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INNOVATION AND KNOWLEDGE IN THE DIGITAL MEDIA SECTOR

An information economy approach

Academic research on service innovation has highlighted the distinct characteristics of services innovation, the knowledge complexes involved, and how services can be autonomous sites of innovation. It also highlights that successful services innovations are often not technology based but can depend on new organizational or managerial practices or marketing and distribution strategies. This paper makes an empirical and a conceptual contribution to this literature by focusing on one sub-sector of the services sector: digital media applications and services. Conceptually, this paper is interdisciplinary and draws upon a range of work on innovation and production in media and communication studies, innovation studies, evolutionary economics, and sociology. Empirically, this paper draws on ten years of qualitative case study research focused on innovation in the digital media sector in Ireland and, to a lesser extent, Europe. More specifically, we draw upon research on the internet, mobile, and games sectors. A key finding emerging from this research is that, despite the widespread popular and academic focus on technology and codified knowledge, a much broader knowledge base (particularly tacit, creative and non-technological knowledge) underpins successful innovative practices in digital media firms. This paper examines the combination of creative ideas and skills, social learning processes of content creators, management, market and business knowledge that underpin the development new digital media applications and services. It argues that a better understanding of the character of knowledge inputs and the innovative practices in digital media companies may contribute to a better understanding of innovation in the knowledge economy.

Keywords regulation; media studies; ICTs; gaming; digital arts; communication studies

1. Introduction: media services, knowledge, and innovation

The services sector accounts for 'over 70 per cent of total employment and value-added' in OECD economies and for 'almost all employment growth in the OECD area' (OECD 2006a, p. 1). Media industries may be considered a specific sub-set of the overall services sector, as well as one key component of the knowledge-based economy (KbE) or primary information sector. In this context, the media industries may be defined as typical of the intangible, information-intensive growth sectors deemed to characterize the contemporary 'knowledge', 'informational', or 'network' economy (Castells 1996).

Despite the dot.com downturn, recent policy reports in Britain, Australia, and the European Union (EU) are optimistic about this sector and identify the media and cultural industries as sectoral sites of significant job and wealth creation. Indeed, they have been accorded a role in EU discourses on the information society since the Bangemann Report (EC 1994). Turnover in the digital media industry was 'worth over \$965 billion in 2004, is projected to grow to \$1.5 trillion by 2009', according to one report (Forfás 2006a).¹ In Ireland, the digital media services sector is 'one of a handful pinpointed several years ago by the Government as particularly promising' for future economic and employment growth (Lillington 2006). In part, this is linked to the development of broadband networks/technologies and of social learning and appropriation of same (e.g. social networking and peer-to-peer services). In sum, several interlocking developments suggest that the digital media sector may be on the cusp of a 'tipping point' (Cawley & Preston 2007; Kerr 2007).

Yet there has been a widespread sense that prior expectations of growth, innovation and job creation in the digital media services sector have not been realized (Preston 2001; Kerr & Preston 2001; Lister *et al.* 2003). While it is acknowledged in academic studies of innovation that services can be autonomous sites of innovation, and that successful services innovations are often not technology based, the actual innovation processes and knowledge inputs are poorly understood. The focus of industrial policy and investment remains on investment in R&D, technology transfer, and measuring innovation through proxies such as patents and citations. The focus of innovation studies is on technical and codified forms of knowledge as a key driver of innovation to the detriment of our understanding of other forms of knowledge. However, in the digital media sector the source, combination, and character of knowledge used in innovation can vary considerably from other sectors and services. Thus, despite the achievement of the growing body of recent academic work on services innovation, we argue that understanding innovation in the digital media sector has an important contribution to make to the wider literature.

In our examination of knowledge, we are mindful that some scholars distinguish between knowledge and information, while others use the term

knowledge in a broad sense to encompass knowledge, information, expertise, and skills. In our discussion of knowledge complexes we adopt the broader definition. Our focus is on exploring the categorizations of different types of knowledge, skills, and practices identified by our interviewees.

Section 2 will review current definitions of the creative, cultural, and media industries, and critique the literature on the creative industries. Section 3 will present an overview of current research on innovation in services generally and in digital media services more specifically. The following section focuses on the source, character and combination of types of knowledge that enable and sustain innovation and growth in the digital media services sector of the economy. We will draw on recent empirical research in the internet, mobile, and games sectors conducted by the authors to explore the particular clusters of new knowledge(s) and other inputs that underpin effective innovation strategies in the sector. This final section summarizes the key lessons emerging from these case studies. It will examine the implications for existing conceptualizations of knowledge used in the knowledge economy and the factors underpinning the innovation process in ‘intangible’ service industries.

2. From ‘creative industries’ to a primary information sector

Writing about the media, cultural, or creative industries suffers from what Galloway and Dunlop (2007) call ‘terminological clutter’. The terminology can be applied in a vague and broad sense or in a narrow sense and it is important to underline these variations in conceptualization. Our focus is on what Hesmondhalgh (2002, p. 5) calls ‘symbol creators’ and the sections of the media industries that produce symbolic content.

The media services sector has, in certain policy circles, become synonymous with the creative industries sector. The UK government’s Creative Industries Task Force defined the creative industries sector as those ‘industries that have their origin in individual creativity, skill, and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property’ (cited in Forfás 2006b, p. 86). The creative industries category includes the following 13 sub-sectors: advertising, architecture, art, antiques, crafts, design, fashion, film and video, computer games, music, performing arts, publishing, software and computer services, TV, and radio. A key goal of the initiatives surrounding the creative industries discourse was to recognize that they constitute ‘a very serious part of the wealth creation of the UK economy’ (Eaglesham 2007).

The creative industries approach has also been taken on board at EU policy level. A recent working paper situates the cultural industries as a subset of the creative industries and regards the creative industries as being less national

and more global and local/regional than the cultural industries (Preston 2003; EC 2005). Further, it notes that there has been a shift away from a policy model where the subsidized arts are to the core of the cultural industries to a model where commercial and economic activities are at the core, with subsidized arts moving to a peripheral position. The working paper noted that:

Creative industries are knowledge and labour intensive and foster innovation: the sector is considered to have a huge potential for generation of employment and export expansion. However, according to UNCTAD, its potential is currently not realized.

(EC 2005, p. 10)

In Ireland, from 2001 to 2005, Forfás produced a number of reports on the digital media sector. These documents did not adopt the creative industries terminology but instead referred to the digital content or digital media industry (e.g. Forfás 2002). In this case, the digital content industry was defined broadly to include digital entertainment industries, e-learning companies, companies providing online services to consumers, and companies providing online services to businesses. The Forfás approach differed from that of the creative industries in the exclusion of traditional arts and crafts. The digital content industry concept, however, includes companies at all stages of the value chain, from content creators to publishers, data storage companies, and telecommunications companies. In more recent policy reports, however, Forfás seems to have shifted towards embracing the current fashion for the creative industries category (Forfás 2006b). It adopts the same definition as the UK's task force on the grounds that it is 'the most frequently agreed definition internationally' (Forfás 2006b, p. 86).

While the creative industries approach appears to be increasingly popular in policy circles in recent years it amounts to a rather arbitrary category, both conceptually and in operational terms. Critics, including Banks *et al.* (2002), Hesmondhalgh (2002, 2005), Galloway and Dunlop (2007), and Rossiter and Lovink (2007), have identified a range of problems with the creative industry approach. The criticisms are important for our concerns with conceptualizing the specificity of the knowledge inputs and innovative activities within the digital media sector.

Here we will focus on three of these concerns. First, the term 'creative industry' neglects the role of creativity in a wide range of other industries besides the chosen 13. Even within the 13 there is a presumption of creativity and variations between sectors are ignored. Second, creativity is placed within the hands of the individual and the role of the social context in the creative process is ignored. Third, it tends to assume that creativity can be defined by the specific products of particular kinds of firms or industries rather than by what they do. Banks *et al.* argue that 'it is essentially output rather than process driven' and it fails to shed light on the creative process (Banks *et al.* 2002, p. 256).

Thus, we argue that the presumption of ‘creativity’ signalled by the current use of the category ‘creative industries’ ignores important differences between the sub-sectors and, crucially, the sectoral and other ‘contexts in which creativity is being defined, located, valued, and managed’ (Banks *et al.* 2002, p. 262). We propose that taking a focused definition of the digital media sub-sector of the cultural industries opens up the question of creativity and creative practices to empirical scrutiny and brings to the fore a range of factors that influence the creative and innovation processes. Our approach is similar to the more restricted definition of the core cultural industries adopted by Hesmondhalgh (2002, p. 12), as it focuses on those industries that are involved in the ‘industrial production and circulation of texts’, in particular those new media forms related to the internet, mobile, and game sub-sectors.

The cultural industries can be situated as one sector within the wider knowledge or information(al) economy and more specifically, using Porat’s terminology, as part of the primary information sector (PIS). Porat (1997) defined the PIS as all industries that produce information machines, goods, and services to sell in the public market place. Crucially, for our purposes, this work distinguishes between those who produce information for the final market and consumers and those who produce information as an intermediate input to production in other industries. Further, this work distinguishes between workers or firms that produce information, those that distribute the information, and those that produce information tools/infrastructure.

We contend that the information economy approach provides a more coherent meta-concept for understanding the evolving role and scope of media services compared to the alternative creative industries model. The information economy approach also provides an operational schema for understanding how ‘creative’ functions are essential to the innovation process in all sectors of the economy, i.e. not merely those sectors arbitrarily selected by the prevailing policy definitions of ‘creative industries’, such as those the UK government advances in its creative industries documents. In this kind of approach, media services may be fruitfully viewed as leading-edge components of the PIS or knowledge-based industries. As services intrinsically involved in the creation, supply, and distribution of information, they may also be regarded as leading-edge application sectors for new ICTs.

3. Innovation in services and knowledge

3.1 Innovation and services: a growing if relatively new field

In retrospect, it is quite striking that services had been ‘close to invisible in discussions of innovation’ prior to the 1980s (Alic 2001, p. 877). Since then, international research and policy analyses have focused on services industries as

significant sites of innovation. This strand of work has been particularly strong in Europe (Alic 2001; Howells & Tether 2006). The recent surge of attention to innovation in services has been prompted by industrial and state initiatives focused on ‘making a business of information’, especially in the USA and UK from the early 1980s (e.g. UK-ITAP 1983; US-NTIA 1988). This impetus has been amplified by the subsequent swarming of ‘information society’ and KbE policy initiatives since the early 1990s. This is reflected in the tendency of many recent contributions to place a major emphasis on knowledge-intensive business services (K-IBS).

Much of this recent research comprises detailed case studies of innovation processes in specific services firms, industries or sectoral, and regional systems. They tend to address the respective roles and forms of innovation – including radical and incremental, product and process, organizational and other novel or sectorally specific (e.g. delivery) types of innovations. Some of this case study work also explores the particular combinations of specialist competencies involved in supporting innovation in the service industries (i.e. technological and other specialist knowledge-bases), the specific modes of networking and similar concerns (Miles 2001, p. 11–25).

Furthermore, an overlapping stream of the recent research focuses on the specific features and role of innovation networks and systems in the services industries. This includes the role of collaborative efforts to mobilize new socio-technical constituencies and/or the requisite clusters of informational resources to bring complex new products to the market. Another notable feature is the extension of large-scale innovation surveys (traditionally confined to manufacturing industries) to provide more systematic and detailed empirical data on innovation trends in the services industries (Tether & Metcalfe 2003).

These complementary research streams combine to produce a range of new typologies that provide improved classifications of the diversity of service innovation patterns and processes (Alic 2001; Boden & Miles 2000; Howells 2001; Howells & Tether 2006; Miles 2001). It also provides us with a range of concepts for understanding the character and source of knowledge used in innovation in many sectors (see Table 1). Despite progress, however, there is a predominant focus on scientific and technological knowledge as the key knowledge type or base in innovation. Other forms of knowledge are under specified. This is evident both in academic analyses as well as in the policy literature. There is a continuing tendency for the technology-led vision of what constitutes research and knowledge to predominate as the default assumption, as Howells and Tether (2006) recognize. We would argue that technological knowledge is only one type of knowledge input to the innovation process in contemporary services, and that this is particularly evident when one examines the digital media sector.

For recent surveys of innovation in services, the default assumption for knowledge inputs is technological knowledge or technical research. This is manifest in the frequent emphasis on the ‘the growing share of services in overall

TABLE 1 Knowledge categories in recent innovation literature.

<i>dimensions</i>	<i>basic categories (polarized)</i>	
	<i>networking</i>	<i>clusters</i>
Ownership forms	Commons	Proprietary
Source	Internal R&D in firms	Users, clients, or audiences
Degree of embodiment	Dis-embodied	Embodied/embedded
Degree of formalization	Codified/Formal	Tacit/informal
Complexity	Complex	Simple
Degree of recognition	Expert	Lay
Knowledge types	Technological	Still largely a 'black-box'

Notes: Other than knowledge related to 'marketing' and 'organizational' innovation, as in the third edition of the Oslo Manual (Eurostat/OECD, 2005).

Source: Kerr 2006; Preston 2006; Faulkner (1994, p. 450).

R&D activity and patenting and trademark activity' – in the absence of any consideration of the diverse features of what counts as research and the relevant knowledge types across the spectrum of services (Howells & Tether 2006, p. 11).

Given the centrality of R&D in the established innovation paradigm, the silence on the range of knowledge inputs for service innovation is significant. A recent exception has suggested that, in addition to the scientific and technological knowledge bases, there may be a 'symbolic knowledge' base particularly evident in the cultural industries (Asheim & Coenen 2007). This approach suggests that innovation in the cultural industries involves knowledge that is embodied, tacit, and context dependant, and is acquired largely through practice and socialization rather than formal training. However, their conceptualization of 'symbolic knowledge' is still under specified and not empirically grounded.

3.2 *Recent studies of innovation in digital media services*

It is widely acknowledged in innovation studies that there are sectoral paths to innovation. The past two decades have witnessed the growth of some empirically grounded research that is more focused on the specificities of innovation in the media services sector. These have emerged from a range of disciplines including geography, economics, sociology, and media studies.

Much of this work has focused on the locational and geographical aspects of the sector, including the role of inter-firm networking, clusters, and networks (e.g. Cooke 2002; Cornford *et al.* 2000; Egan & Saxenian 1999; Florida 2002a, 2002b; Scott 2000). Many of these works are somewhat vague when it comes to the specificities of industrial or innovation dynamics of digital media services. Too frequently we encounter a heavy emphasis on technological

trends or logics (e.g. 'convergence') or a parallel tendency to conflate the important distinctions between the industries producing new media tools and those producing content services. For Florida (2002a, 2002b) the focus is on exploring the location or social context of innovation, and his work highlights the importance not only of technology, but also of talent and tolerance. This work has proved extremely popular with policy and planning officials involved in national and city economic development initiatives over the past two decades.

Meanwhile, in a study of Belfast's creative industries, Jeffcutt (2004) contends that 'knowledge relationships involve the bringing together of diverse expertise (both creative and non-creative) in complex value circuits of symbolic goods that connect the originators of novel ideas with the consumers of novel experiences' (2004, p. 71). In an explicit rebuff to the policy focus on creative industries he notes that, despite their designation as creative, the creative industries are not more or less (in principle) creative than other industries. He argues there is much variation and there is a need for empirical analysis of the industries in question. Jeffcutt's study identified three main groups of creative industries: design, expressive and media, and information. While they all had a range of 'knowledge interfaces', a mix of creative and business expertise, and an ability to harness technology through practice, they also had distinctive needs as well.

In a similar vein, work by O'Connor (2000) has noted that successful clusters are increasingly predicated not so much on creativity but on access to a range of knowledge(s) about global markets, larger companies, and distribution networks. Both Pratt (2004) and Jeffcutt (2004) highlight the role of regulation, organizational structures, non-traded dependencies and the interface between micro-enterprises and global distribution networks in the innovation process in media sectors. Pratt further argues that, in crucial respects, 'these processes are situated in particular places and times (here we include the regulatory specificities) and, significantly, in particular industries'. The 'particularity' of media service industries 'is clearly explained by the diversity of production processes as well as the unique character of regulation in this sector' (Pratt 2004, p. 55).

Compared to the (relatively) large amount of work on spatial and networked aspects of innovation, there has been less work focused on the mix of knowledge inputs (especially along the disciplinary dimension) that form the enabling or crucial supports for the innovation process in the media services sector (Preston & Cawley 2004). The most useful work for our purposes focuses on the division and process of labour and the creative tensions involved in the production of content. A recent contribution by Pratt *et al.* empirically examining production in film special effects, web design, and game production in the UK found that a balance of technical and artistic sensibility was important across these sectors, and that 'whilst technologies underpinned activities and changes, they were not sufficient motors of change in and of themselves, nor were they independent of usage, content or application. They were always experienced and embedded in labour markets and localities, networks of

information and learning, and markets and organizations’ (Pratt 2004). Indeed, ‘sensitivity to content and use’ was seen as important as technical skills. Research by Gill (2002) on freelance new media workers argued that to succeed these workers must combine creative, business, and technical knowledge.

4. Media services’ case studies: innovation and knowledge

4.1 Introduction

In this and the following section, we explore in more detail a number of themes that emerged from a series of studies of innovation in digital media companies in Ireland, particularly those involved in content production or enabling access to content. These cases are in the main studies of small to medium sized digital media firms. In the research we employed semi-structured and structured face-to-face interviews, participant observation, and secondary document analysis. Space, here, does not permit a detailed description or analysis of each case study. Rather, our approach is informed by the accumulation of insights on the innovation process and knowledge inputs gained through engaging in this research over the last decade. Our discussion explores the themes emerging from that body of work. We highlight specific examples from some of the case studies to illustrate our analysis. In chronological order the case studies are as follows:

1. Study of an online media service in the branch plant of MNC (1997–1999).
2. Studies of digital media content innovation initiatives in three Irish firms (1999–2002).
3. Study of jobs, functions, and occupations in 23 digital media firms (2002).
4. Study of innovation and knowledge in 10 mobile content and enabling technologies firms (2003–2005).
5. Innovation processes in the digital games industry (ongoing).

While there are some important differences between the sub-sectors, in this context we would like to highlight a number of similarities. What becomes clear from these case studies is that content innovation in digital media services involves a heterogeneous mix of knowledge in terms of disciplinary background, skills, and practices. Thus, while technical knowledge plays a role, particularly for those focused on enabling technology innovations, knowledge related to design and the market are at least as important, and more so for those focused on content innovation. Further, despite the reification of theoretical or codified knowledge, much of the knowledge required in these innovation activities is acquired on the job and on previous jobs, and is therefore tacit, embodied, and domain specific. Finally, the source of innovation is less upstream in research labs and universities and more a mix of personal and collective experience, horizontal input from

competitors and partners and downstream information from users. We will look at examples of these findings in the next sections.

4.2 *Heterogeneous and embodied knowledge*

In 2002, Forfás estimated that there were a total of 282 companies in the digital content sector in Ireland, employing about 4,500 people (Forfás 2002; Cawley & Preston 2007; Kerr 2007). The first case that we will present involves a study of employment, occupations and skills in 23 digital content firms in 2002. The companies were involved in e-learning, digital games, digital television, and film and mobile content development. The occupational categories presented in Table 2 involved the combination of a wide range of occupations into a small number of high-level categories. What is clear from Table 2 is that content and media authoring activities dominate in terms of total numbers employed, followed by management, quality assurance, and testing. Content authoring includes occupations such as journalists and writers, while media authoring includes occupations such as graphic and web design, sound design, animation, and video. Software development includes software and database programming.

A key challenge for these companies was to obtain the right mix and balance of technical, creative/design and business skills and manage workflow, and communication between the design and programming teams. Indeed, discussions with employers noted that there was a need, particularly in smaller to medium sized companies, for employees to be able to work alongside and negotiate with people from very different disciplinary backgrounds. Face-to-face

TABLE 2 Occupations in 23 digital content companies with a total of 866 employees (2005).

<i>occupational family</i>	<i>full time (%)</i>	<i>permanent</i>		<i>temporary</i>	
		<i>contract (%)</i>	<i>contract (%)</i>	<i>part time (%)</i>	<i>total (%)</i>
Management	13	1	1	–	15
Content authoring	7	0.1	0.5	–	7.6
Media authoring	20	3	3	–	26
Software development	12	0.5	–	–	12.5
IT and sys support	2	0.1	–	–	2.1
QA and testing	9	10	1	–	20
Sales and marketing	5	–	–	–	5
Other specific	0.5	0.1	–	–	0.6
Other generic	11	–	–	0.2	11.2
Total	79.5	14.8	5.5	0.2	100

Source: McNaboe (2005).

interviews emphasized the importance of core skills, such as an ability to work in teams and an ability to communicate with team members and clients across disciplinary boundaries. These skills were seen as particularly lacking in graduates from college where many courses did not expose students to proper interdisciplinary working environments.

While qualifications were increasingly important in terms of recruitment, and could be seen from job advertisements, a good portfolio or show reel and previous experience of product or service development were crucial for full-time positions. Thus, showing previous examples of work was important for staff. A company's reputation was based on the fact that it employed a certain designer, writer, or producer, and this status increased their chances of obtaining new and repeat clients and publishing deals. Inexperienced graduates tended to be recruited into roles such as quality assurance and testing. Good artistic employees who were also knowledgeable about programming and more technical processes or vice versa were highly sought after.

If we were to focus more specifically on a particular sub-sector such as games, we see again the heterogeneous mix of knowledge required to design a new product and the need to balance technical and more aesthetic knowledge as well as types of occupations. Kerr (2006) describes the various roles involved in the game production process in which the production team includes producers, artists, designers, modellers, animators, scriptwriters, audio designers, and programmers. This team is often supplemented towards the end of production by a quality assurance and testing team. In an average console game development team there are usually more artists and designers than programmers. Managing the interaction between the various parts of the production team is a key challenge. As Kline *et al.* (2003, p. 199) point out, 'game development . . . requires a synthesis of narrative, aesthetic, and technological skills'. The design and development process is collaborative, involves teams working in a studio, and can take one to two years for a high-end title. There are significant differences across platforms, however, with mobile games taking a considerably shorter period of time to develop.

In the games industry, generic design and programming skills must be adapted to particular platforms. Thus, employers place great emphasis on experience of working on previous titles and an ability to operate in a team ahead of formal educational qualifications.

The need to have a balance of technical, creative, and business skills is underlined by another study of the games industry in Ireland. While Ireland has experienced ten years of rapid economic growth, particularly in the software industries, no Irish games company has succeeded in bringing a console or PC game to market, despite numerous attempts. A study of the games industry in Ireland using face-to-face interviews found that, while Irish game companies have traditionally been strong technically, they tended to lack creative and business skills (Kerr 2002). As Gallagher and Park (2002) point out,

technological innovation has been a necessary but not sufficient factor for success in the games industry.

Kerr (2006) also identifies four distinct content segments in the games industry: console, standard personal computer, massively multiplayer online games, and casual games. Each segment is structured differently and companies within each segment have different production cultures and routes to market. These four segments network with a range of publishing, distribution, retail, middleware, and hardware companies. To support innovation in this industry, policy makers need to attend to the specificities of content innovation generally and digital game production specifically.

Globally, the key trends in the games industry are towards greater concentration and conglomeration of publishing and distribution capabilities, increased licensing of intellectual property from real world and other media resources, and a decrease in the production of independent games. When one examines the top selling console games in the UK and US markets over the past ten years there is an increasing trend towards sequels, multi-platform licenses, and derivative game ideas. The structure of the games industry, while predicated on technical innovation, is arguably experiencing decreasing content innovation.

There are important differences between the American, the European, and the Asian markets in terms of platform and content, and companies need to be mindful of these regional differences when bringing an innovation to market. These relate not only to infrastructure, regulation, and payment systems in each country. Each market has a different affinity with particular game platforms, game genres, and indeed character and game designs. Thus, in the games industry, we see that technology is an important but not sufficient input into the innovation process. Design, technology, and market skills and knowledge mediated through relationships with global publishers and local innovation environments can crucially influence the innovation process.

Another study comprising in-depth interviews with the staff of ten companies active in the mobile and wireless industry in Ireland, conducted in 2004, further supports our argument (Cawley 2005). This research revealed that each of the companies required a diversity of knowledge inputs for innovation: business knowledge, authoring/design, technical knowledge, as well as the tacit knowledge gained through the social process of learning by doing. Although the companies interviewed in this study had specialized functional areas with accompanying specializations in knowledge and competencies, they also sought to ensure that their functional areas understood and contributed to each other to enhance the overall innovation process. The business development officer of one company emphasized the need to complement technical knowledge with a broad understanding of business processes.

One thing that I know from past experience with the [software programming] people coming out of college is that...they've got all the mathematical or

programming skills possible, but don't understand business needs and business processes. And they're developing tools which work but there's no marketplace for them.

Similarly, the mobile marketing and content companies expected content creators to understand the underlying technical architecture to better frame content and information within the parameters and limitations of devices, e.g. mobile handsets' display of content.

The content officer of a mobile marketing and content company stressed the need to maintain a consistent blend of authoring/design skills as technologies and applications advance:

People will need a strong technical capability. The provision of content, to write content, will be essentially the same, but you would need to be able to structure it [the content] technically. Journalists have a role of content supplier, but to market it would need someone who could convert it into the digital environment. It would be important to have an understanding of journalistic practice but also an understanding of technical delivery.

All the companies believed the value of specialized knowledge increased significantly if complemented with a broader-based understanding of other functional areas. The vice president of products at an enabling technologies company highlighted the link between technology and content in the sector when stating that content and data transmission could not be disregarded during the technical design of an application. He believed that, even from a technologists' point of view, considering the size and scale of content and information delivered to mobile and wireless devices was an important design issue. A strong concern was the need to scale content to the particular parameters of a growing diversity of devices, for example different models of mobile handsets and PDA (personal digital assistant) devices. As this informant put it:

We're still in an environment where we have to be very worried about the size of the data pipe that's going down on a wireline site . . . it's important that we send down the bare minimum of information that we can to a phone, and that we make sure it is readily accessible and it doesn't take the user five minutes to figure out how to use it.

The mobile marketing and content companies had small technical functional areas. They delivered their marketing campaigns and content across SMS. Although technical knowledge was still required, they could function without large technical teams because the technologies and applications associated with SMS were, at this stage of the industry's development, still relatively simple. However, even if their emphasis was on authoring/design knowledge, access to technical knowledge was necessary to function.

In many sub-sectors of the ICT sector, such as mobile media and digital games content production, the technology and content cannot be separated and treated in isolation. The characteristics of the content impact on application design, and the parameters of devices and applications impact on content creation. Underpinning this are the business models and strategies that stabilize the products or services in the market and sustain companies as enterprises. The activities of these companies highlight the value of a well-integrated, multi-disciplinary approach to studies of innovation. They also suggest that a focus on one set of specialized knowledge – either technical, design, or market – is insufficient to succeed in the marketplace (Kerr 2000; Preston 2001; Kerr & Preston 2001).

4.3 *Theoretical knowledge and sources of innovation*

Examining the various studies conducted by the authors over the past ten years there are very few examples of university spin-offs or companies explicitly based on a research project or theoretical knowledge. Where they do exist, they tend to be focused on process innovation and be in the enabling category of companies.

A recent study of a digital media industry cluster of 100 companies in Dublin further reiterates this finding. It found that in terms ‘of cooperative arrangements’, customers and clients are the most favoured partners. Later, the same survey notes that external market sources, including customers and clients, are the strongest source of knowledge for innovation for companies (31 per cent) while a further ‘28 per cent of companies highlighting their own internal organization as the primary source of innovation’ (Digital Hub 2008). Over half of these companies indicated that research was not a priority in the short term. In terms of types of innovation, the focus of this cluster was on product innovation (43 per cent), followed by process innovation (25 per cent), and business model innovation (24 per cent).

These findings are in contrast to studies in other high tech sectors. Faulkner (1994) notes that across all industries about two thirds of the knowledge used in innovation comes from in-house research and development, while another third comes from external sources. Further, she notes that the contribution of government and academic laboratories varies across sectors from 5 per cent to 20 per cent. Nevertheless, in her own research, she found that tacit and specific knowledge (from learning by doing, from other companies) makes a greater contribution than formal knowledge to innovation. She also classified knowledge into five different types including: knowledge related to the natural world, knowledge related to design practice, knowledge related to experimental research and development, knowledge related to the final product, and knowledge related to knowledge.

Interestingly, the development of content in digital media companies has not always been able to take advantage of market and user knowledge. Previous research by the authors and colleagues has found that companies often use

explicit strategies such as testing or surveys but still may not incorporate the findings back into the development process for various contextual, organizational, political, and financial reasons (e.g. Oudshoorn & Rommes 2004; Silverstone & Haddon 1996; Williams *et al.* 2000). In addition, designers may adopt an implicit ‘I-methodology’ strategy and largely incorporate their own needs and desires into an innovation (Kerr 2002; Rommes 2002). While users are increasingly an important source of innovation, broad surveys need to be supplemented by more qualitative studies of innovation processes before we can tell exactly how and in what ways users contribute to innovation. Nevertheless, the increasing use of testers and quality assurance staff, the use of community support and online forums, the development of modding tools and communities, and the development of web 2.0 applications signal that the varieties of ways to engage with users is increasing in the digital media sector.

Finally, an often under examined source of knowledge for innovation is the more horizontal networks of workers in a specific sector, particularly the informal networks. Surveys and interviews clearly point to the felt importance of trade shows, conferences, professional associations, disciplinary bodies and standards bodies in the informal spread of knowledge. The authors’ own studies are also pointing to the importance of informal ties especially those utilizing virtual communities spaces such as bulletin boards, websites, and social networking sites: in sum, these are virtual spaces that flow beyond the boundary of the firm. These are not necessarily tied to geographical proximity but may relate more to cognitive and social proximity, although they may be reinforced by geographical proximity (Asheim & Coenen 2007).

5. Conclusions

The recent surge of research on innovation in services has achieved some progress in understanding the role and forms of knowledge and research functions within certain sub-sectors of services industries. This is most notable in the specific sub-sector known as K-IBS. However, this particular sub-sector is centred on technical knowledge. In effect, it centres on a segment of the services sector that is most akin to the kinds of key knowledge inputs that typically characterize the high-tech manufacturing sectors.

As regards the great majority of services sectors (i.e. other than K-IBS), however, we are still largely confronted by a veritable ‘black box’ when it comes to understanding the crucial knowledge inputs supporting innovation and dynamic industrial change. We have adopted an information economy approach as the optimum means of understanding the ‘creative’ functions within our digital media case studies. One key lesson to emerge from our case studies – with implications for wider studies of services innovation – is the important role played by a heterogenous mix of knowledge(s). This includes

the important role of intangible (tacit, creative, non-technological) knowledge inputs, as well as design and business/market knowledge. These forms of knowledge sit alongside the relative R&D knowledge(s) that are usually central in the innovation studies literature. Our case studies research indicates that four knowledge domains provide the essential mix of knowledge inputs to innovation in the digital media sector:

1. Technical knowledge.
2. The specific new 'soft communication' knowledge forms related to digital media authoring, design, textual/editorial, and production functions, as well as intangible (tacit, creative) knowledge such as experience of, and building reputation through, working on content titles.
3. Sectorally specific business, entrepreneurial, policy, and/or regulatory knowledge.
4. New policy knowledge that addresses the specificities of the media sector and is better attuned to its organizational and industrial culture.

Our case studies emphasize that technical skills, competencies, and expertise are necessary but not sufficient for successful industrial innovation strategies in the digital media sector. We have highlighted the diverse mix of knowledge(s) that are crucial to the innovation process in the sector. Today's media sector is not only facing growth but also multiple and major changes linked to increasingly mobile, ambient, and media-rich products. These technical innovations challenge existing paradigms, models, and concepts that have guided the practices of all knowledge-based media sector actors hitherto. They pose new challenges and opportunities for product and process innovation across the spectrum of new and established media sub-sectors. Again, the relevant challenges are not solely technical. They equally impact on the critical authoring/design, publishing, packaging, and business/market dimensions of the media sectors.

The authors' work, in demonstrating the variety of knowledge(s) inputs that underpin innovation in the digital media sub-sector, underlines the need for a critical re-thinking of what constitutes R&D and innovation-relevant new knowledge clusters in the services sector. This is required if we are to address and fully embrace the dynamics of the innovation process in services.

Here, we are mindful of problems facing any attempt to define a specific theory of innovation in the services sector, not least those arising from the broad constellation of products and companies that constitute the sector. (As we highlighted earlier, it is a challenge in itself to arrive at a tightly defined grouping of companies and activities even within the creative industries; hence our alignment with an information economy approach.) These challenges have been long recognized (e.g. Miles & Gershuny 1983) and the elusiveness of the search for any general model of innovation in services has been succinctly addressed in the more recent literature (e.g. Alic 2001; Metcalfe & Miles 2000; Miles 2000, 2001).

However, there are lessons from innovation in the digital media sector that can have implications for innovation in the wider services sector. We would advance two points in relation to this issue:

1. First, our case studies reveal the importance of distinctive sets of knowledge inputs that are crucial for the innovation process. Such knowledge lies some distance from the disciplinary spectrum that has been the focus of R&D and innovation policy supports up to now. At the very least, this suggests that future research must be attentive to the prospects of identifying other sets of sectorally specific clusters of non-technical knowledge playing crucial roles in the innovation process.
2. Second, some of the specific set of ‘soft communication’ or tacit knowledge inputs revealed in our case studies may play a crucial role in the innovation process in other sectors of the contemporary K&E.

The advent of new digital technology devices and networks has brought about major and multiple new challenges as well as opportunities for researchers engaged with the services sectors and the digital media sub-sector. These recent developments point to the need for cross-disciplinary, but well-integrated, research efforts to address the inter-locking changes in technological, intangible (e.g. tacit, creative, non-technological knowledge) and business/market dimensions of innovation in the services sector. They suggest a multi-dimensional reassessment of the established models and concepts guiding the practices of researchers and practitioners engaged with the field of services innovation.

Note

- 1 Forfás is the Irish government’s policy agency for enterprise, science, technology, and innovation.

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