the third largest film and entertainment production centre after Los Angeles and New York, and it is also the location for some of the major entertainment-related theme parks in the US (Walt Disney World, Universal Orlando);
- in 2003, the University of Central Florida combined the disciplines of computer science, graphic arts, communication and film into the School of Film and Digital Media; and

- in 2004, the State established the Florida Interactive Entertainment Academy (FIEA) at the University of Central Florida to produce a deeper, more highly skilled talent pool for the Digital Media industry.

The two key areas in Florida where clusters have developed are Central Florida and South Florida.

High-Tech Corridor: Florida's High-Tech Corridor (Central Florida) includes the areas of Tampa, Daytona Beach, Orlando, Gainesville, and Melbourne. The Corridor, established in 1996, includes a high concentration of firms specialising in the following sectors: aviation and aerospace; IT; medical technologies; microelectronics; modelling, simulation and training; and optics and photonics.

The High-Tech Corridor is supported by the Florida High-Tech Corridor Council. The Council is a partnership involving more than 20 local and regional economic development organisations (EDOs) and 14 community colleges. It is made up of the presidents of the three State universities (the University of Central Florida, the University of South Florida and the University of Florida), the presidents of two of the community colleges (who serve on a rotating basis), the president of Florida Institute of Technology, and up to 24 representatives of high tech industry.

The Council's mission is to attract, retain and grow high-tech industry, and the workforce that supports it, within the Corridor. This employs a partnership between research and business and a strategic approach to high-tech economic development, which uses three distinct strategies to leverage governmental, EDO and corporate budgets on a regional rather than local basis:

- providing matching funds for university and business R&D projects;
- encouraging the progression of workforce development initiatives (through associate degree programmes, primary and secondary school programmes and workforce research programmes); and
- conducting collaborative marketing projects with the local business, educational and economic development organisations that raise awareness of the region.

The Council's Matching Grants Research Programme is managed on the three university campuses by a committee of university researchers and Council partners. The committee issues, reviews and approves proposals on a year-round basis – to date, the Council has partnered with more than 215 companies on more than 550 projects, and has contributed more than $40 million in funding. The partnering companies have matched this with funding of $80 million, all of which has been dedicated to research. More than 75% of total funds (nearly $90 million) have been used to engage 1,000 graduate and doctoral students and research assistants and 300 university faculty members in research with scientists and engineers from 215 companies.

DMAF and FDMEC: The Digital Media Alliance Florida (DMAF) and Florida Digital Media Consortium (FDMEC) are two relevant "mediating organisations" that support Digital Media clustering in Florida. The DMAF is a non-profit industry association, established in 1999, whose mission is to provide a focus and forum for the continuing development and worldwide recognition of Florida's Digital Media and e-entertainment industry. Its objectives are to:

- support and aggressively promote Florida's worldwide leadership in the research, development, application and usage of interactive, dynamic and experiential Digital Media for learning, entertainment, marketing and information purposes;
- facilitate collaboration and partnerships between the Digital Media industry and Government, educational, creative and financial organisations, to strengthen the industry and workforce for global competition;

- provide a strong and unified voice for Florida's Digital Media and e-entertainment industry, based upon credible research and enlarging the community of members;
- encourage and facilitate professional, career and workforce development;
- work to ensure the availability of world-class resources, capital and workforce in a supportive environment, such that entrepreneurial Digital Media companies can start successfully and existing companies can compete, grow and flourish; and
- actively seek co-operative relationships with existing Florida organisations to further these objectives, using Digital Media whenever and wherever effective.

FDMEC is a non-profit educational organisation, comprised of participants from Florida industry, Government and education, who are committed to advocacy of excellence in Digital Media education. In partnership with the DMAF, the FDMEC aims to:

- serve as a common focal point for co-operation, collaboration, information sharing and joint planning and action for Digital Media education and awareness;
- jointly contribute to effective development and utilisation of resources for educational networking at all levels and with industry;
- co-host annual, State-wide Digital Media education conferences and/or workshops to provide networking and learning opportunities between industry, State and private educational institutions and Government;
- advise and assist in educational articulation;
- provide mentors, speakers and assistance to K-20 education[26] as well as adult education and training;
- conceive, research, analyse, evaluate, develop and disseminate educational and co-operative efforts that further the goals and purposes of the organisation and its members;
- create valuable linkages between related efforts; and
- jointly plan actions and pursue resources to continually improve the availability, quality and effectiveness of Digital Media education in Florida.

InternetCoast: The InternetCoast (South Florida) is made up of a collection of technology companies and organisations operating in South-East Florida. It is a technology cluster of businesses, organisations and educational facilities, whose mission is to focus on social innovation, entrepreneurship and a knowledge-based workforce to facilitate investment and drive economic growth. The InternetCoast has over 2,000 participants, including the private sector, education, existing organisations, and local and State governments.

Within the InternetCoast, the Education Research Consortium facilitates dialogue among educational institutions and businesses, which results in education programmes designed to produce an ongoing supply of qualified workers to support the InternetCoast. This consortium has in turn been able to access funding through the Florida Technology Development Act 2002, which provides $30 million for building university-based Centres of Excellence that develop research projects, leading-edge facilities, the recruitment of world-class personnel, and strategic partnerships with business entities that may commercialise the technologies developed in centres.

26 The K-20 concept views education as a continuum from pre-school through graduate school.

In addition, the InternetCoast's CIO Advisory Council enhances community awareness of IT issues through education and communication. The participation of Chief Information Officers (CIOs) from South Florida's commercial business, Government and educational institutions creates opportunities for executives to grow their respective organisations. The Council provides a forum for an open exchange of ideas, collaboration on issues of mutual importance, leveraged vendor relationships, and focused community involvement. Its objectives include:

- sharing ideas across industries and technology platforms to create innovation;
- improving the IT talent pool by interacting with higher education to develop programmes and curricula geared to fill industry needs and retain qualified prospects locally;
- develop a concise role in the strategic direction of the membership's respective organisations;
- educate the membership to properly fill the role of the CIO, as it evolves;
- educate corporate leadership on the role technology can play in the success of the organisation; and
- impact service and pricing from vendors that are critical to the success of the membership.

The InternetCoast furthers these objectives through networking events, conferences and the work of committees established to further specific agendas (e.g. education, entrepreneurship, governmental and marketing issues).

Texas: San Antonio's "2004 Strategic Plan for Enhanced Economic Development" sets out a number of economic development strategies to grow San Antonio's creative economy. Amongst the objectives cited was to "… implement the San Antonio Technology Accelerator Initiative action plans, particularly with respect to fostering the growth of the Digital Media cluster". In 2004, the San Antonio Technology Accelerator Initiative Network (SATAI) created a new Digital Media arts technology cluster. The new cluster includes the following technologies:

- television and film production;
- computer graphics;
- animation;
- holograms;
- audio production;
- web design; and
- the gaming industry.

DCI and the Interstate 35 Corridor: The Digital Convergence Initiative (DCI) is an example of a "mediating organisation" facilitating the creation of Digital Media clusters in Texas. It is a public/private venture to facilitate the growth of the digital-oriented industrial and scientific base of Central Texas to:

- Create regional and US competitive advantage in the international digital market;
- advance economic opportunities for regional businesses with attention to small business growth; and
- align institutional and private sector digital-oriented R&D with consumer demands and Government requirements.

By connecting the regional entities and leveraging the convergence of these separate industries, the DCI therefore aims to create a "super economic cluster" in Central Texas.

DMC: The Digital Media Collaboratory (DMC) in Central Texas, located in the IC2 Institute, University of Texas, was launched in 2003. It is a centre of expertise for technology-related virtual environment research within Texas's Digital Media cluster. The DMC works with a variety of collaborators from academia, industry and Government to conduct innovative research in five key areas:

- modelling and simulation;
- decision support systems;
- educational technology;
- digital games; and
- machine learning.

The DMC works with partners such as the Sandia National Labs, the US Army and the National Science Foundation. It is currently working on the following activities:

- Games for Learning – transforming the interactive experiences and popular appeal of games for entertainment into games for learning;
- Valuation Matrices for Learning/Educational Content in Popular Games – researches the potential for commercially situated computer games to demonstrate educational utility;
- Artificial Intelligence – development of dynamic and sophisticated computer interaction systems to achieve engaging, immersive experiences;
- Focused Knowledge Bases – extends the traditional knowledge base to capture the processes and functions of the domain considered as a system;
- EnterTech, EnterTech Spanish – a simulation based workforce training programme;
- Digital Entrepreneur – a micro-enterprise education programme using blended learning; and
- Career Connect – an experiential job preview that combines engaging, high-quality and interactive simulated work environments with meaningful occupational information.

In addition, the Future Media Institute (FMI), established in 2003 by the DMC and the Capital Area Training Foundation (CATF), provides training opportunities in film, gaming, Digital Media, software and networking. The FMI's goals are to empower individuals in Central Texas to explore their creativity, to build programmes to assist students in investigating careers in technology, and to give educators access to experts in industry.

California: The "Digital Coast" of Southern California is home to the largest combination of companies developing, distributing, and delivering Digital Media to meet the needs of a wide range of market interests from health care to entertainment. The business interests and skills of the Digital Coast, from Santa Barbara to San Diego, cover the range from technology to content. Companies in this region develop Internet-based Digital Media, software tools and utilities, databases, applications for education and consumer entertainment, and electronic commerce.

There are two key mediating organisations involved in this region – the Digital Coast Foundation and the Digital Coast Roundtable.

DCF: The mission of the Digital Coast Foundation (DCF) is to serve as a facilitator for leveraging resources in the service of community-based arts, technology and education organisations in the Digital Coast Region. In addition, the DCF collaborates on initiatives that impact the greater technology community. The services provided by the DCF include:

- developing seminars and workshops with New Media Academies to integrate art and technology into high school curricula;
- assisting identified non-profit organisations with shared goals and interests; and
- conduct industry research to analyse and track trends and growth in the Digital Coast region.

DCR: The Digital Coast Roundtable (DCR) brings together industry, academic and Government leaders to promote the success of emerging technology and Digital Media companies in the Southern California region. The group includes influential rich media, technology and financial executives in Southern California. In addition, the DCR convenes organisations, associations and guilds to collaborate on events, initiatives and public policy.

The Industry Relations Committee is a service of the Digital Coast Roundtable and brings together on a quarterly basis the presidents of Southern California's technology and media professional associations to discuss timely issues and events facing the companies and individuals in local Digital Media industries. The DCR is working to unite the Southern California technology and Digital Media communities to collaborate on important issues and increase awareness of the region.

6.5 Evidence from the Leading-Edge Digital Media Companies

This section examines the relevance of Digital Media clustering to leading-edge Digital Media companies, based on the evidence of the companies interviewed in the seven sectors reviewed – games, CGA and SFX, digital film, digital television, e-music, wireless and mobile services, and e-learning. The evidence for Digital Media clustering is provided for three separate issues:

- access to skills as a critical influencing factor for location decisions;
- access to education and research as a critical influencing factor for location decisions; and
- co-location with other companies as a factor in location decisions.

Access to Skills: Discussions with the leading-edge Digital Media companies suggest that access to skills is certainly a factor that influences location decisions. Most companies regarded it as an important influence, and indeed for some companies it was cited as a crucial factor in influencing location decisions. For example:

- one company pointed to an example where a series of closures by other companies in its sector, in a particular location, led the company to set up a studio in that location, which in turn could then feed off the talent pool left behind by the company closures;
- another company indicated that it has declined incentives to locate in certain places in the past because insufficient skills were available at those locations;

- another company, which is a heavy user of Microsoft/Windows technology, indicated that it has opened an operating base in Seattle to feed off the local talent pool that has been generated by the growth of Microsoft and its location in Seattle; and
- skills were also a crucial factor in another company's decision to locate an operating base in Singapore, while the same company pointed out that a number of other major Digital Media companies (across a number of sectors) have similarly located in Singapore in recent years.

However, access to skills and resources is not the only factor influencing company location decisions, nor is it necessarily even the most important factor. A decision to situate an enterprise in a particular location can in fact be made for any number of random reasons – some of these other reasons include:

- lifestyle choice by the founder of the business, e.g. a business may be situated in a particular location simply because it is where the founder of the business lives;
- some firms have inherited additional locations as a result of pursuing attractive business acquisition opportunities – a number of companies interviewed pointed to this as being a factor underlying the location of some of their operations – though in such cases the acquiring company will often inherit a skilled talent pool;
- the availability of lower cost bases is another reason cited as influencing location decisions – while a lower cost base can derive from a number of elements, the availability of highly qualified but lower cost talent pools would be a factor here also; and
- location of a firm's target market(s) is also a key factor, and companies interviewed have pointed to the clustering of effects and animation houses near to Hollywood, for example, or the location of post-production houses clustered around Soho in London. One company pointed to its decision to open facilities in China and Tokyo as being directly linked to the huge market opportunities there, while another indicated that it had situated sales and marketing offices in capital city locations as a means of optimising market opportunity.

Where markets and costs are a key factor, however, having access to skills is obviously also a pre-requisite. At the same time, market and cost advantages may be sufficiently attractive to encourage companies to relocate skills or to source them from other locations if they are not available in the targeted location.

Access to Education and Research: Clustering with universities and research facilities does not appear to be a strong motivator underlying company location, though some companies would consider it useful or at least acknowledge its potential where such resources are close by. In addition, there is evidence that some companies have sought to develop relationships with universities and research facilities – some of the outputs of this activity (either directly through the companies interviewed or through their parent companies) include the following:

- industry investment and involvement in the Mobile Media Institute at the University of Southern California;
- relationships with other universities and research institutes such as the University of California (including Berkeley, UCLA etc), the University of Columbia, the MIT MediaLab, Rutgers University (New Jersey), North-Eastern University (Massachusetts), Lowell University (Massachusetts) etc;
- industry hosting of "academic summits" and industry forums with college professionals to discuss industry developments and the link to skills training and R&D; and

- industry sponsorship of university technology and equipment, including the sharing/donation of company proprietary tool sets with universities for teaching purposes.

Co-location with Other Companies: Co-location with other companies in a common geographical area is again not a crucial factor underlying company location decisions, though it can be considered useful from a consumer/client and company perspective. For example:

- being located near to other companies in your sector or in similar sectors can augment the talent pool available in a particular area, which in turn can attract more people to locate there and further enhance the talent pool;
- having other companies close by can be a potential outlet for outsourcing during periods of short-term demand on resources;
- for games developers, proximity to major games publishers is useful in terms of being able to do business more effectively; and
- co-location can be useful for clients, who may at any one time be dealing with a number of companies within a particular sector or related area.

The companies interviewed provide very little evidence of formal linkages or partnerships with other companies operating in the same/similar sectors and in the same geographical location.

6.6 Evidence from the Skills Providers

Although clustering between Digital Media education/skills and industry is a partnership actively encouraged by both universities and colleges, discussions with both Irish and US Digital Media education providers highlight the limited development of Digital Media skills and enterprise clustering – though there is notable evidence of links to joint industry-academic research activities.

In the US, Full Sail attributes the under-development of clustering to the reluctance of Digital Media companies to collaborate with colleges. However, Full Sail also reports that the situation has gradually improved in the US – attitudes have changed, and many Digital Media companies now appreciate the value of collaborating with education providers. Full Sail points to the "Education Summits" hosted by the leading software developers as evidence of this change in attitude. Typically, a major Digital Media company, such as Adobe or Apple, invites leading Digital Media education providers together for a discussion on current and future technology provisions. Also, it should be noted that Full Sail does not engage in research activities, where more evidence of joint industry-academic activity is found.

The majority of US and Irish colleges interviewed have introduced initiatives that can help to foster clustering of skills and enterprise. Carnegie Mellon has developed strong links with Digital Media companies (Microsoft, Intel), for example, through the establishment of an incubation centre and Digital Media research centres. In Ireland, there is also some evidence of cluster initiatives/opportunities across the colleges, including research and incubation centres and joint industry research projects. While these are still at an early stage, there are some interesting developments emerging.

UCD is involved in a cross disciplinary research centre with DCU called the "Adaptive Information Cluster", involving industry players such as Vodafone, Ericcson, Mitsubishi and Changing Worlds. In addition, UL is located in and part of the National Technology Centre at Plassey. It is primarily involved through the park's incubation centre – however, an opportunity exists for UL to develop further linkages with industry (ICT/Digital Media) through the companies located in the park. Further initiatives are also in place across other Irish colleges – both IADT and DCU have created linkages with industry through their incubation centres, with the incubation centre located in IADT specifically focused on supporting Digital Media companies.

The benefits that can arise from a college perspective from this activity are varied, but may include the following:

- industry participation in joint research activities will universities and colleges can increase the financial resources made available for research as well as bringing additional, industry-oriented intellectual capital to the research process;
- research activities and findings can in turn inform course design and teaching within universities and colleges; and
- the relationships made with industry open up opportunities for other forms of co-operation such as guest lecturing on taught programmes, development of placement programmes and internships, access to technology resources or sponsorship for same etc.

6.7 Summary of Chapter Findings

- The review of clustering policy in the US and UK shows that both countries provide evidence of clear strategies that are focused on developing and nurturing Digital Media clusters. In both cases, most of this evidence is to be found at a regional/sub-regional level rather than a national level.
- These strategies have in turn stimulated a large number of initiatives that are designed to promote Digital Media clustering and its benefits. However, many of these initiatives are relatively recent developments, and it may therefore be too early to gauge their relative success.
- It is also clear that there are a variety of factors that influence clustering, whether based on Digital Media activities or otherwise. These include the availability of finance/capital, accessibility of anchor firms and mediating organisations, targeted public policy, good quality services and infrastructure, an appropriate base of knowledge and skills, a strong university research base and associated commercial linkages, and a diversity and quality of place.
- Education, research and skills does not appear to drive clustering policy or strategy, but it does play an important role in clustering strategies, e.g. through technology transfer, development of research Centres of Excellence, industry collaboration on Digital Media course content.
- Facilitating collaboration between stakeholders appears highly important to clustering policy and strategy, particularly through the development of "mediating organisations" that can drive clustering.
- Access to education, research and skills can be a factor in influencing location decisions for companies, but it is not necessarily the most important factor. In addition, access to skills appears to be a more important influencer than access to education and research.

- For education and training providers, there is limited evidence of clustering-type activities with enterprise based on access to skills, however there is more evidence of joint research activities between industry and academia.
- Policy makers generally appear to be the main drivers of clustering initiatives, with companies more lukewarm in terms of initiating activity. This may suggest that large scale clustering activities have elements of market failure, i.e. while it can no doubt generate very positive impacts and outcomes, these impacts are may not be immediately obvious to the private enterprise (particularly where it requires enterprise to commit resources).

7. Conclusions and Recommendations

7.1 Introduction

The purpose of this chapter is to set out the key conclusions and recommendations arising from the study. This is done through three main sections in the chapter:

- Section 7.2, which outlines the key study findings and conclusions;
- Section 7.3, which outlines the relative "gaps" between the skills needs of leading global Digital Media companies, the evidence of practice by leading US education and training providers, and the evidence of practice by Irish education and training providers; and
- Section 7.4, which outlines the key study recommendations.

7.2 Conclusions

This section provides a summary of the key findings and conclusions arising from the study research. These key findings are summarised in two main sub-sections, which are detailed below – company findings and college findings.

Company Findings: The analysis of the skills needs of leading global Digital Media companies has identified a number of key overall findings that apply across most of the Digital Media sectors examined. Among the main findings arising from the company perspective are the following:

1. For enabling technologies, high quality programming skills are a pre-requisite for most Digital Media sectors. In this regard, skills in C++ and Java appear to be the main programming requirements. However, database programming skills are also very important for developing content management systems, for example Oracle or SQL, while knowledge of Internet technologies and protocols is crucial in developing relevant web applications. In addition, high quality, high-end talent programmers are also very analytical, with strong skills in mathematics, physics, algorithms etc – such skills have become increasingly necessary as programming needs in some sectors have become more specialised (e.g. artificial intelligence programming, virtual reality programming, visual effects programming, computer graphics programming, gameplay programming for games and computer generated animation/special effects etc).

2. Skills requirements in content creation roles are also continually evolving, including increased technological specialisation of roles – examples include the high level of specialisation emerging for animation and graphics roles in various sectors, continuous update and development of industry tools (e.g. proprietary company tools as well as vendor-based tools such XSI and Maya), and the skills implications arising from the rapid expansion of content opportunities in the wireless and mobile sector, the increasing sophistication of wireless devices, and the greater complexity and diversity of applications required.

3. The critical importance of non-technical skills within Digital Media sectors should not be overlooked. Central to this is the over-arching importance of creative skills, which remain a core skill requirement even among very technically skilled content creators. Furthermore, the more recent emergence of business-oriented skills, project management skills, communication skills and client-facing skills as important attributes for Digital Media industry employees is very marked, and certain Digital Media sectors also need people with very well-developed, but traditional, sales and marketing skills.

4. A better understanding of how the whole Digital Media production process works is another trait that seems to be increasingly valued among employees in the Digital Media industry, e.g. programmers with a better understanding of the artistic/creative disciplines and needs that they are building tools for, artists and designers who can manipulate tools using script programming etc. Allied to this, adaptability will become a lot more important in future, as staff are increasingly required to work on different types of Digital Media projects, new Digital Media technologies, and on different types of Digital Media platforms.

5. Clustering of enterprise where there are skills available is an important consideration for a lot of companies when making location decisions, however it is not the only factor to be considered and there are often more important factors underlying these decisions (e.g. access to markets, lower costs). Clustering with education and research, as opposed to skills, appears to be less important.

College Findings: The college findings also have identified a number of interesting overall findings, particularly when comparing Irish education and training provision with what is found in leading US universities and colleges. Among the main findings arising from this perspective are the following:

1. The scope of Digital Media education and training provided in the US is more varied and diverse than in Ireland, particularly in terms of the higher level of sectoral specialisation allowed within course modules and also the higher level of technological specialisation within courses. While this should be recognised as being partly a function of scale, i.e. the US has a much larger and more diverse economy, with a very large population that can support a more varied course scope, it may still present some lessons for Ireland on the nature of its Digital Media education and training provision.

2. Similarly, the ability of Irish third-level institutions to update course content with speed and flexibility appears to be more limited than US counterparts. While this is again partly a function of the nature of Irish college structures generally, the more limited scope for regular course development and update is probably at odds with the needs of a fast-changing industry such as Digital Media.

3. In addition, industry linkages in Ireland, both in terms of course design/delivery and course development/update, are not as well-developed as those in the US colleges reviewed. Again, the nature of the enterprise base in Ireland may place a brake on the development of such linkages (high proportion of SMEs, which would not have the resources to become involved in industry-academic partnerships), however the relatively less structured nature of most industry linkages in Ireland provides a definite contrast to the evidence of structured industry input (through Review Panels, Advisory Panels, structured guest lecturer programmes, extensive joint industry-academic research etc) in the US.

4. Clustering initiatives supported by universities and colleges mainly involve attempts to develop research activities with industry as opposed to industry involvement in course design, delivery and update. While some universities and colleges have been successful in this regard, others have been less so.

7.3 Irish Digital Media Skills Providers – Gap Analysis

Table 7.1 summarises the key findings of the previous section by presenting the relative "gap" analysis between (a) the education and training offered by the Irish education and training providers reviewed and (b) the offerings of a small number of leading US education and training providers and the needs of the leading global Digital Media companies. It shows that there are a number of criteria where the Irish education and training offering could be improved, which again tie closely to the findings above. These include:

- course scope, including more sector-specific skills, technology skills and business/project management skills;
- processes for fast-tracking course development and update;
- processes for facilitating well-developed industry linkages; and
- processes for benchmarking courses against leading national and international counterparts.

Table 7.1: Irish Digital Media Skills Providers – Gap Analysis

Criteria	Rating	Description
Against Leading Colleges Reviewed		
Course scope	◐	▪ Irish universities and colleges reviewed provide a similar extensive range of broad Computer Science and Engineering courses and a similarly small number of sector specific Digital Media courses. ▪ Irish universities and colleges have less sectoral specialisation on a modular basis, however, and a less deep technology specialisation within Digital Media courses.
Course positioning	○	▪ Little evidence that Irish universities and colleges have similar structured college or course benchmarking processes to those found in the US.
Course development and update	◐	▪ Irish universities and colleges do not appear to have the same level of flexibility as leading US colleges to update and develop courses in line with industry needs and trends.

Industry linkages	◐	▪ Industry linkages in Irish universities and colleges, while they exist, are less formally structured and embedded than is the case in leading US colleges. In addition, there is less joint industry-academic research in Irish colleges vis-à-vis US colleges.
Against Company Needs Reviewed		
Sector-specific skills	◐	▪ Irish universities and colleges do not provide the very broad range of sector-specific skills that are demanded across the leading Digital Media sectors, while US colleges offer more of these skills in either courses or modules.
Technology skills	◐/○	▪ Irish universities and colleges do not provide the very broad range of technology skills that are demanded across the leading Digital Media sectors, though this applies more to dedicated Digital Media courses rather than Computer Science or Engineering courses. In some cases industry standard technologies (e.g. XSI, Maya for animation and graphics) are not extensively used.
Creative skills	●	▪ Irish Digital Media and related courses are well equipped to provide students with the necessary creative skills, albeit that the best creative talent is more often innate to the individual.
Business skills	○	▪ Very little business-oriented, project management or related training in Irish Digital Media or Computer Science/Engineering courses.
Accreditation	●	▪ Course accreditation levels in Ireland generally meet the expectations of Digital Media company needs.

Key: ● = Achieved ◐ = Partially achieved ○ = Not achieved

7.4 Recommendations

This section outlines the key study recommendations. The report makes six key recommendations, incorporating 17 different actions (of which 11 are high priority actions), with the recommendations covering three key themes:

- making courses relevant to Digital Media potential and needs;
- keeping courses relevant to Digital Media potential and needs; and
- promoting Digital Media clustering.

The recommendations and actions under each of the three themes is outlined below.

Making Courses Relevant to Digital Media Potential and Needs: Chapter 2 has highlighted the high-growth nature of the global Digital Media industry, while Chapter 3 shows that the skills profiles for several Digital Media sectors contain a range of very high-end, high value-added skills that could present potentially attractive opportunities for Ireland. Chapters 4 and 5, meanwhile, provide examples of some leading edge Digital Media education and training provision in the US as well as reviewing the nature of Digital Media education and training provision in Ireland. These chapters show that there may be opportunities to improve Digital Media course provision in Ireland in ways that would make the skills base even more relevant to the industry's growth potential and skills needs.

The report therefore presents three key recommendations, covering seven different actions (five high priority actions), to make course provision in Ireland more relevant to Digital Media potential and needs. These recommendations include:

- prioritising key Digital Media target sectors for course development in Ireland;
- providing high quality creative, technical and programming skills to meet the needs of the Digital Media industry; and
- providing a more practical, industry-oriented focus to Digital Media education and training.

Table 7.2: Making Courses Relevant to Digital Media Potential and Needs

	Recommendation		Actions	Priority	Responsible
1.	Prioritise key Digital Media target sectors for course development in Ireland	A.	Skills development for Digital Media in Ireland should target the wireless and mobile sector, the games sector, the film and television sectors (with an emphasis on digital technologies), and the e-learning sector. This should include the development of more sector-specific Digital Media courses and more specialist Digital Media modules in related courses. This could include, where justified, sector-specific Digital Media courses for content creation or programming as well as Digital Media electives/modules in broader creative or programming courses. The absence of any wireless and mobile courses in Ireland was highlighted and acknowledged in the Phase I study, which also pointed to the recent development of a number of courses in this sector in the UK, which cover a range of wireless and mobile related areas including Java programming, analogue and digital electronics, radio frequency engineering, mobile networking, mobile application design, wireless systems etc.	High	Universities and Colleges, HEA, DoES, IDA Ireland
2.	Provide high quality mix of creative, technical and programming skills to meet the needs of Digital Media	A.	Computer Science and Engineering courses should provide high-end programming skills in C++ and Java, database programming, programming for Internet and networking technologies etc as well as some exposure to specialist programming skills (e.g. artificial intelligence, gameplay, visual effects, animation systems).	High	Universities and Colleges
		B.	Where necessary, creative courses should be enhanced by incorporating more Digital Media electives and modules, including appropriate technical training with a more varied range of software and technology tools using up-to-date technologies and platforms (e.g. XSI and Maya for animation, Linux for operating systems). Consideration could be given to providing funding to universities and colleges on a once-off basis to upgrade technologies and platforms. This could be done, for example, through a scheme whereby major software or technology providers "sponsor" universities and colleges by providing technology at a reduced price (say 50%), with the public sector (e.g. Department of Education and Science, HEA) providing the matching funding.	High	Universities and Colleges, HEA, DoES
		C.	For programming skills, more Digital Media electives/modules should be provided through Computer Science and Engineering courses to stimulate student interest in pursuing a Digital Media career. For example: games development and programming; wireless and mobile technologies; content management systems; and user interface applications.	High	Universities and Colleges
		D.	Technology specialisation within existing Digital Media and related media courses should be enhanced. This could include a better understanding of technical specialisms within particular Digital Media sectors or roles.	Medium	Universities and Colleges

Table 7.2: Making Courses Relevant to Digital Media Potential and Needs (Contd.)

	Recommendation		Actions	Priority	Responsible
3.	Provide a more practical, industry-oriented focus to Digital Media education and training	A.	Course curricula should incorporate practical, industry-oriented elements such as: project work on practical prototypes/outputs (e.g. games prototypes, animation showreels); the development of a standard, structured guest lecturer input into course curricula; "co-running" of classes with industry; industry mentoring of courses/students; and structured work placements and internships. Developing a practical and industry-oriented focus to education and training should apply to both creative and technical skills. For example, practical course work in the games sector might involve group projects that bring both content creators and programmers together to build a complete games prototype.	High	Universities and Colleges, IDA Ireland, EI
		B.	Digital Media and related courses should incorporate more modules that equip students with business-oriented and other similar skills. This should include skills required in project management as well as communication skills, interpersonal skills, client management skills etc. For a management level, this might also include the development of "Media Management" courses (e.g. and MBA for the Entertainment and Media sector) that provide skills in project management, finance, international sales and marketing etc. This was also a recommendation of the Phase I study and the 2002 Digital Content Strategy for Ireland.	Medium	Universities and Colleges Industry

In the short- to medium-term, Ireland's relatively high cost base and its current skills base in Digital Media mean that the industry is unlikely to generate individual FDI projects of the employment scale seen previously in Ireland (e.g. Intel, Wyeth). At the same time, this does not mean that there will not be opportunities to attract high value FDI in Digital Media or indeed to further develop Ireland's indigenous base in Digital Media. This is particularly the case given the industry's very high growth potential as well as the existing investment advantages that Ireland can offer (e.g. taxation). Target sectors should therefore be prioritised based on their global scale and importance, their high growth potential, and any evidence of existing/potential capabilities and an enterprise base within these sectors in Ireland.

On this basis, the wireless/mobile and games sectors should be key targets for skills development going forward – this is because:

(a) the wireless and mobile sector has very strong growth prospects, and wireless/mobile service adoption in both Ireland and Europe is very high; and

(b) the games sector is another high growth area, not just for consoles but also for wireless and mobile games, and Ireland has already developed some competency in this area.

In addition, the digital film and television sectors will also be important for indigenous market opportunities as well as for global opportunities, particularly in the UK and Europe. The e-learning sector, meanwhile, is a smaller sector compared to the others and its recent growth has been somewhat disappointing, however it is already a major Digital Media sector for Ireland and is therefore worth monitoring for future developments. Of the other sectors examined, the e-music sector would not appear to offer the same kind of high value opportunities as these sectors, while there is already strong competition for investment (e.g. from Asia) in the CGA and SFX sector.

Targeting the right sectors will in turn have implications for the types of courses and skills that education and training in Ireland should be providing. High priority actions that could be addressed are as follows:

- developing (from what is currently a fairly low base) more Digital Media-specific education and training within sectors, both in terms of sector-specific Digital Media courses and specialist Digital Media modules in other courses;
- ensuring that Irish education and training provides high quality programming skills in C++, Java, database programming, programming for Internet and networking technologies etc;
- maintaining high quality traditional creative skills as a priority, but combined with the high quality technical training needed to develop Digital Media skills, and using up-to-date technologies in delivering education and training; and
- incorporating practical "work-related" projects and assignments in courses, encouraging industry participation in course delivery and mentoring, and promoting structured work placements.

This study has not involved a rigorous assessment of future employment opportunities in Digital Media in Ireland. At the same time, the throughput of people from Digital Media courses in Ireland is fairly small in any case, however. Estimates also show that the Digital Media industry is growing very strongly on a global basis, and other countries (e.g. Scotland) have made small but significant steps in this area. The scale of global industry growth therefore probably warrants a "ramping up" of skills provision in its own right, not just for stimulating overseas investment but also for fostering indigenous enterprise growth.

Such improvements could be best facilitated by developing a national approach to Digital Media education and training in Ireland, which would aim to maximise the resources already available and then build on these where necessary. This would involve adopting an integrated approach to providing Digital Media courses in Ireland, which recognises the existing strengths of courses/colleges, identifies gaps in education and training provision where they exist, and identifies how best particular universities and colleges can contribute to providing an even better Digital Media education and training structure. This may involve the development of actual/virtual "Centres of Excellence" for different Digital Media skills and sectors in Ireland, which could combine education and training strengths and opportunities on a cross-faculty or cross-college basis (see below). Potential key players in developing such a national plan would include Enterprise Ireland, IDA Ireland, Forfás, the HEA, the Department of Education and Science, and the universities and colleges themselves.

Keeping Courses Relevant to Digital Media Potential and Needs: Just as it is important to make courses in Ireland relevant to Digital Media potential and needs, it will likewise be equally important to ensure that Ireland thereafter keeps its courses relevant to Digital Media potential and needs. This is especially important for an industry like Digital Media, given its rapidly changing nature. The report therefore makes two key recommendations, covering nine different actions (of which five are high priority actions), to keep course provision relevant to Digital Media potential and needs. These recommendations include:

- developing more flexible means of providing Digital Media courses in Ireland; and
- developing mechanisms to ensure that courses remain appropriate to industry needs.

Table 7.3: Keeping Courses Relevant to Digital Media Potential and Needs

Recommendation	Actions	Priority	Responsible
4. Develop more accessible means of providing Digital Media courses in Ireland	A. Potential cross-faculty and cross-college/ university development and running of courses, on a joint basis, should be explored to leverage synergies or complementarities in college strengths, and to provide options for combining creativity and technology in course design etc.	High	Universities and Colleges HEA, DoES
	B. Electives/modules across all courses should be made available from an early stage in course curricula (Year 1-2) rather than in later years only.	High	Universities and Colleges
	C. Irish universities and colleges should explore opportunities for more accelerated learning in Ireland as a means of developing course access and availability.	Medium	Universities and Colleges, HEA, DoES
5. Develop mechanisms to ensure that Digital Media courses remain appropriate to industry needs	A. Given the fast-changing nature of the Digital Media industry, all Digital Media and related courses should be subject to a full, formal review of course content and relevance on a regular basis. Such reviews would be separate from the existing quality assurance procedures adopted for universities by the Irish Universities Quality Board and for Institutes of Technology by the Council of Directors of the Institutes of Technology.	High	Universities and Colleges, HEA, DoES
	B. The course review process should be supported by the establishment of: • Course Review Panels, which have powers to modify and review course content in response to industry development; • Industry Panels, which would complement the Course Review Panels by providing a formal and distinct industry input into course review, design and update. Course Review Panels would be independent of the formal course accreditation bodies, but operating with the approval of the accreditation bodies and according to defined standards laid down by these bodies. These panels should have the power to significantly modify course content and should consist of both leading industry experts and academic experts who would act as a "control mechanism" for the quality and scope of revised course content. Industry Panels should consist of a membership that brings together leading industry professionals, who would meet 2-4 times a year to discuss course-related development requirements at each university or college.	High	Universities and Colleges, HEA, DoES
	C. Each university and college should be encouraged, as a standard activity, to develop more consistent ongoing interaction with the Digital Media industry. This could include the formal networks of industry linkages at each university or college, the active development and promotion of more joint industry-academic events (e.g. seminars and conferences), and more joint industry-academic research into Digital Media sectors, trends and developments.	High	Universities and Colleges Industry

Table 7.3: Keeping Courses Relevant to Digital Media Potential and Needs (Contd.)

Recommendation	Actions	Priority	Responsible
5. Develop mechanisms to ensure that Digital Media courses remain appropriate to industry needs	D. Irish universities and colleges should develop procedures for formal benchmarking of each Digital Media and related course against leading international Digital Media programmes, for use on an ongoing basis.	Medium	Universties and Colleges
	E. Formal partnerships should be developed and encouraged between Irish universities and colleges and their leading US and UK counterparts. At a basic level this could include student/teacher exchange, but it could also provide a mechanism to compare and review courses and technologies and better access to global industry-based research and expertise through US/UK partner contacts and relationships with industry.	Medium	Universities and Colleges
	F. Agencies or organisations supporting the Digital Media sector (e.g. relevant industry associations, the new umbrella "Digital Media Forum", Enterprise Ireland or IDA Ireland) should support the course review process by updating universities and colleges on latest Digital Media industry trends and research.	Medium	Enterprise Ireland, IDA Ireland, Digital Media Forum

Developing more flexible means of course provision in Ireland would help to increase student throughput from Digital Media courses in Ireland as well as making courses more potentially responsive to changing industry needs. In this regard, key actions that could be explored to enhance the flexibility of course provision include:

- the development of Digital Media courses on a cross-faculty or cross-college/university basis (e.g. through the development of "Centres of Excellence"); and
- the increased provision of Digital Media electives and modules within the early years of course curricula.

Mechanisms for accelerated learning could also be explored in order to speed up student throughput (i.e. similar to the mechanisms evident in both Full Sail and Florida State University in the US). While issues of scale may place limits on what can be achieved here (i.e. Ireland is a much smaller economy than the US, with a much smaller pool of prospective students/trainees), its potential is nevertheless worthy of examination. For example, new course entry on a semester rather than monthly basis could be examined, or developing cross-college courses that could facilitate accelerated learning. Establishing a national plan for developing Digital Media skills across all Irish universities and colleges could also provide a better opportunity to explore such potential.

Courses also need to remain appropriate to industry needs, however, which requires course content to be changeable in line with key industry changes. The evidence in this report suggests that Irish Digital Media courses could be better equipped to support this, and recommended actions to update course content in line with industry needs are therefore presented. Key actions recommended here include:

- the development of regular, formal reviews of course content and relevance; and
- the establishment of independent "Course Review Panels" with power to modify and review course content in line with key industry developments.

As a medium priority, more initiatives to improve benchmarking for Digital Media and related courses could further help universities and colleges to gauge the ongoing relevance of their courses to Digital Media needs. This could incorporate (a) the development of formal benchmarking mechanisms to compare Irish Digital Media courses with leading international courses and (b) the development of more partnerships between Irish universities and colleges and other international universities and colleges providing leading edge education and training for the Digital Media industry.

Keeping courses relevant to industry will also need a strong industry input into course review and update. The report suggests two key priority actions that might be used to strengthen this input, including:

- the development of "Industry Panels" to provide a formal and distinct industry input into course review, design and update; and
- the development of better academic-industry linkages through networks, joint events and research.

Incentivising collaboration and linkages between industry and universities/colleges may need a "carrot and stick" approach, and may involve multiple strategies. Universities and colleges could be mandated to actively engage with the Digital Media industry, for example. At the same time, facilitating better collaboration probably needs some form of "honest broker" mechanism, which sells the benefits to industry as well as colleges and which helps to facilitate the development of partnerships between the two, e.g. some form of "linkage programme" operated by Enterprise Ireland/IDA Ireland/HEA. Financial mechanisms might also be a possibility for generating more industry-academic research, e.g. by setting up a dedicated fund(s) for promoting such research on a pilot basis, based on appropriate criteria, or by extending the scope of R&D tax credits to better facilitate Digital Media R&D[27].

In addition, developing a better structure for industry-academic collaboration could help to better harness the existing levels of activity in this area, which are very welcome but which are also somewhat fragmented. Such a structure, together with incentives, could serve to further increase the scope for industry-academic collaboration in Digital Media.

Promoting Digital Media Clustering: Chapter 6 has shown that there is a lot of activity among policy makers in other territories that is targeted at developing clustering activity in Digital Media – and education, research and skills play an important role in this. Developing a similarly structured approach to targeting Digital Media clustering in Ireland would therefore be worthwhile, and key elements in this (from an education, research and skills perspective) would include the continued formal development of a Digital Media clustering policy for Ireland (i.e. building on existing initiatives such as the 2002 Digital Content Strategy, the development of the Digital Hub, and the proposed Digital Media Research Centre) and the stimulation of even more joint industry-academic research activity in Digital Media.

27 Most activity that currently represents "R&D" in Digital Media does not qualify for the tax credits presently available for R&D, which is more limited to very early stage research activities.

Table 7.4: Promoting Digital Media Clustering

Recommendation	Actions	Priority	Responsible
6. Continue efforts to promote Digital Media clustering among the public, private and university/college sectors	A. Government, in co-operation with the relevant Government departments, State agencies and other interested bodies, should continue to develop a Digital Media clustering policy for Ireland by: • building on existing Government-supported activities and initiatives (e.g. the 2002 Digital Content Strategy, the Digital Hub, and the proposed Digital Media Research Centre); • encouraging more initiatives to develop joint industry-academic research activity in the Digital Media industry .	High	Universities and Colleges, DETE, Enterprise Ireland, IDA Ireland, SFI

Appendix A: Methodology

1. **Project Mobilisation and Company/College Selection:** The purpose of this phase of the work programme was to initiate the project and clarify the study approach/methodology with the client. In addition, the phase incorporated the identification of target leading-edge Digital Media companies for interview and the selection of a relevant sample of providers of education and training in Ireland and the US. A total of 18 target companies was chosen, covering seven Digital Media sectors, as well as eight Irish education and training providers and four "leading" US education and training providers. Sectors were chosen on the basis of their importance as target growth sectors for the Digital Media industry in Ireland, including targets for foreign direct investment.

2. **National Literature Review:** This phase involved a short review of selected relevant literature on the Digital Media industry in Ireland. The purpose of the phase was to provide an overview of key issues and trends affecting the Digital Media industry in Ireland (including technology, market and convergence trends) as well as inform both the consultations with leading-edge Digital Media companies and the interviews with US and Irish education and training providers. The review focused on key PwC and other Digital Media reports only, and the literature reviewed included the following publications:

   - "The Digital Media Industry in Ireland", the 2002 report prepared by PwC for Forfás;
   - "Skills Requirements of the Digital Media Industry in Ireland: Phase I", prepared for the EGFSN by FÁS in conjunction with the STeM Research Centre, DCU, 2005;
   - "Electronic Games Study", a report prepared by Forfás in January 2004;
   - "Wireless Communications: an Area of Opportunity for Ireland", a report prepared by Forfás in April 2004;
   - PricewaterhouseCoopers' "Global Entertainment and Media Outlook 2005-09";
   - "The Future of Digital Media", PricewaterhouseCoopers, 2002; and
   - "Irish Film – the Digital Future", a PricewaterhouseCoopers report for the Irish Film Board.

3. **International Literature Review:** This phase involved a brief review of international literature on the provision of education/research and its link to the creation of critical mass/clustering among Digital Media enterprises in selected other countries. The purpose of the phase was to provide some international context that would inform the analysis and discussion of the role that skills can play in fostering Digital Media clustering in Ireland.

   The focus of the review was on evidence from the US and the UK, in particular the evidence from strategies and policy reports focused on Digital Media clustering. This included a review of the enterprise clustering context in each country and the evidence for Digital Media clustering at enterprise and industry/research level – where such information was available.

4. **Consultation with Menlo Park Digital Media Experts:** The purpose of this phase was to gain some expert insights on the key trends and drivers-of-change currently impacting on the global Digital Media industry. This was done through discussions with the consultants' Digital Media experts in PricewaterhouseCoopers' Global Technology Centre in San Jose, California.

Discussions focused specifically on the sectors/activities relevant to the target companies being interviewed in the company consultation phase of the work programme. These sectors were: Electronic Games; Computer Generated Animation and Special Effects (CGA and SFX); Digital Film; Digital and Interactive Television; e-Music; Wireless and Mobile Services (i.e. location-based services); and e-Learning.

5. **Consultations with Leading-edge Global Digital Media Companies:** This phase was a core component of the overall work programme, and it was a key contributor to understanding the existing skills profile of the Digital Media industry and the future skills requirements across its key sectors. The phase involved carrying out 18 detailed interviews (using an interview questionnaire agreed with the client in advance) with leading-edge Digital Media companies in the US and the UK. These companies cover the seven priority Digital Media sectors referred to earlier, and more detail is provided in Section 1.5 below.

6. **Consultations with "Leading" Digital Media Education and Training Providers:** The purpose of this phase of the work programme was to understand the type of education and training that a typical "leading" Digital Media education and training institute provides. To do this, interviews were carried out with four of the leading Digital Media education and training providers in the US. Target colleges were: Carnegie Mellon (Pittsburgh, Pennsylvania); Full Sail Real World Education (Orlando, Florida); UCLA (Los Angeles, California); and NYU (New York). Interviews were carried out with a number of representatives (e.g. Programme Directors, Chairs of Department, Deans of School etc) of: Carnegie Mellon; Full Sail; Florida State University; and UCLA.

   These interviews were again conducted using a questionnaire agreed in advance. Through the discussions, the consultants obtained a better understanding of the scope, nature, technical and non-technical aspects of "leading" Digital Media education and training providers, how they synchronise with industry developments, and how they contribute to clustering and critical mass. This in turn served as a comparative mechanism for understanding the education and training provided by Irish universities and colleges serving the Digital Media space.

7. **Consultations with Irish Providers of Third-level Digital Media Education and Training:** The purpose of this phase was to understand the type of education and training provided by a typical Irish education and training institute in the Digital Media space. In this case, a limited number of interviews were carried out with eight Irish universities and colleges – Trinity College Dublin, University College Dublin, Dublin City University, University of Limerick, Dublin Institute of Technology, Galway-Mayo Institute of Technology, National College of Art and Design, and Dun Laoghaire Institute of Art, Design and Technology – each of which was chosen as a leading provider of Digital Media and related skills in the Irish education and training environment.

   As with the discussions with "leading" education and training providers, the interviews were conducted using a questionnaire agreed in advance. A particular focus of the questionnaire was on identifying the scope and nature of courses in Irish universities and colleges, and mechanisms for course development/update and for synchronisation with industry developments. The review of course providers did not, however, involve a detailed audit of Digital Media education and training in the universities and colleges chosen.

8. **Digital Media Skills Supply and Demand "Gap" Analysis:** The purpose of this phase of the work programme was to pull together the research from the earlier work programme phases and compare the skills requirements of leading Digital Media companies worldwide with Irish education and training providers' ability to meet these requirements. In doing so, this phase therefore identifies the relative "gap" between the skills needs of the global Digital Media industry and skills provided by Irish education and training providers.

The analysis for this phase was done using a "gap analysis framework", which was used to facilitate comparison and set out the gap analysis findings.

9. **Development of Key Study Recommendations:** The purpose of this phase was to set out a series of recommendations and policy initiatives with regard to:

   - the gaps in the Irish third-level education and training provision for the Digital Media industry;
   - mechanisms to ensure that education and training in Ireland is synchronised with evolving developments in the global Digital Media industry, and consequently its evolving skills needs; and

     fostering Digital Media enterprise critical mass through education and research.

10. **Preparation of Draft and Final Report:** This phase of the work programme involved the formal reporting of the key study findings and recommendations. This report is the draft report, which has been made available to the Project Steering Committee for review. Following feedback from the Steering Committee, the final report will then be completed and agreed with the client, followed by a presentation of findings to the EGFSN.

Appendix B: Skills Profiles

Table B.1: Core Skills Profile for the Games Sector

OCCUPATIONS	INDICATIVE SUB-CATEGORIES	INDICATIVE SKILLS/EXPERIENCE
Management/ Project Management	General Management Executive Producer Project Manager Technical Director Discipline Leads	▪ Management roles are traditionally from a technical background and with games development experience, but this is not exclusively the case ▪ Business and project management skills are becoming increasingly important, with a requirement for the ability to effectively manage budgets, resources, timelines etc ▪ Strong communication and interpersonal skills required as games development teams expand
Design	Games Designer Lead Designer Design Director Level Designer Scripter Designer Technical Artist	▪ College degree or equivalent typically sought, e.g. Fine Arts, Film, Games Development, with Technical Artists often coming from Computer Science, Architecture or Engineering backgrounds ▪ Excellent creative thinking and innovation skills necessary, as designers are key influencers of games ideas and concepts ▪ Excellent communication and writing skills needed, desk-top publishing skills also necessary ▪ Project management skills also welcomed, especially for Technical Artists ▪ Experience with 3D layout tools and similar technical and design tools is welcomed, e.g. Maya, Visio ▪ Programming experience not necessary, but considered a plus, e.g. C++, scripting languages ▪ Comprehensive games experience is welcomed, including a good knowledge of all aspects of the game production pipeline
Artistic/ Creative	Concept Artist 2D Artist 3D Artist Texture Artist Modeller Animator Pixel Artist Character Artist Environmental Artist Background Artist User Interface Artist VFX Artist Art Director	▪ Relevant third-level qualification usually found among incumbents, e.g. Art, Animation, Computer Graphics/Traditional drawing skills a necessity for artistic/ creative roles ▪ Experience with relevant software packages for 2D, 3D and computer graphics is also necessary for most roles, e.g. Maya, 3D Studio Max, Soft Image XSI, Photoshop, Illustrator, Lightwave, Pro Motion ▪ Strong animation and/or traditional art backgrounds, experience in designing, modelling, texturing, rigging, lighting, colouring, compositing

		■ Knowledge of scripting languages an advantage ■ Project management, communication and interpersonal skills increasingly sought as the size and complexity of games production teams expand
Programming	Tools Programmer Software Engineer Graphics Engineer 3D Software Engineer Network Engineer Console Programmer Technology Programmer	■ Generally, programmers require a degree in Computer Science or a related area. ■ Games development experience is highly valued, proven experience in completing games titles an advantage ■ Proficiency in standard programming languages is typically sought: C/C++; Java; Perl; Python; TCL; CSharp etc ■ Ability to use these languages to write well constructed, fast running code is highly valued, a strong background in maths usually helps here ■ Knowledge of specialist programming techniques is emerging, e.g. physics, computer graphics (Cg), artificial intelligence (AI Implant), 3D rendering, shading, gameplay, lighting, shadowing, visual effects, audio techniques ■ Knowledge of key graphics software packages is useful, e.g. Maya, Soft Image XSI, 3D Studio Max, as it helps programmers to find ways to improve these packages ■ Experience in a variety of relevant games platforms is welcomed (not just console, but also online/mobile), e.g. networking skills, hardware optimisation, Internet/ wireless technologies, 3G mobile technology ■ Communication/interpersonal skills increasingly sought along with development of project management skills
Quality Assurance	QA Engineer Games Tester	■ PC literacy is a basic skill requirement, though entrants to this role are increasingly technically qualified, e.g. Degree in Computer Science or related discipline
		■ Need to have good bug tracking/reporting skills and good attention to detail
		■ Key skill required is to have an enthusiastic interest in, and a well developed ability to play games

Table B.2: Balance of Skills for the Games Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Technical	Non technical Skills	Balance
Management/Project Management	General Management Executive Producer Project Manager	◐	○	●	Increasingly requires good business and project management skills
	Technical Director Discipline Leads	●	◐	◐	Need a strong familiarity with technical operations, however project management skills are also very important
Design	Games Designer Lead Designer Design Director Level Designer Scripter Designer	◐	○	●	Knowledge of technical skills across all aspects of game production have become more important, however creative skills and excellent communication and writing skills are crucially important
	Technical Artist	●	○	●	Link between designers and artists or programmers, more technically skilled but also needs good project management skills
Artistic/Creative	Concept Artist Modeller	◐	●	●	Traditional creative and artistic skills are a strong necessity, use software tools less than other artists but may still be competent in using such tools
	2D Artist 3D Artist Texture Artist Animator Pixel Artist Character Artist Environmental Artist Background Artist User Interface Artist VFX Artist Art Director	●	●	●	Skills can be quite specialist and require technical competency in using animation and effects tools, but also need strong traditional creative and artistic skills and increasingly need good communication and interpersonal skills
Programming	Programmer Tools Programmer Software Engineer Graphics Engineer 3D Software Engineer Network Engineer Console Programmer Technology Programmer	●	◐	◐	Very technically competent in programming, specialist roles and expertise in programming emerging, communication/ interpersonal and project management skills increasingly sought
Quality Assurance	QA Engineer Games Tester	◐	○	●	Key skill required is an active interest in and ability to play games, though entrants to this role increasingly come with technical qualifications that allow them to progress within games production
Key:	● = Very Important ◐ = Important ○ = Less Important				

Table B.3: Core Skills Profile for the CGA and SFX Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
Management	General Management Executive Producer Project Manager CG Supervisor Technical Director Art Director	■ Management is traditionally from a technical background (except for normal business support functions such as Finance and HR) ■ Business and project management skills and strong communication and organisational skills are very important ■ Ability to effectively manage budgets, resources, timelines etc is needed ■ Strong technical background in CGA and SFX is particularly needed for CG Supervisor/Technical Director/Art Director type roles
Creative: Art/ Story Development	Artist Character Designer Prop and Set Designer Modeller (e.g. Organic,Hard Surface) Storyboard Artist Editors Editorial Technical Assistant	■ Usually have traditional artistic or creative degrees (e.g. Fine Arts), film-related, degrees etc ■ Need an aesthetic eye and/or artistic background, knowledge of traditional animation principles, excellent artistic and design skills, writing and storyboarding skills for Storyboard Artists ■ Good understanding of the film-making and post-production process is important as CGA and SFX jobs become more complex ■ Good communication skills and interpersonal skills are also important for this purpose ■ Editors need technical ability to use editing systems such as Apple Final Cut or Avid editing products
Computer Animation/ Graphics	Creature Developer Character Animator CG Modeller CG Technical Assistant Lighting Director Layout Artist Motion Capture Technician Compositor Matchmover Rotoscope Artist Digital Matte Artist Digital Plate Restoration Rigger/"Chainer"	■ Usually graduates with degrees in areas such as Film, Fine Art or Animation, though Computer Science degrees are important for some positions (e.g. Creature Developers, Motion Capture Technicians, Technical Assistants) with photography/industrial design/ architecture qualifications useful in others (e.g. Digital Matte Artists, Lighting Directors) ■ Knowledge of 3D modelling and animation software needed in many positions (e.g. Maya, Soft Image XSI, 3-D Studio Max, Motion Builder, After Effects, FormZ, Electric Image, LightWave, in addition to specialist packages such as Syflex) ■ Other specialist software required for other positions (e.g. Discreet Shake and Adobe After Effects for compositing, 3D Equalizer and Realviz Matchmover for matchmoving, XSI Matador, Digital Magic and Elastic Reality for rotoscoping) ■ Knowledge of rendering software needed for many positions (e.g. Renderman, Mental Ray) ■ Strong programming background (C/C++, Java) needed for Technical Assistant positions, knowledge of C++ and scripting languages (e.g. Perl, Shell) useful for compositors ■ Working knowledge of UNIX for compositing, digital resource and digital plate restoration, proficiency also generally useful ■ Understanding of film-making and acting particularly useful for some areas (e.g. Creature Developers) ■ Verbal and written communications, and project management skills becoming more important

R&D	Tools Programmer Systems Developer Database Applications Developer R&D Engineer Interaction Designer User Interface Prototype Developer Quality Assurance Engineer Automation Engineer Technical Writer	■ Bachelor Degree in Computer Science or Engineering ■ Experience in software development/systems programming (C/C++, Java) and relevant operating systems (UNIX, Windows XP Pro, Linux) ■ Script programming skills (e.g. Python, TCL, Perl) also useful in some cases ■ Specialisms can include experience for systems development in animation systems, modelling systems, compositing systems, renderers and shaders, physical simulation, artificial intelligence, knowledge and experience of 2D and 3D graphics and computer vision algorithms ■ Database experience (Oracle, SQL, PLSQL) for some systems, applications and tools development ■ Experience in computer graphics production and knowledge of 3D graphics applications also desirable (e.g. Maya, XSI) ■ Strong communication skills, including writing skills (for Technical Writer, who creates technical support documentation)

Table B.4: Balance of Skills for CGA and SFX

Occupations	Indicative Sub-categories	Technical Skills	Specialist Technical Skills	Non-technical Skills	Balance
Management	General Management Executive Producer Project Manager	◐	○	●	May have technical backgrounds, but key skill requirements lie in good project management
	CG Supervisor Technical Director Art Director	●	○	●	Technical skills are more central to these roles, however they also need people to have good project management skills
Creative: Art/ Story Development	Artist Character Designer Prop and Set Designe Modeller Storyboard Artist	○	○	●	Key skills required for such roles are traditional artistic and creative skills and training in the relevant area, good communication skills becoming increasingly important
	Editors Editorial Tech Assistant	◐	○	◐	Also have an artistic/creative background but with more technical expertise in the use of editing systems
Computer Animation/ Graphics	Creature Developer Character Animator CG Modeller CG Technical Assistants Layout Artist Motion Capture Tech Compositor Matchmover Rotoscope Artist Digital Matte Artist Digital Plate Restoration Rigger/"Chainer" Video Engineers	●	●	●	Typically computer animation and graphics roles are very technical and very specialist, covering competency in a wide range of technical tools, however artistic and creative talent is also crucially important
R&D	Tools Programmer Systems Developer Applications Developer R&D Engineer Interaction Designer UI Prototype Developer QA Engineer Automation Engineer Technical Writer	●	◐	◐	Very technical roles requiring a Computer Science/Engineering background, with an increasing degree of specialisms emerging and a greater need evident for project management and communication skills
Key:	● = Very Important	◐ = Important	○ = Less Important		

Table B.5: Core Skills Profile for the Digital Film Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
Management	Producer Executive Producer Associate Producer General Management Finance Human Resources	■ Producers and related positions need a unique mix of finance and fundraising skills, legal and contract negotiation skills, general deal-making skills and commercial nous ■ Strong management, organisational, budgeting and scheduling skills are also required among producers, while creative and conceptual skills are highly valued. Extensive previous experience in film or related sectors is required, including knowledge of production methodologies and technologies ■ Producer familiarity with relevant technical skills is a plus (e.g. use of editing tools such as Avid X-Press) ■ General business skills and related qualifications are needed for other mainstream management roles, previous experience of working in the film or other media sectors also common
Content Creation	Director Writer Storyboard Artist	■ Directors and writers can have diverse educational backgrounds, though media-related qualifications are common ■ Strong creative, conceptual and visual ability and skills are needed for any role in creating film ideas and content, strong scriptwriting skills are needed for writers ■ A broad knowledge of production and post-production techniques is welcomed, while directors also need strong business-related skills such as budgeting, scheduling etc ■ Digital technologies have emerged as an aid to the content creation process, e.g. ability of writers to use script creation software (Drakkon Script, Dreamascript, SceneWriter, Scriptware, Storybase), familiarity of storyboard artists with electronic storyboarding techniques (Storyboard Quick, Storyboard Artist, Storyboard Pro)
Pre-production	Pre-visualisation Set Development Location Management Casting Costume Design Make-up	■ People filling these roles can have diverse educational backgrounds, though artistic/film, television or other media backgrounds are common ■ Creative and visual ability is a commonly sought trait across most pre-production and production roles ■ Digital technologies are again an aid to some pre-production roles, including software for set development and pre-visualisation (Avid Film Composer, Antics Pre-viz, IKTRIX Impulse, 5D Android), location management databases and websites (locamundo.com), costume design (Personal Patterns 4 Deluxe, PatternMaker, Expert Vision) and make-up (eImagePro, MAGGI Mirror)
Production	Digital Camera Operators Motion Control Operators Digital Lighting Technicians Digital Video Operators	■ Knowledge of relevant hardwares and softwares needed for specific digitised activities in film production, including digital camera technology, computerised motion control for cameras, lighting techniques for digital cameras, electronic dailies transfer etc ■ Prior film or TV production experience is welcomed among production staff

Post-production	Telecine Non-linear Editing Image Manipulation Sound Design and Mixing Compositing	■ Most people in post-production roles have media, fine art, film/TV/video or related degrees, though formal qualifications in these areas are not necessarily a deciding factor ■ Creative skills and personality skills are a key requirement ■ Practical experience in film and video post-production is important ■ Knowledge of special effects, graphics, telecine and non-linear editing tools (Discreet Smoke, Discreet Flame, Adobe After Effects, Pinnacle Commotion, Avi Symphony and Avid Xpress, Spirit for telecine, Wire Pilot/Curious for wire removal), digital tools for sound design and mixing (e.g. Digidesign Pro Tools and Lightworks Touch hardware and software) ■ Can also incorporate use of 3D, special effects and animation techniques (see Table 3.3) ■ Business/project management skills increasingly important, particularly for stand-alone post production houses
Other Roles	Marketing and Distribution Legal – Rights	■ Creative marketing ability, proficiency in online techniques ■ Good communication and organisational skills ■ Specific legal expertise in rights negotiation and protection

Table B.6: Balance of Skills for the Digital Film Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Skills	Non-technical Skills	Balance
Management	Producer Executive Producer Associate Producer General Management Finance Human Resources	○	○	●	Core skills needed are typically commercial, management, organisational and financial/ budgeting
Content Creation	Director Writer Storyboard Artist	◐	○	●	Strong creative, conceptual and visual ability is still the key requirement, technical skills can aid these roles however
Pre-production	Set Development Location Management Casting Costume Design Make-up	◐	○	●	Balance of skills somewhat similar to the balance required for content creation, including strong creative skills aided by technology improvements
Production	Digital Camera Operators Motion Control Operators Digital Lighting Tech Digital Video Operators	●	◐	◐	Technical skills necessary for camera work and related areas, but creative and visual flair is also important
Post-production	Telecine Non-linear Editing Image Manipulation Sound Design and Mixing Compositing	●	◐	◐	Strong technical skills needed in the use of digital post-production technology, but people with creative abilities underlying these skills are very much sought after
Other Roles	Marketing/Distribution Legal – Rights	○	○	●	Very important roles where strong non-technical business and legal skills are required
Key:	● = Very Important	◐ = Important	○ = Less Important		

Table B.7: Core Skills Profile for the Digital Television Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
Management	Producer Executive Producer Associate Producer General Managemen Finance Human Resources	■ Producers and related positions need a unique mix of finance and fundraising skills, legal and contract negotiation skills, general deal-making skills and commercial nous ■ Strong management, organisational, budgeting and scheduling skills are also required among producers, while creative and conceptual skills are highly valued ■ Extensive previous experience in television or related sectors is required, including knowledge of production methodologies and technologies ■ Producer familiarity with relevant technical skills a plus (e.g. use of editing tools such as Avid X-Press) ■ General business skills and related qualifications needed for other mainstream management roles, previous experience of working in the television or other media sectors also common
Content Creation	Director Writer Storyboard Artist	■ Directors and writers can have diverse educational backgrounds, though media-related qualifications are common ■ Strong creative, conceptual and visual ability and skills are needed for any role in creating television ideas and content, strong scriptwriting skills are needed for writers ■ A broad knowledge of production and post-production techniques is welcomed, while directors also need strong business-related skills such as budgeting, scheduling etc ■ Digital technologies have emerged as an aid to the content creation process
Pre-production and Production	Set Development Casting Costume Desig Make-up Digital Camera Operators Digital Lighting Technicians I-TV Content Creation	■ People filling these roles can have diverse educational backgrounds, though artistic/film, television or other media backgrounds would be common ■ Creative and visual ability is commonly sought trait across most pre-production and production roles ■ Digital technologies are again an aid to some pre-production roles, including software for set development and pre-visualisation, costume design etc ■ Production roles are increasingly being influenced by the use of digital equipment, including technology for digital video production and new digital video tape formats, digital lighting equipment etc ■ Content creators for interactive television can have more technical skills similar to those found in other sectors, e.g. in developing animation and graphics for ancillary interactive television content, games for interactive television content etc

Post-production	Video Post-production Non-linear Video Editing Non-linear Audio Editing Compositing	■ Most people in post-production roles have media, fine art, film/TV/video or related degrees, though formal qualifications in these areas are not necessarily a deciding factor ■ Knowledge of major effects and non-linear video and audio editing tools (Discreet Smoke, Discreet Flame, Adobe After Effects, GenArts Sapphire Plug-ins, Pinnacle Commotion, Avid Symphony and Avid Xpress, Apple Final Cut Pro, DVora Pro, Amiga ProStationAudio, Pro Tools 5) ■ Practical experience in film and video post-production is important ■ Increasingly need experience of working on television for multiple platforms – interactive, mobile, online etc
Systems Development	Designer Internet Architect Software Engineer Systems Developers	■ Engineers and developers typically require a relevant degree (Computer Science, Engineering) plus experience in developing internal support systems, customer interface applications and content management systems ■ Programming skills to include Java/J2EE/JavaScript, UML and Weblogic, Oracle, HTML, Perl, AWK/sed, CGI (Common Gateway Interface), XML, FTP, Telnet, TCP/IP, SQL ■ Experience with Sun, UNIX, Solaris or Linux operating systems ■ Web designers and Internet architects typically have a related qualification as well as strong conceptual and visual design skills ■ Strong web design skills, working knowledge of HTML capabilities, experience with menu-based and navigation systems ■ Proficiency in packages such as Photoshop, Visio and Illustrator are also valued for web design roles Interactive skills covering broadband, multi-platform technologies, digital television design and development software, DTV middleware platforms (OpenTV, Liberate)
Marketing and Distribution/ Other Roles	Marketing Associate Marketing Co-ordinator Account Manager Market Research Manager Programme Planner Rights Lawyer	■ Business or marketing degrees common for people working in marketing and distribution, though this is not universal ■ Degree in film/media preferred for programme planners ■ Creative marketing ability is highly valued (e.g. finding new ways to place product and sell product), proficiency in online marketing techniques ■ Market research roles require strong analytical abilities and problem solving skills as well as knowledge of research techniques ■ Communication and organisational skills very important Experience in developing marketing collateral materials ■ Specific legal expertise is often needed in rights negotiation and protection

Table B.8: Balance of Skills for the Digital Television Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Technical Skills	Non-technical Skills	Balance
Management	Producer Executive Producer Associate Producer General Management Finance Human Resources	○	○	●	Core skills needed are typically commercial, management, organisational and financial/ budgeting
Content Creation	Director Writer Storyboard Artist	◐	○	●	Strong creative, conceptual and visual ability is still the key requirement, technical skills can aid these roles however
Pre-production and Production	Set Development Casting Costume Design Make-up	◐	○	●	Balance of skills somewhat similar to the balance required for content creation, including strong creative skills aided by technology improvements
	Digital Camera Operators Digital Lighting Tech I-TV Content Creators	●	◐	◐	Technical skills necessary for camera work and related areas, but creative and visual flair is also important
Post-production	Video Post-production Non-linear Video Editing Non-linear Audio Editing Compositing	●	◐	◐	Strong technical skills needed in the use of digital post-production technology, but people with creative abilities underlying these skills are very much sought after
Systems Development	Designer Internet Architect Software Engineers Systems Developers	●	◐	○	Very technical roles, where key requirement is to build systems and applications
Marketing and Distribution/ Other Roles	Marketing Associate Marketing Co-ordinator Account Manager Market Research Programme Planner Rights Lawyer	○	○	●	Very important roles where strong non-technical business and legal skills are required, with television experience needed for good programme planing and scheduling
Key:	● = Very Important	◐ = Important	○ = Less Important		

Table B.9: Core Skills Profile for the e-Music Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
R&D	Applications Developers Systems Developers Computer Programmers Software Engineers Web Designers	■ Typically graduates with Bachelor Degrees in Computer Science or a related Engineering discipline, also some graduates of maths and physics, typically with prior work experience preferable ■ Building content systems, media distribution systems, client applications and retail platforms, reporting systems ■ Computer programming skills a necessity, e.g. C++, CSharp, VB.Net, Perl, Java for mobile and wireless, database languages like RPG ILE (for IBM's iSeries platform), SQL, COBOL, Oracle ■ Knowledge of Windows and Linux operating systems ■ Knowledge of and experience in using Digital Rights Management (DRM) technologies ■ Web design and user interface programming skills (e.g. HTML, XML), knowledge of traditional layout and design programmes (e.g. Photoshop, InDesign, Quark, Illustrator) ■ Experience of working with e-commerce or other consumer-facing applications is very welcome (especially those involving high levels of, and very complex, transactions)
Operations/Technical Support	Technical Support Infrastructure Support Content Management (Input) Customer Support Business-to-Business Support	■ Technical operations roles almost always require people with Bachelor Degree in Computer Science or similar, together with relevant technology experience drawn from any sector ■ Monitoring of systems and reacting to problems, skills in networking, server and systems technologies needed ■ Infrastructure support roles have similar backgrounds, but are more involved in optimising and enhancing systems capacity ■ Knowledge of media softwares required (particularly the Microsoft suite of softwares), basic networking protocols (e.g. TCP/IP), Windows NT Networking ■ Technical backgrounds in Internet/media technologies desirable for customer and B2B support roles, but not necessary ■ Spoken language skills a key requirement for customer support and business-to-business support roles
Marketing and Distribution	Content Planning A&R Content Procurement Product Marketing Business-to-Business Sales Consumer Marketing	■ Qualifications can be fairly general, some people with traditional marketing backgrounds/qualifications, come with technical backgrounds in products design/modification and acquired marketing experience ■ Traditional marketing skills, ability to define strategy (products, market segments), product specification ■ Online marketing experience and skills very important, experience in marketing for wireless and mobile services also becoming very important ■ Classic sales force expertise, music industry experience but also drawn from software sales backgrounds ■ Specialists in A&R and content programming/planning need to be well versed in prevailing music tastes (including variations by territory)
Management, Executive and Other Roles	General Management Finance Human Resources Public Relations Royalty Management Legal – RightsLegal – Other General Administration	■ Normal need for generic business skills in areas such as finance, legal, human resources, general administration etc ■ Record industry experience is common among management positions, IT/e-commerce backgrounds also useful ■ Specialist legal expertise needed in negotiation and protection of rights, typically needs qualified professionals with an intimate knowledge of music law

Table B.10: Balance of Skills for the e-Music Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Technical Skills	Non-technical Skills	Balance
R&D	Applications Developers Systems Developers Computer Programmers Software Engineers Web Designers	●	◐	○	Technically competent in C++ programming et al with additional skills required in database programming and user interface programming
Technical Support	Technical Support Infrastructure Support	●	◐	○	Typically graduates of Computer Science with some specialist background or expertise in networking and server technologies
	Content Input	○	○	○	No major technical, specialist or non technical skills required, other than PC literacy for data inputting
	Customer Support B2B Support	◐	○	●	Technical competency useful but not critical, needs very good customer service support and language skills however
Marketing and Distribution	Content Planning A&R Content Procurement Product Marketing B2B Sales Consumer Marketing	○	○	●	Not technical roles, more typically they require traditional business and marketing skills, however specialist experience or expertise in the music sector or in online marketing environments is useful
Management, Executive and Other Roles	General Management Finance Human Resources Public Relations Royalty Management Legal – Rights Legal – Other General Administration	○	○	●	Typically these are conventional management and executive roles, though some require specialist non-technical skills in legal rights negotiation and protection and in royalty management
Key:	● = Very Important	◐ = Important	○ = Less Important		

Table B.11: Core Skills Profile for the Wireless and Mobile Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
Management	General Management Finance Human Resources Mobile Technology Manager Project Manager	■ Typical business-related experience and qualifications are required, not especially different to these general requirements in other sectors ■ Roles such as Mobile Technology Manager and Project Manager are more technically-oriented in terms of experience, but the core of their roles involves project management and related skills
Technical/R&D	Software Engineer Software Developer Web Designer Software Tester Quality Assurance Engineer Technical Support Systems Engineer Product Engineer ASIC Engineer RFIC Engineer DSP Engineer	■ Degrees in Computer Science, Engineering or a related area usually a necessity ■ Programming skills in Java/J2EE/JavaScript, C++, Visual Basic, database languages (Oracle) and scripting languages (e.g. Perl, Shell, Python) ■ Experience in Linux, UNIX and Windows operating systems, experience with Sun, Solaris, Open Source ■ Knowledge of Internet technologies (HTML, XML, WML)scripting Web designers need strong web design skills including a strong understanding of interface design and usability, with skills in Adobe Illustrator, Adobe PhotoShop, Adobe Imageready, Macromedia Flash, QuarkXPress ■ Experience of working with, and developing, content management systems, customer relationship managementtools, rights management systems etc ■ Previous experience in developing software applications, web design and wireless technologies (e.g. AMPS, TDMA, EDGE, GSM, 3G/UTMS, WLL, LMDS) desirable ■ Hardware development roles require expertise and experience in areas such as radio frequency engineering and integrated circuits (RF/RFIC), digital signal processing (DSP), application specific integrated circuits (ASIC) ■ Project management, communication and interpersonal skills increasingly important
Content Development	Content Writers Mobile Games Developers Audio Content Developers Video Content Developers Creative/Graphic Artists Musicians Animators Voice Artists	■ Traditional skills necessary for sourcing and generating SMS content – strong writing and editing skills (can often use freelance journalists for this role), creative music and artistic skills ■ For games development skills and experience for mobile, see Section 3.2 ■ For video and audio positions, hands-on video and sound editing experience can be required (Premiere, After Effects, Acid, Sound Forge, Final Cut Pro, SoundEdit) ■ Deal-making and negotiation skills etc important (for dealing with outside content providers) ■ Language skills are important for localising content across territories
Sales and Marketing	Account Executive Sales Executive Marketing Executive	■ Traditional sales and marketing backgrounds and qualifications ■ Experience in sales or business development for mobile content or retail products, previous wireless or mobile sector experience useful (e.g. work for wireless and mobile operators, mobile games developers) ■ Understanding of wireless and mobile technologies important (SMS, MMS, WAP, GPRS, 3G) ■ Strong negotiation skills and ability to create and maintain excellent customer relationships ■ Well-developed written, oral communication and interpersonal skills

Table B.12: Balance of Skills for the Wireless and Mobile Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Skills	Non-technical Skills	Balance
Management	General Management Finance	○	○	●	Mainly requires general business and management skills
though the core	Human Resources Mobile Technology Mgr Project Manager		◐	◐	● More technical roles, function of the roles concerned are management-based and therefore require good project management skills
Technical/R&D	Software Engineer Software Developer Web Designer Software Tester Quality Assurance Engineer Technical Support Systems Engineer Product Engineer ASIC Engineer RFIC Engineer DSP Engineer	●	●	◐	Very technical roles with expertise in programming and web design (but particularly for wireless and mobile, e.g. Java), non-technical project management and communication skills becoming more and more important
Content Development	Content Writers Mobile Games Audio Content Video Content Creative/Graphic Artist Musicians Animators Voice Artists	◐	◐	●	Roles are less technical than for R&D positions, with core creative skills underlying most content development tasks as well as an ability to identify and source good content
Sales and Marketing	Account Executive Sales Executive Marketing Executive	○	○	●	Traditional non-technical skills in sales and marketing are the core requirement, with some experience of the wireless and mobile sector highly valued
Key:	● = Very Important	◐ = Important	○ = Less Important		

Table B.13: Core Skills Profile for the e-Learning Sector

Occupations	Indicative Sub-categories	Indicative Skills/Experience
Management/Business Roles	General Management Finance Human Resources Business Development Sales Director/Executive Lead Designer Project Manager Project Support Officer	■ General business management skills important as in other sectors as well as functional management skills in areas such as finance, HR etc ■ Design management roles require very good project management skills, including requirements analysis and high-level solutions design for clients ■ Business development and sales roles require traditional sales and marketing skills, experience in selling consultancy or technology solutions an advantage ■ Strong communication/consultation and interpersonal skills, skills in managing budgets, developing strategies, monitoring quality control etc, depending on the management role involved ■ Understanding of e-learning developments in the wider market is useful
Technical/R&D	Web Developer Lead Developer Systems Developer e-Learning Developer Interactive Designer Software Engineer	■ Degrees in Computer Science, Engineering or Information Technology are common ■ Good user interface design skills, experience of designing/working on database driven websites and content management systems ■ Programming skills include experience in coding for HTML/DHTML and Java/Javascript, CSS/XML/XSLT, writing Coldfusion and ASP scripts, database design (Oracle, SQL Server), server configuration, UNIX operating systems ■ Experience with DreamWeaver, learning management systems, Flash, InstallShield, Netscape, NT Server, VBA ■ Experience in developing client-side and server-side programming for web based training software programmes, extensive knowledge of the capability of web-based technologies desirable, understanding of latest developments in e-learning technology and standards ■ Knowledge of relevant industry standards such as SCORM, IEEE ■ Ability to work for a variety of clients/projects across a variety of platforms ■ Project management skills important, including timescales and costings, client management skills
Content Authoring and Design	Content Author Instructional Designer Learning Designer Art Director Graphic Designer	■ Traditional artistic, writing and graphic design skills necessary, strong creative skills underlying this, though instructional design typically involves qualifications in English, Communications, Education, Media or a related area ■ Can come from a variety of backgrounds, both within and outside multimedia sectors ■ Ability to demonstrate a creative flair is important, very good conceptual and visual design skills necessary ■ Experience in delivering art for web design and interface design is important for art-related roles, development of bespoke content imagery also useful ■ Ability to use relevant artistic and graphic design packages (e.g. Adobe Photoshop and Illustrator, Quark Xpress, Macromedia Flash) ■ Ability to communicate (orally and in writing) in a clear, concise and effective manner ■ Excellent client management skills, including ability to understand and assess client needs, as well as increasingly strong project management skills

		■ Skills in training needs analysis desirable for learning design and instructional design ■ In some cases (e.g. company development of vendor elearning products), specific subject matter knowledge and expertise is needed for content authoring
Technical Support	Content Tester Software Tester Systems Administrators	■ Technical skills useful but not necessarily essential for testers, more important to be able to think in a logical or methodical way ■ Good eye for detail necessary ■ Systems administration typically requires a Diploma/Degree in Computer Science or Software Engineering ■ Programming skills necessary for understanding networks and servers ■ Good problem solving skills ■ Project management skills also important

Table B.14: Balance of Skills for the e-Learning Sector

Occupations	Indicative Sub-categories	Technical Skills	Specialist Technical	Non-technical Skills	Balance
Management/ Business Roles	General Management Finance Human Resources Business Development Sales Director/Executive	○	○	●	General non-technical business and project management skills the most important requirement, with knowledge of e-learning market developments
	Lead Designer Project Manager Project Support Officer	◐	◐	●	More technically proficient roles that work directly in developing e-learning packages, but project management skills are still the key need
Technical/R&D	Web Developer Lead Developer Systems Developer e-Learning Developer Interactive Designer Software Engineer	●	◐	◐	Very technical skills, including programming, content management systems and database design, with project management and interpersonal skills increasingly sought aswell
Content Authoring and Design	Content Author Instructional Designer Learning Designer Art Director Graphic Designer	◐	◐	●	Core skills are creative in nature, but ability to use graphics software is important for some roles Pedagogical Skills
Technical Support	Content Tester Software Tester Systems Administrators	◐	○	◐	Some technical skills (especially systems administration), but non-technical skills are also important (e.g. logical, eye for detail)
Key:	● = Very Important	◐ = Important	○ = Less Important		

Appendix C: Review Framework

Table C.1: Framework for Review of Digital Media Education and Training

Criteria	Aspects Reviewed	Description of Potential Indicators to Review Digital Media Courses
Course Scope	Number of Digital Media Courses	■ The numbers of Digital Media / Media courses and modules. ■ The number of related courses such as computing, informatics etc. ■ The number of faculties in the college through which they are delivered and level of cross-faculty coordination in their delivery.
	Sector Specific Courses/ Value Chain Specialisation	■ Courses dedicated to specific Digital Media sectors such as games, animation, film & TV etc. ■ Modules within courses dedicated to Digital Media sectors as above. ■ Course specialisation on specific areas of the Digital Media Value Chain, i.e. production, distribution, publishing etc.
	Technology Specialisation	■ Level of technology specialisation within Digital Media courses and course modules. ■ Whether the technologies (software, platforms, tools etc.) are industry standard and most up-to-date. ■ Whether technologies taught are basic versus more advanced / highly specialised etc.
	Course access and availability	■ Number of students on courses and turnout of students (i.e. numbers graduating / frequency of graduation). ■ How expensive are the courses. ■ What entrance requirements etc. as appropriate.
Course Positioning	Digital Media Course Benchmarking/ National & international recognition of Digital Media courses / Faculties etc. and frequency of same.	■ Extent of international / national benchmarking ■ Formal / structured approach to benchmarking. ■ Position of college / Digital Media courses vis-à-vis benchmarks. ■ Recognition of Digital Media courses (nationally / internationally) and associated measurement framework.
	Graduate Demand by Leading Digital Media Companies	■ Extent to which graduates are employed by leading digital media companies / within what timeframe.
	Accreditation / certification level	■ Level of accreditation of courses: Diploma; Degree; Post grad; PhD; Other.
Course Development & Update or course modules.	Flexibility of course modules	■ Extent of flexibility of introducing new courses and / ■ Extent of flexibility of updating / changing course modules.
	Frequency of course / module update	■ Timeframe of formal versus informal course reviews and updates.
	Industry Synchronisation Mechanisms	■ Nature of the mechanisms used to ensure Digital Media courses are regularly updated and are linked to industry trends and developments.

	Cross Faculty Coordination	■ Level of coordination across related departments with regards to Digital Media (courses and research).
		■ Mechanisms to drive formal versus informal coordination. Perceived benefits.
Digital Media Industry Linkages	Industry Design of Course Content	■ Extent and nature of industry input into Digital Media course / module design. ■ Nature and frequency of input ■ Nature of the mechanisms used by the colleges to ensure structured industry input.
	Industry Delivery of Course Content	■ The nature and frequency of industry delivery of courses / course modules.
	Joint Research Programmes	■ Extent to which joint research is undertaken with industry and through what format.
		■ The nature / extent to which it is jointly funded, including resources and R&D delivery etc.
	Other Industry Participation	■ Industry membership of college / university Boards. ■ Internships / work placements. ■ Industry mentoring and sponsorship. ■ Any other linkages / participation in the college by industry.

Appendix D: Literature Review

1. Introduction

There is no definitive definition of what constitutes a cluster. However, almost all definitions share the idea of proximity, networking and specialisation[28]. One of the leading authorities in this area, Michael Porter (1990) describes clusters as "geographically close groups of interconnected companies and associated institutions in a particular field, linked by common technologies and skills". He emphasises that clusters "normally exist within a geographic area where ease of communication, logistics and personal interaction is possible" and can range from the urban scale to even a group of countries. However, "clusters are normally concentrated in regions and sometimes in a single town"[29].

Clusters provide many benefits to the cities in which they are located. Clusters, for example, generate both high-paying and entry-level jobs, the quality of which is regarded as high. As clusters grow, new business formations become more likely through start-ups and spin-offs and the local geographic barriers to entry become lower than elsewhere as the required assets, financial support, skills, inputs and employees become available in the vicinity.

Porter's definition of clusters is a broad description capturing all industries and types of clustering. However, the purpose of this chapter is to find evidence of a specific type of clustering, namely "Education/research and the link to the creation of Digital Media Enterprise Critical Mass/Clustering". Furthermore, analysis is limited to the US and the UK through desk based research/ literature review. Both countries have successfully supported and developed the clustering of the digital content industry through regional and/or national initiatives. Of specific interest to the study are the policy or strategy initiatives used to foster clustering between skills and enterprise in the digital content industry. Such initiatives could include: the provision of education (universities, colleges); research (joint industry research centres, incubation centres); and/or skills. Identification of any key UK and US policies and strategies for this type of clustering will feed into policy recommendations for Ireland on how digital media enterprise critical mass can be fostered through skills/ education-related factors.

An important point is that the digital content industry can be defined as including both the digital media (creative) and software applications (technology) industries; therefore spanning the creative industries and the ICT sectors[30]. As a result, digital content policy or strategy to achieve enterprise clustering may not be an isolated, well defined set of initiatives/objectives.

Some countries/regions have created a clear strategy focused on developing digital content clusters. Other cases may not be so clear, with some countries/regions developing clustering strategies for one of/ both the ICT and the creative industries sector. Therefore the following findings encompass evidence of ICT, creative industries and digital content clustering.

28 European Commission, (2002). "Final Report of the Expert Group on Enterprise Clusters and Networks". p.9
29 Ibid
30 South West Screen, (2004). Digital Content Strategy.

2. Key Success Factors for Clustering

The following factors were identified as being essential to cultivating successful creative clusters[31]:

1. outstanding university research and commercial linkages;
2. the availability of venture capital;
3. the accessibility of anchor firms and mediating organisations;
4. the appropriate base of knowledge and skill;
5. targeted public policies;
6. good quality services and infrastructure; and
7. diversity and quality of place.

2.1 Outstanding University Research and Commercial Linkages

Outstanding university research and commercial linkages is deemed essential to the cultivation of successful creative clusters. According to research, most creative economies spring up near universities where research and industrial activity are part of the local culture. Central to this is a university's ability to build intellectual capacity. Consequently tight-knit R&D communities can result, with people who start up as graduate students together ending up as faculty members at the same institution or collaborators in different firms.

2.2 Accessibility of Anchor Firms and Mediating Organisations

The accessibility of anchor firms and mediating organisations is another factor contributing to the success of creative clusters. With regard to anchor firms, research shows that new clusters have risen in some areas from innovative companies that stimulated the growth of others. For example, Microsoft played this role in cultivating a software cluster in Seattle and, MCI and America Online have also been hubs for the telecommunications cluster in Washington DC.

Collaborating or mediating organisations can also stimulate the growth of clusters. These organisations can facilitate the exchange of information and foster joint actions. Sometimes these organisations are established prior to the takeoff of innovative activities while others emerge as part of the process. University technology offices are an example of collaborating or mediation organisations. They facilitate commercialisation by connecting researchers with entrepreneurs. For example, the Massachusetts Institute of Technology (MIT) and Stanford University had significant roles in fostering the creative communities in Boston and Silicon Valley respectively.

31 Weiping WU, "Dynamic Cities and Creative Clusters", World Bank Policy Research Working Paper 3509, February 2005

2.3 Appropriate Base of Knowledge and Skill

The appropriate base of knowledge and skill is a further essential factor to the success of creative clusters. Research shows that creative centres tend to be areas with a high concentration of educated people and the ability to retain skills. Attracting and retaining such people is integral to the creation and growth of a creative cluster. For the software industry, for example, the tangible asset is their software developers and entrepreneurial thinkers.

2.4 Targeted Public Policies

While the development of clustering often occurs independent of significant government intervention, public policy can play a critical role.

Research shows that having a readily availably and qualified workforce is one of the best investments regions can make. As such, Governments can intervene to provide high quality maths, science and IT programmes in schools. Governments can also provide financial support directly to companies for technology upgrading, towards new start-ups and towards R&D in new product development. Assistance to young entrepreneurs to develop viable business plans and start-up operations could also be considered by Governments.

The research shows that in the new knowledge economy, the costs or government-influence low costs (e.g., lower taxes) and access to natural resources are less important than they previously were. Local policies designed to build an infrastructure to support small and emerging creative businesses are particularly important. These policies can include "establishing industry forums to identify sectoral needs, creating publicly supported venture capital funds, investing in digital labs, supporting art and technology studios, organising trade missions around particular products, to providing business development support and training."[32]

Despite some leading research universities presence and development efforts creative clusters have not developed. Baltimore's, John Hopkins University is cited as such an example. The University's dedication to "open science" has led to its unwillingness to allow commercial interests to influence research.

The failure of the University's first industry link, Rowland Telegraphic Company, further enforced this culture. In addition, the lack of a supportive and innovative local community environment has compounded this disconnect.

3. UK Findings

To place UK 'clustering' in context, it is useful to review common strategies across Europe to foster clustering of industry, and develop 'best-practice' guidelines which are important to the successful development of a cluster. Following on from this, a number of UK regions are presented due to the evidence of digital media enterprise clustering with digital media skills/universities/research. Specifically, details on the strategy and policy initiatives introduced by two Regional Development Authorities in England, namely the South East of England Regional Development Authority and Advantage West Midlands, are provided, as well as the substantial creative industries cluster in Scotland.

32 Weiping WU, "Dynamic Cities and Creative Clusters", World Bank Policy Research Working Paper 3509, February 2005.

3.1 European Clustering Policy

A report launched by the European Commission in 2002, titled "Final Report of the Expert Group in Enterprise Clusters and Networks", identifies how EU Member States, Candidate Countries, EFTA/EEA Countries and the European Commission incorporate clusters and networks in their national, regional, local and EU policies.

This research states that clusters generally emerge spontaneously; therefore it is practically impossible for governments to create clusters artificially[28]. However, clusters need to be backed by policy measures to ensure their development. In particular, the report emphasises the need for policy to encourage the collaboration of all stakeholders involved in a cluster. Specifically, a policy on clusters should "provide a framework for dialogue and inter-firm co-operation, as well as co-operation between small enterprises, higher education and research institutes, public and non-public organisations at local, national and European and international level".

The report identified a number of main areas of activity to promote and develop clusters – with national, regional or EU authorities each having a distinctive role to play.

- Catalytic Role. The catalytic role of national and regional governments consists of supporting synergies between actors. Furthermore, enhancing the sharing of information, technology, and practices between European regions and clusters at an EU level could also have a significant contribution towards the efficiency of a cluster.
- Framework Conditions. National and regional authorities are responsible for creating and implementing good framework conditions to help clusters develop. Best practice appears to involve national authorities establishing the overall framework conditions, with Regional Governments responsible for the implementation phase and management of the clusters.
- Exchange of Information. National authorities should support initiatives for gathering and disseminating strategic information for regions and clusters. Regional and local authorities are best placed to organise and foster internal exchange of information between local actors.
- Financial Support. The issue of whether public authorities should provide financial support to clusters is controversial. However, it is recognised that government aid is often needed to finance restructuring and investments in infrastructure, development of co-operation between local actors, research and education, transfer of knowledge and cluster animation.
- Raise Awareness. The report further emphasises the importance of fostering collaboration/clustering between stakeholders involved in a cluster, including education & skills providers and enterprise. Such collaboration can be used as a stage to raise awareness amongst enterprises of the potential offered by clusters and networks, thus contributing to the long-term success and growth of the cluster. This can be achieved through organising the exchange of information through annual meetings involving enterprise, education providers, press media etc., as well as encouraging co-operation between enterprise, universities and public research institutions and including guidelines for forming alliances and co-operation.

3.2 Evidence of digital media clustering with skills/research in England

3.2.1 Role of the DTI and the RDAs in Cluster Development

The Department of Trade and Industry (DTI) in the United Kingdom established a Cluster Policy Steering Committee to identify the existing economic strengths in the UK and the barriers to the successful development of clusters[33]. Following the winding up of this Steering Group in January 2003, responsibility for the strategic development of clusters was devolved to Regional Development Authority (RDA) level as follows:

- Northwest Development Agency
- Yorkshire forward
- One North East
- Advantage West Midlands
- East Midlands Development Agency
- East of England Development Agency
- South East England Development Agency
- South West Regional Development Agency
- London Development Agency

The RDAs are non-departmental public bodies, their primary role being strategic drivers of regional economic development in their region. As aforementioned, since January 2003 the RDAs are responsible for implementing clusters policy in their respective regions. Approaches and priority clusters vary from region to region, but current work includes the commissioning of regional mapping studies, identifying and building links with important regional clusters and using clusters as the vehicle for wider economic development initiatives[34].

By way of funding, the DTI established a £15m Innovative Clusters Fund (ICF) in 2000-2001 as a pioneer funding stream to RDAs to promote cluster development and business incubation in the regions, with a further £35m provided as part of the DTIs Regional Innovation Fund (RIF) in 2001-2002[35]. Since 2002, the RDAs are financed through a Single Programme, with money from the contributing departments pooled into one single budget. The funding is available to the RDAs to spend as they see fit to achieve the regional priorities identified in their Regional Economic Strategies, with cluster and business incubation continuing to form a key driver of this process[36].

Out of the nine RDAs, two were identified as developing substantial digital media clusters in their region. Details are provided on the policy and strategy initiatives used to foster the clustering of digital media with a particular emphasis on initiatives used to create collaboration/clustering between skills and enterprise.

33 European Commission, (2002). "Final Report of the Expert Group on Enterprise Clusters and Networks". p.60
34 http://www.dti.gov.uk/clusters/policy.htm
35 http://www.dti.gov.uk/clusters/rdas.htm
36 http://www.consumer.gov.uk/rda/info

3.2.2. Advantage West Midlands

Advantage West Midlands (AVM), the RDA for the West Midlands, identified 10 priority clusters considered vital to the development of the regions economy, output and employment levels. The Information and Communications technology (ICT) sector was acknowledged by AVM as one of the priority clusters. ICT output accounts for a significant proportion (6%) of regional output and supports almost all sectors of the economy through its enabling technologies. Hence, the creation of a successful ICT cluster in the West Midlands will have a substantial knock-on benefit for the regional economy as a whole.

The central body of the ICT cluster, empowered by AWM to oversee and direct the delivery of the region's ICT strategy, is the Cluster Opportunities Group (COG). This group is industry led, having a majority of private sector members supported by several key public sector partners[37].

The COG is responsible for drawing up an annual strategy on behalf of the ICT cluster. During the early part of 2003 the Cluster Opportunity Group (COG) commissioned its first consultation exercise across the region with both public organisations and the private sector. The findings of the consultation process were then validated through a series of workshops with private and public sector attendees. Since this original ICT cluster strategy document, a strategic revision in 2005 reconfigured the direction of the ICT cluster. Three key Strategic Directions were identified, and are supported by three Strategic Enablers acting as the key underpinning infrastructure that will support and link activities delivered under the Strategic Directions.

The Directions are:

- Developing Networks: creating a well networked sector, with strategic coordination of small firms to raise competitiveness and market access, and a strong reputation and credibility both within and outside the region
- Growing Sub-Clusters: pick winners for a small number of niche sub-sectors.
- Exploiting Innovation: appropriately targeted and well disseminated research in ICT, effective collaboration and spin out activities resulting in leading edge knowledge based firms in the sector, together with using their knowledge resource to develop the management competence of the sector.

The Strategic Enablers are:

- Hard and Soft Infrastructures: includes knowledge, facilities, infrastructure, people, business, expertise and finance.
- Data and Intelligence: vital to underpin strategy and decision making in a rapidly changing industry.
- Skills and Education: the full range of skills required to achieve a successful ICT industry in the region, together with a forward view of new skills required to support the industry in the future. Liaison with skills and education providers such as the Learning Skills Council (LSC), Higher Education Institutions (HEIs), Further education (FE) and third party suppliers to achieve demand led provision[38].

AVM established 6 task groups with the responsibility of reporting directly to the COG on the development of the ICT cluster and the strategic initiatives implemented to foster this development. The task groups, involving some 50 people from the industry and partner organisations are focused on a number of specific elements of the ICT cluster: Marketing and Communications; Innovation; Work force development; Public sector procurement; and Export.

37 http://www.wmictcluster.org/about/COG%20Membership%20and%20Structure/
38 The West Midlands ICT Cluster Strategy (2005)

The strategy outlined above forms the basis for the existing funded projects and is the framework against which new projects are being developed and assessed. To date a number of regional projects are successfully underway. Relevant projects which help to foster partnership between research/education and industry in particular include the following:

- OpenAdvantage, the West Midlands Open Source Solutions Centre, is a collaboration between the University of Central England, the National Business to Business Centre at Warwick University and the National Computing Centre to encourage the take up of Open Source Software. OpenAdvantage provide free consultancy and knowledge to industry through seminars and training workshops about Open Source software and best practices[39].

- The Centre of Excellence for Research in Computational Intelligence and Applications (CERCIA) based on the international expertise in this field was established in the computer science department of Birmingham University. CERCIA organises courses and workshops and gives technology reviews and briefings to business. Additionally, it provides consultancy services and contract R&D work to external organisations and is looks to form partnerships with industry and businesses in joint R&D work, which may lead to joint ventures in the future[40].

- The IT Futures Centre at Wolverhampton University provides consultancy, training and support to SMEs in high growth sectors. IT Futures offers advice and practical assistance on the evaluation of the latest technologies for use in business, advice on bespoke and off-the-shelf solutions, access to staff training, and website development services to industry. Five days free consultancy can be provided to SMEs if they meet a range of criteria: employ less than 250 people; operate in West Midlands; and involved in one of the following: Creative Industries, Engineering Design, Tourism and Leisure, Medical Technology, and/or Food and Drink[41].

A number of proposed projects and initiatives were put forward in 2002 and are either awaiting approval or are expected to be introduced in the near future.

- West Midlands Mobile and Wireless is a regional project led by Staffordshire University which consists of a consortium of 5 Universities working together to promote the exploitation of wireless and mobile technologies. The initiative will allow for the exploitation of knowledge from the regions universities to feed into industry as well as promoting a new sub cluster within the region.

- West Midlands ICT Hub, although not formally presented for approval as of yet, is described to be a single point of reference for information on ICT in the West Midlands by the leaders of the existing cluster funded projects. It is expected to work in collaboration with other public sector partners, including education providers, in order to promote inward investment, improve access to and use of ICT by the end user community and increase the market opportunity for the ICT suppliers to sell to the end user community[42].

39 http://www.openadvantage.org
40 http://www.cercia.ac.uk/
41 http://www.initiativeitsolutions.co.uk/
42 Cluster Opportunity Group, April 2005. ICT Cluster Strategic Plan, 2005-2008.

3.2.3 South West of England Regional Development Agency

In the South West region, ICT and the creative industries are centrally important to the regional economic development strategy of the South West of England Regional Development Agency (SWERDA). The RDA identified five economically important sectors and three emerging sectors that it regards as crucial for increasing economic growth. Creative industries is one of the emerging sectors with one of the established sectors being ICT. A number of strong industry clusters have been developed, as well as a strong network of incubation centres and science parks and the creation of partnerships between industry, education and digital related bodies.

2004 was the first year SWERDA produced a strategy report focused specifically on the digital content industry in the South West of England. Prior to this, strategy work related to the sector was covered by reports under the ICT sector and the creative industries. The "Digital Content Strategy" was developed by South West Screen, the film, television and digital media agency for the South West of England. The strategy report sets out a clear action plan for developing the digital content industry in the South West, particularly through fostering a culture of integration and collaboration between industry stakeholders. The action plan is made up of a set of recommendations which are divided among five strategic elements. The recommendations which emphasise the collaboration and clustering of stakeholders across the digital media sector are described below:

- Objective A: Sector Profiling
  - Recognise the different structures, networks, cultures and commissioning patterns in digital content which are quite distinct from traditional, established media.
  - Support the six key venues across the South West, for example the Watershed, which act as hubs of activity and expertise in digital content and nodes of energy.
  - Identify, brand and profile emerging 'digital quarters' in key South West cities centred on these key venues in partnerships with local bodies.
  - Encourage collaboration between those venues and the digital arms of the existing media/interactive clusters and innovation local digital companies.
  - Support existing talent showcasing and incubation programmes.
  - Develop a strategic presence for the South West digital content industry both regionally, at a UK level and internationally.
- Objective B: Know How Development
  - Support knowledge transfer between and amongst SMEs, corporates and universities providing opportunities to engage in UK wide networks like the Creative Entrepreneurs Club.
  - Support cutting-edge academic institutes in the region which engage and serve the digital community, and associated placements, shadowing schemes and mentoring opportunities.
  - Look at how skill development initiatives can be pulled together to maximise their strategic impact, possibly clustering them together under one umbrella.

- Objective C: Innovation and Commercialisation Support
  - Engage the industry with leading edge applied academic research particularly enabling SME engagement.
  - Investigate the creation of an investment fund for digital content or more widely, the creative industries.
- Objective D: R&D Programme
  - Encourage major platform operators, media companies and university R&D departments to form new collaborations to pitch for new funding streams for innovative digital work, in particular to access UK and EU level funds.
  - Seek funding for a feasibility study for a Digital Media Service to support the South West digital media community.
  - Seek active participation in UK-funded initiatives, i.e., the UK Film Council Digital Screen Network programme to research new audiences and business models in cinematic distribution based on digital technology.
  - Explore the potential for partnership with the South East region.
- Objective E: Expertise SW
  - Business expertise should be made available to the digital content sector, which may be part of the creative industries as a whole.
  - Provide access to a single source of intellectual property advice.
  - Provide support and advice on enterprise development – entrepreneurship from successful entrepreneurs, possibly through a managed mentoring system.
  - Encourage Trade International support for SME participation in international festivals, markets and showcases.
  - Provide a distillation of market intelligence and access to a respected analyst[43].

The above objectives are intended to build on existing strengths achieved to date in the digital content industry in the South West Region. These achievements, with details provided below, have fostered a greater collaboration within the digital content sector by providing the stakeholders, including industry, digital related bodies, and education providers, with an opportunity to exchange knowledge and work together to develop and grow the industry.

There are six digital content related industry clusters or networks in the South West region. These are Bristol Interactive Cluster (BRIC); Digital Peninsula Network (DPN); Gloucestershire Media Group; interactive; Plymouth Media Partnership; and Wessex Media Group. Each cluster's objective is to create a focus for the growth and development of the media/creative industries within that particular sub-region. Bristol is the longest established cluster having provided a model for the development of the other networks. The Gloucestershire, Plymouth and Wessex Groups are recent developments having been launched in 2003/2004.

43 South West Screen, 2004. Digital Content Strategy, p.22.

Different industry architectures, regional specialisms, sources of funding and partnerships have led to different emphases in each cluster. However, three clusters in particular have developed links/partnerships with training and education providers in their region:

- Wessex Media Group. Wessex Media Group is a collective group of producers, directors, camera people, sound recordists, writers, designers, animators, music composers, and others in the screen-based media industries including training providers from the region. They form a network to support the growth and development of the media industries in the Wessex region. In particular, one of the key aims of the group is support education and training to strengthen the regions skills base. To facilitate this, the Group has strong links with most of the Higher Education institutions in the region running digital media courses, including: Bournemouth University; Salisbury College; Weymouth College; Bournemouth & Poole College of Further Education; and Learning & Skills Council Bournemouth Dorset & Poole[44].

- Plymouth Media-Partnership. Pm-Ps objective is to develop a networking forum to foster and develop links and commercial partnerships amongst creative industries in and around the greater Plymouth area. It supports a broad range of sectors including: television, film and radio, facilities houses, interactive media, animation, website design, marketing design and music composers. One of their key aims is to collaborate with the local academic and training organisations to provide guidance on the quality and relevance of courses as well as building networks and relationships across the South West with all stakeholders[45].

- InterACTIVE. InterACTIVE represents local digital content companies and the converging media cluster. It is a University of Bath initiative, which includes members ranging from web and internet developers to interactive content producers and digital technology companies.

In addition to the establishment of media/creative cluster groups, SWRDA have developed a number of incubation facilities and science parks in the region, each having strong links with the training and education in the south west region. For example:

- The Arts Institute at Bournemouth University's new Enterprise Pavilion provides high quality business incubation with accommodation and business support services with industry standard equipment including postproduction facilities for digital media.

- The University of West England (UWE) Innovate eMedia Incubator & eMedia at Watershed, Bristol's Digital Media Centre, provide hi-tech managed office space in prime locations in the heart of Bristol's creative district[46].

SWRDA recently published the "Incubation and Science Park Strategy". The report focuses on how they can build the right environment for innovative businesses, with the provision of workspace where possible and the establishment of the Business Incubation South West Network identified as the key strategies to achieve the desired environment. Business Incubation South West is a virtual network that links all existing and future incubator facilities and other centres of excellence (i.e. Enterprise Pavilion and UWE Innovate eMedia Incubator) with and outside of the region in order to facilitate the exchange of knowledge and expertise. The network will focus on standards and best practice in Incubation management which will be a resource for each regional centre. This initiative aims to create further links amongst the universities/colleges in the region and aid in fostering collaboration between industry and education providers, through exploring options for sharing resources and expertise, joint promotional activity celebrating the success of incubation and by sharing of best practice between incubation facility managers[47].

44 http://www.wessexmediagroup.co.uk/
45 http://www.pm-p.com/default.asp
46 http://www.southwestrda.org.uk/what-we-do/business-growth/inward-investment/sectors/creative/index.shtm
47 http://www.southwestrda.org.uk/what-we-do/business-growth/incubation.shtm

Other digital media partnership initiatives have been created, which involve a consortium of industry bodies and councils. DShed, a partnership initiative led by the Watershed with support from other bodies including SW Screen, and BRIC, was established to develop and promote creative digital media talent and skills in the South West. They aim to create a focus for digital media development encompassing: publishing, distribution, production, training and research, by actively encouraging networking and knowledge and skills transfer between the media industry, R&D and education providers and the creative community. DShed's location in the physical hub of the Watershed is seen as key to the long term success of the initiative. The Hub houses some of the key targets for the DShed partnership including digital media creative industries and bodies involved in R&D and education, i.e. the University of West England eMedia Incubator, UWE Watershed Senior Research Fellow in Digital Arts, and Mobile Bristol (research partnership between Hewlett Packard and the University of Bristol)[48].

3.3 Evidence of digital media clustering in Scotland

To begin with, this section presents a high-level overview of Scotland's clustering initiative, before detailing the specific objectives and growth targets for the cluster initiative and the key achievements to date.

In the late 1990's Scottish Enterprise, Scotland's main economic development agency, funded by the Scottish Executive, identified a number of industries as possible components of a meaningful cluster, which acquired the name "creative industries". The industries which conform to this "creativity" model are: games; radio and television; new media (including multimedia and Internet); film; music production; design (including fashion design and crafts); publishing; architecture; advertising; arts; and, cultural industries.

The action phase of the creative industries cluster initiative was launched in April 2001. Resources of £25 million were allocated to the programme to run over a 3-5 year period.

Prior to the late 1990s most of these had not been explicitly targeted for economic development. Therefore, the early stages of engagement primarily aimed to establish contact and promote communication, both between the creative sectors and Scottish Enterprise and among the creative sectors themselves.

An early stage of the initiative involved identifying a set of opportunities or objectives for the digital "creative" cluster. It immediately became apparent that the engine of immediate growth of the cluster was digital media and its ability to transform all of the constituent industries in the cluster. Therefore, from the very beginning the focus has been on digital media and the ability of these industries to fully utilise its benefits.

A five year action plan was developed with specific growth targets established for the end of the five year period:

- Grow Cluster by 10-20% each year
- Create 2,000 new creative jobs
- Increase export trading to 15% of total cluster turnover
- Adoption within economic development policy of Scottish Executive

Furthermore, four main objectives/ opportunities for development of creative industries were determined:

- Generate a more "creative-friendly" and supportive business infrastructure in Scotland.

48 South West Screen, 2004. Digital Content Strategy, p.9.

- Establish more effective means of identifying and nurturing creative talent
- A greater international reputation for Scotland as a creative sector
- Greater interaction between Scotland's creative industries and the research community (from virtual reality to animation, and from computer science through artificial intelligence to communications technologies).

The final objective gives a clear message of the strategic importance Scottish Enterprise awards to increased cooperation/linkages between research institutions and creative businesses.

The creative industries cluster was primarily run by the national office of Scottish Enterprise, but with extensive consultation and collaboration with industry representatives. However, in some cases, component sectors of the creative industries cluster are co-ordinated from a local office, in line with regional strengths. There is no dedicated separate office for the creative industries initiative. In general, support and activity are delivered through existing structures and bodies such as Local Enterprise Companies, Industry Associations and partners such as the Scottish Arts Council.

To date Scottish Enterprise has succeeded in introducing a number of initiatives to foster growth of the creative industries cluster in Scotland. Specific achievements include:

- In terms of baseline cluster growth, figures show that the number of creative companies grew by 3,000 to 18,000 companies between 2001 and 2002. In the same period, the figure for total jobs increased by 20,000 to 155,000 in 2002.
- The cluster initiative activities have generated new spin-off companies in the creative industries sector.
- The penetration of export markets to lure new talent into the cluster has improved through trade missions, international events, talent events and recruitment affairs.
- In the period 2001 to 2004, 50 companies were accessing new global markets.
- By 2004, the image of Scotland as a location for the games industry was enhanced by the creation of 3 worldwide top selling games in Scotland.
- Innovation in the creative industries sector was encouraged through the Proof of Concept Fund which supports the pre-commercialisation of leading-edge technologies emerging from Scotland's universities, research institutes and NHS Boards. Since 2001, 13 new projects in the digital media and creative industries sector were funded by a $2m investment from the Proof of Concept Fund[49].
- On the infrastructural side, a world class digital media centre, earmarked as a 'digital media campus' and business park is being developed in Glasgow, with a second digital media park under construction in Dundee, which will see a £50m injection into the area over the next 10 years.
- A number of support and development agencies have been developed to provide support to the creative industries sector and enhance partnership between academia and industry.

For example Interactive Tayside is a partnership between public, private and academic sectors to develop and promote Tayside's digital media industry. The body aims to: build the digital media industry in the Tayside area; develop new commercial opportunities; promote the high-quality skills and talents of the area's digital media practitioners to a wide audience; and encourage higher levels of collaboration between businesses and with academia.

49 Tibbetts, Mike, November, 2004. The Creative Industries Cluster Initiative in Scotland, Presentation to 'Community Colleges in Creative Economics' conference, North Carolina.

Interactive Tayside can offer a range of business support services, all geared towards the development of the digital media industries in this area. These services for large and small businesses include: advice and funding; help with PR and promotion; research and development; and training and skills.

In addition, the Research Centre for Television & Interactivity in Glasgow provides practical help to independent production companies. Set up in 1998, in partnership between Scottish Enterprise Glasgow and Channel 4, its work focuses on: supporting and developing business growth among content producers; encouraging research and development within the industry; and enhancing the quality of ideas and commercialisation of content across all platforms.

4. US Findings

The research highlights a number of digital media related enterprise clusters in the US which have linkages with education / academic research and skills. Key clusters, of which an overview is provided in this report, include: Boston (specifically computing and IT – key enablers of Digital Media), Florida (the High-Tech Corridor, the InternetCoast and the Digital Convergence Initiative); Texas (Interstate 35 Corridor) and LA/ California (the Digital Coast). Key factors driving successful clustering are set out as an introduction to the section. However, as per the terms of reference of the study, our focus is on reviewing clusters in which "Education, Research and Skills have strong links to the creation of Digital Media enterprise clustering / critical mass".

Case studies for Boston, Florida, Texas and LA/California are now presented below.

4.1. Boston

Research conducted at universities in Massachusetts has had a major impact on the growth of sectors such as computing and IT. The State's eight research universities are large beneficiaries of federal research funding and authors of new patents. This serves to attract large national and international companies to locate in the area[50]. Some such companies include – Cisco and Sun Microsystems.

Research states that the licensing of technologies to commercial enterprises is perhaps the most direct way in which academic research can be translated into industrial growth[51]. To facilitate this, the Boston research universities have created technology transfer offices. Support offered through these offices includes:

50 Weiping WU, "dynamic Cities and Creative Clusters", World Bank Policy Research Working Paper 3509, February 2005
51 Ibid

- seed money for further work on inventions,
- assistance in business planning,
- introduction to venture capitalists,
- assistance with recruitment and
- incubator space.

MIT is well known for its institutional culture which encourages faculty entrepreneurship with many companies having been founded by university alumni.

Boston's "Research Row" is made up of MIT, Harvard and a number of other local universities and a concentration of industrial labs which together offer a superior technical labour pool. Research states that for software firms, the computer culture in Boston, which is formed around MIT (dubbed Technology Square), helps explain clustering there.

The research universities in Boston have worked to design their teaching and training programmes to meet the needs of the regional labour force. The universities also contribute to the quality of life in the region through the provision of affordable housing programmes, community improvement programmes, and programmes to help deliver health services.

4.2. Florida

A number of Digital Media and IT clusters have emerged in the state of Florida as a result of increased cooperation between research institutions and enterprise.

The principal drivers for this development include:

1. Florida has a number of key IT products and information service companies including:
    - Citrix Systems
    - Electronic Data Systems (EDS)
    - Hewlett-Packard
    - IBM Global Services
    - Intel
2. Four of the top ten theme parks are located here including Walt Disney, Universal Orlando, and SeaWorld Orlando. [52]
3. Florida is the third largest film and entertainment production centre after Los Angeles and New York. [53]
4. In 2003, the University of Central Florida combined the disciplines of computer science, graphic arts, communication and film into the School of Film & Digital Media. [54]

52 "Putting Imagination to Work", Metro Orlando Economic Development Commission
53 Ibid
54 Ibid

5. In 2004, the State of Florida established the Florida Interactive Entertainment Academy (FIEA) to produce a deeper, more highly skilled talent pool for the industry at the University of Central Florida. [55]

The two key areas in Florida where the clusters have developed are Central Florida and South Florida. The High-Tech Corridor (Central Florida) and the Internet Gateway (South Florida) are presented in further detail below.

4.2.1 High-Tech Corridor (Central Florida)[56]

Florida's High-Tech Corridor includes the areas of Tampa, Daytona Beach, Orlando, Gainesville, and Melbourne. The Corridor, established in 1996, includes a high concentration of firms specialising in optics/photonics, modelling/simulation/training and telecommunications. The technology sectors within which the Corridor operates include:

- Aviation and Aerospace,
- Information Technology
- Medical Technologies
- Microelectronics
- Modelling, Simulation & Training, and
- Optics & Photonics.

The High-Tech Corridor is supported by the Florida High-Tech Corridor Council. The Corridor Council is a partnership involving more than 20 local and regional economic development organisations (EDOs) and 14 community colleges. The Council itself is made up of the presidents of the three state universities (the University of Central Florida (UCF), the University of South Florida (USF) and the University of Florida (UF)), the presidents of two of the community colleges who serve on a rotating basis, the president of Florida Institute of Technology (FIT), and up to 24 representatives of high tech industry.

The Council's mission is to attract, retain and grow high tech industry and the workforce to support it within the 23-county Florida High Tech Corridor.

The High-Tech Corridor partnership between research and business has resulted in a strategic approach to high-tech economic development that employs three distinct strategies to leverage governmental, EDO and corporate budgets on a regional rather than local basis. These strategies are:

- Providing matching funds for university and business research & development projects;
- Encouraging the progression of workforce development initiatives (through associate degree programmes, primary & secondary school programmes and workforce research programmes); and,
- Conducting collaborative marketing projects with the local business, educational and economic development organisations that raise awareness of the region.

The Council's Matching Grants Research Programme is managed on the three university campuses (UCL, USF & UF) by a committee of university researchers and Council partners. The committee's issue, review and approve proposals on a year round basis. To date, the Council has partnered with more than 215 companies on more than 550 projects and has contributed more than $40 million. The partnering companies matched $80 million, which is a total of more than $120 million dedicated to research. [57]

55 Ibid
56 www.floridahightec.com
57 Ibid

In addition, more than 75 percent or nearly $90 million of these combined funds have been used over the eight year period to engage 1,000 graduate and doctoral students and research assistants and 300 faculty members in side-by-side research with scientists and engineers from the 215 companies. [58]

4.2.2 Digital Media Alliance FLORIDA (DMAF)[59] & Florida Digital Media Consortium (FDMEC)[60]

The Digital Media Alliance Florida (DMAF) & Florida Digital Media Consortium (FDMEC) are two relevant "mediating organisations" that support digital media clustering in Florida.

The DMAF is a non-profit industry association, established in 1999, whose mission is to provide a focus and forum for the continuing development and worldwide recognition of Florida's digital media and eEntertainment industry. The organisation is being founded and headquartered in Central Florida.

Its objectives include, to:

- Support and aggressively promote Florida's worldwide leadership in the research, development, application and usage of interactive, dynamic and experiential digital media for learning, entertainment, marketing and information purposes
- Facilitate collaboration and partnerships between the digital media industry and government, educational, creative and financial organisations, to strengthen our industry and workforce for global competition
- Provide a strong and unified voice for Florida's digital media and eEntertainment industry, based upon credible research and enlarging the community of members
- Encourage and facilitate professional, career and workforce development
- Work to ensure the availability of world-class resources, capital and workforce in a supportive environment such that entrepreneurial digital media companies can start successfully, and existing companies can compete, grow and flourish
- Actively seek cooperative relationships with existing Florida organisations to further these objectives, using digital media whenever and wherever effective

FDMEC is a non-profit educational organisation, comprised of participants from Florida industry, government and education who are committed to advocacy of excellence in digital media education.

In partnership with Digital Media Alliance Florida FCMEC aims to:

- evaluate and disseminate digital media definition modifications,
- research and advocate for advancements in digital media education and
- champion integration with industry needs.

58 Ibid
59 www.dmaflorida.org
60 www.dmaflorida.org/fdmec

Through the following activities FDMEC aims to achieve these strategic goals:

- Serve as a common focal point for cooperation, collaboration, information sharing and joint planning and action for digital media education and awareness.
- Jointly contribute to effective development and utilization of resources for educational networking at all levels and with industry.
- Co-host annual, state-wide digital media education conference(s) and/or workshops to provide networking and learning opportunities between industry, state and private educational institutions and government.
- Advise and assist in educational articulation.
- Provide mentors, speakers and assistance to K-20 education as well as adult education and training.
- Conceive, research, analyze, evaluate, develop and disseminate educational and cooperative efforts that further the goals and purposes of the organisation and its members.
- Create valuable linkages between related efforts.
- Analyze and evaluate the economic impact and contributions from and to digital media education.
- Advise the industry Board of Directors of Digital Media Alliance Florida, and assist mentors of the Digital Media Alliance Florida M.E.D.I.A. (Mentoring Entrepreneurship through Direct Involvement in Activities) program.
- Jointly plan actions and pursue resources to continually improve the availability, quality and effectiveness of digital media education in the State of Florida.
- Work in tandem with DMAF to continually monitor, adjust if necessary, and disseminate definitions of digital media and its disciplines, consistent with industry changes and technological advances.

4.2.3. "2004 Film, Digital Media and Entertainment Production Activity Survey"[61]

Innovation Insight produced the "2004 Film, Digital Media and Entertainment Production Activity Survey" for the Metro Orlando Film & Entertainment Commission, July 2005. The report examined production activity in the film and entertainment industry based upon a direct survey of metro Orlando film, digital media and entertainment companies.

The survey listed the following companies for whom/ areas where digital media projects were recently being undertaken in Florida:

- Novartis,
- Arizona Diamondbacks,
- NCAA Football,
- Geist (Nintendo game title),
- Pittsburgh Steelers,

61 "2004 Film, Digital Media and Entertainment Production Activity Survey", July 2005, Report to the Metro Orlando Film and Entertainment Commission, A Division of the Metro Orlando Economic Development Commission (www.innovationinsight.com)

- presidential election,
- Walt Disney,
- Philadelphia 76ers,
- and numerous distance education, entertainment publications, sports, and other digital projects.

The survey also noted that there had been 12.43% growth in digital media projects in Florida during the period 2002-4 and that the average number of employees employed by digital media content firms was 12.6.

4.2.4. InternetCoast[62] (South Florida)

The InternetCoast is made up of a collection of technology companies and organisations operating in Southeast Florida. It is a technology cluster of businesses, organisations and educational facilities. It is located on the Southeast coast of Florida and stretches across Palm Beach County, Broward County and Miami Dade County.

The InternetCoast's mission is to focus on social innovation, entrepreneurship, and a knowledge based workforce to facilitate investment and drive economic growth.

The InternetCoast has over two thousand participants including the private sector, education, existing organisations, and local and state government.

Some of the universities/ colleges which the InternetCoast has links with include:

- Digital Media Arts College,
- National School of Technology and
- The Art Institute of Fort Lauderdale.

The mission of the InternetCoast's Education Research Consortium is to facilitate dialogue among educational institutions and businesses that results in education programmes designed to produce an ongoing supply of qualified workers to support the InternetCoast.

The Florida State Legislature passed a bill in 2002 known as The Florida Technology Development Act. The current version of the Act provides for $30 million to be set aside to build university-based Centres of Excellence. The budgets for the Centres include monies for research projects, leading edge facilities, the recruitment of world-class personnel and strategic partnerships with business entities that may commercialize the technologies developed in the Centres.

In response to this legislation, the InternetCoast Education Research Consortium developed the proposal that was submitted to the State to obtain some of the funds that will be provided to the Centres of Excellence. In March 2003 the research monies were awarded to three state universities that included Florida Atlantic University, University of Central Florida and University of Florida. Each university received $10 million.

The mission of the InternetCoast's CIO Advisory Council is to enhance community awareness of Information Technology issues through education and communication. The participation of Chief Information Officers (CIO's) from South Florida's commercial business, government, and educational institutions creates opportunities for executives to grow their respective organisations. The Council provides a forum for an open exchange of ideas, collaboration on issues of mutual importance, leveraged vendor relationships, and focused community involvement.

62 www.internetcoast.com

The objectives of the Council include:

- Share ideas across industries and technology platforms, to create innovation for the membership.
- Improve the IT talent pool by interacting with higher education, to develop programmes and curricula geared to fill industry needs and retain qualified prospects locally.
- Develop a concise role in the strategic direction of the membership's respective organisations.
- Educate the membership to properly fill the role of the CIO, as it evolves.
- Educate corporate leadership on the role technology can play in the success of the organisation.
- Impact service and pricing from vendors that are critical to the success of the membership.

The InternetCoast furthers these objectives through networking events, conferences and the work of committees established to further specific agendas (e.g. education, entrepreneurship, governmental and marketing etc. issues).

4.3. Texas

San Antonio's "2004 Strategic Plan for Enhanced Economic Development" set out a number of economic development strategies to grow San Antonio's creative economy. Amongst the objectives cited was to "Implement the San Antonio Technology Accelerator Initiative action plans, particularly with respect to fostering the growth of the digital media cluster."

In 2004, the San Antonio Technology Accelerator Initiative (SATAI) Network created a new digital media arts technology cluster. The new cluster includes the following technologies:

- television and film production,
- computer graphics,
- animation,
- holograms,
- audio production,
- Web design and
- the gaming industry.

In the past year, the new digital media arts technology cluster has taken the lead in directing activities that have included a day long trip to the Austin Film Studio, meetings with IC2 of the University of Texas to deploy a project defining the technology assets between San Antonio, Austin, and Waco or the Interstate Highway 35 corridor, and the ground to build an environment for the local film industry.

The Digital Convergence Initiative (DCI) & the Interstate 35 Corridor

The Digital Convergence Initiative (DCI) is an example of a "mediating organisation" facilitating the creation of digital media clusters in Texas. It is a public/private venture to facilitate the growth of the digital-oriented industrial and scientific base of Central Texas to:

- Create regional and U.S. competitive advantage in the international digital market
- Advance economic opportunities for regional businesses with attention to small business growth
- Align institutional and private sector digital-oriented research and development with consumer demands and government requirements

By connecting the regional entities and leveraging the convergence of these separate industries, the DCI aims to create a "super economic cluster" in Central Texas.

Digital Media Collaboratory (DMC) (Central Texas)

The Digital Media Collaboratory (DMC), located in the IC2 Institute, University of Texas, Austin, was launched in 2003. It is a centre of expertise for technology-related virtual environment research within Texas's digital media cluster and is included on the DCI Interstate 35 Corridor diagram above.

The DMC works with a variety of collaborators from academia, industry, and government to conduct innovative research in five key areas:

- modelling and simulation
- decision support systems
- educational technology
- digital games
- machine learning

The DMC works with partners such as the Sandia National Labs, the US Army and the National Science Foundation.

The DMC is currently working on:

- Games for Learning – transforming the interactive experiences and popular appeal of games for entertainment into games for learning.
- Valuation Matrices for Learning/ Educational content in Popular Games – researches the potential for commercially situated computer games to demonstrate educational utility.
- Artificial Intelligence – development of dynamic and sophisticated computer interaction systems to achieve engaging, immersive experiences.
- Focused Knowledge Bases – extends the traditional knowledge base to capture the processes and functions of the domain considered as a system.
- EnterTech, EnterTech Spanish - simulation based workforce training programme.
- Digital Entrepreneur – micro-enterprise education programme using blended learning

- Career Connect – experiential job preview that combines engaging, high-quality and interactive simulated work environments with meaningful occupational information.

The Future Media Institute (FMI), established in 2003, by the DMC and the Capital Area Training Foundation (CATF), provides training opportunities in film, gaming, digital media, software and networking. The FMI's goals are to empower individuals in Central Texas to explore their creativity, to build programs to assist students in investigating careers in technology and to give educators access to experts in industry.

4.4. The Digital Coast (LA and California)

The Digital Coast region is San Diego, Orange, San Bernardino, Los Angeles, Riverside, Ventura and Santa Barbara Counties. The Digital Coast of Southern California is home to the largest combination of companies developing, distributing, and delivering digital media to meet the needs of a wide range of market interests from health care to entertainment.

The business interests and skills of the Digital Coast, from Santa Barbara to San Diego cover the range from technology to content. Companies in this region developing Internet-based digital media, software tools and utilities, databases, applications for education and consumer entertainment, and electronic commerce.

There are two key mediating organisations involved in this region:

Digital Coast Foundation

The mission of the Digital Coast Foundation (DCF) is to serve as a facilitator for leveraging resources in the service of community-based arts, technology and education organisations in the Digital Coast Region. In addition, the DCF collaborates on initiatives that impact the greater technology community. The Digital Coast region is San Diego, Orange, San Bernardino, Los Angeles, Riverside, Ventura and Santa Barbara Counties.

The services provided by the DCF are to:

- Develop seminars and workshops with New Media Academies to integrate art and technology into high school curricula.
- Assist identified non-profit organisations with shared goals and interests.
- Conduct an industry study to analyze and track trends and growth in the Digital Coast region.

The DCF is a non-profit making organisation.

Digital Coast Roundtable

The Digital Coast Roundtable (DCR) is also a non-profit organisation. The DCR brings together industry, academic and government leaders to promote the success of emerging technology and digital media companies in the Southern California region. The group includes influential rich media, technology and financial executives in Southern California. In addition, the DCR convenes organisations, associations and guilds to collaborate on events, initiatives and public policy.

The Industry Relations Committee is a service of the Digital Coast Roundtable and brings together on a quarterly basis the presidents of Southern California's technology and media professional associations to discuss timely issues and events facing the companies and individuals in our local digital media industries. The DCR is working to unite the Southern California technology and digital media communities to collaborate on important issues and increase awareness of the region.

Appendix E: Membership of the Steering Committee

Úna Halligan (chair)	Hewlett-Packard Ireland / Expert Group on Future Skills Needs
Barry O'Neill	Upstart Games
Liam Fitzgerald	Bua Consulting
Liam Lennon	X Communications
Hannah Grene	ICT Ireland
Jerome Morrissey	National Centre for Technology in Education
Michael Hallissy	Digital Hub Development Agency
Dr. Stephen Brennan	Digital Hub Development Agency
Maeve McConnon	IDA Ireland
Jim Whelan	IDA Ireland
Liam O'Donohoe	Enterprise Ireland
Michael Cantwell	Enterprise Ireland
Roger Fox / Joan McNaboe	FÁS
Maria Ginnity / Andrew Stokes	Forfás
Eamonn Cahill	Forfás

Appendix F: Membership of the Expert Group on Future Skills Needs

Anne Heraty	CPL Resources PLC	Chairperson
Senan Cooke	Waterford Crystal Ltd.	Member
Jack Golden	Cement Roadstone Holdings PLC/IEI	Member
Una Halligan	Hewlett Packard	Member
Joe McCarthy	Arkaon Ltd.	Member
Dr. Sean McDonagh	Former Director of Dundalk IT	Member
Dr. Brendan Murphy	Director Cork IT	Member
Aileen O'Donoghue	IBEC	Member
Peter Rigney	ICTU	Member
Linda Tanham	Mandate	Member
Ruth Carmody	Dept. of Education & Science	Advisor
Fergal Costello	Higher Education Authority	Advisor
Roger Fox	FÁS	Advisor
Pat Hayden	Dept. of Enterprise, Trade & Employment	Advisor
Andrew McDowell	Forfás	Advisor
Anne Nolan	Dept. of Finance	Advisor
Martin Shanahan	Forfás	Head of Secretariat

Appendix G: Publications by the Expert Group on Future Skills Needs

Report	Date of Publication
Careers and Labour Market Information in Ireland	July 2006
Skills at Regional Level in Ireland	May 2006
SME Management Development in Ireland	May 2006
Monitoring Ireland's Skills Supply: Trends in Educational/Training Outputs	January 2006
Data Analysis of In-Employment Education and Training in Ireland	January 2006
National Skills Bulletin 2005	October 2005
Skills Needs in the Irish Economy: The Role of Migration	October 2005
Languages and Enterprise	May 2005
Skills Requirements of the Digital Content Industry in Ireland Phase I	February 2005
Innovate Market Sell	November 2004
The Supply and Demand for Researchers and Research Personnel	September 2004
Literature Review on Aspects of Training of those at Work in Ireland	June 2004
Financial Skills Monitoring Report	November 2003
Responding to Ireland's Growing Skills Needs - The Fourth Report of the Expert Group on Future Skills Needs	October 2003
The Demand and Supply of Skills in the Biotechnology Sector	September 2003
Skills Monitoring Report - Construction Industry 2003/10	July 2003
Benchmarking Education and Training for Economic Development in Ireland	July 2003
The Demand and Supply of Engineers and Engineering Technicians	June 2003
The Demand and Supply of Skills in the Food Processing Sector	April 2003
National Survey of Vacancies in the Private Non-Agricultural Sector 2001/2002	March 2003
National Survey of Vacancies in the Public Sector 2001/2002	March 2003
The Irish Labour Market: Prospects for 2002 and Beyond	January 2002
Labour Participation Rates of the over 55s in Ireland	December 2001
The Third Report of the Expert Group on Future Skills Needs - Responding to Ireland's Growing Skills Needs	August 2001
Benchmarking Mechanisms and Strategies to Attract Researchers to Ireland	July 2001
Report on E-Business Skills	August 2000
Report on In-Company Training	August 2000

The Second Report of the Expert Group on Future Skills Needs - Responding to Ireland's Growing Skills Needs	March 2000
Business Education and Training Partnership 2nd Forum, Dublin	March 2000
Business Education and Training Partnership Report on the Inaugural Forum, Royal Hospital Kilmainham	March 1999
The First Report of the Expert Group on Future Skills Needs - Responding to Ireland's Growing Skills Needs	December 1998