Getting Creative in Healthcare

The contribution of creative activities to Australian healthcare

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Abstract: The contribution of creative occupations to Australian healthcare was examined using a mix of statistics and case studies. Creative occupations were found to be making significant, growing and widespread contributions to the development and delivery of healthcare goods and services, the initial training and ongoing professionalism of doctors and nurses and the effective functioning of healthcare buildings. Key functions that creative activities addressed were information management and analysis and making complex information comprehensible, assisting communication and reducing psycho-social and distance-mediated barriers, and improving the efficiency and effectiveness of services.

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Executive summary

Creative skills are widely distributed across economies, but their contributions to economic performance and social outcomes and their role in enabling nations and institutions to respond to competitive and other pressures are not well understood.

The British Government pioneered the assessment of industries specialising in the production of creative goods and services.[1] That approach has been extended at the ARC Centre of Excellence for Creative Industries and Innovation (CCI) by including both the specialist industries and the creative occupations embedded in other industries in measurements of creative economic activity. As defined by CCI, the Australian creative capability comprises architecture, design and visual arts; music and the performing arts; film, radio and television; writing and publishing; advertising and marketing; and software.[2]

This project set out to explore aspects of the contribution of creative activities to the Australian healthcare sector, which already accounts for 9.8% of gross domestic product and appears set to increase its share. Already significant, healthcare cost pressures are projected to increase, partly as a result of the demand for more sophisticated treatments but also because of the squeeze on the healthcare system from an ageing population structure that is limiting the supply of medical professionals while boosting the demand for health services.[3] There is also the prospect of higher incidences of unusual diseases as a result of climate change. A number of other issues have been identified, such as the adequacy of the supply of services for remote and Indigenous groups within the population. Health services are very information intensive, so opportunities stemming from information and communication technology are another driver of change in the healthcare system. Responding to these pressures, the Australian healthcare system is being forced to adapt to meet the many and diverse challenges facing it.

This study adopted a two-pronged approach to investigate the contribution of Australia's creative capability in assisting the healthcare system to provide health goods and services and to meet its challenges through innovation and change. First, we examined the census data for creative occupations within the healthcare system. Because the census data reveal only certain parts of the story and in particular because data on creative occupations involved in the external supply of goods and services to the healthcare sector were not available from this source, the second prong comprised interview-based case studies of those occupations and of creative activities within the system. We selected the case studies after taking into account major health expenditure areas, the creative occupations and some key healthcare issues.

An estimated 3,810 people were employed in creative occupations in the healthcare sector in 2006, which is equivalent to about 0.5% of total employment in the sector. This was lower than the average proportion (2%) of creatives in other non-creative industries.[4] However, employment in health creative occupations grew 2.5 times faster than the health sector. We found Software and Advertising and Marketing to be the two largest sectors, comprising about 38% and 25% respectively of the total healthcare creative occupations in 2006, followed by

1 *See, for example http://www.culture.gov.uk/Reference_library/Publications/archive_1998/Creative_Industries_Mapping_Document_1998.htm?contextId={A0AF8413-7A4E-4776-ADEE-7C4DBBFF6913} (accessed 13 March 2008).*
2 *P Higgs, S Cunningham and J Pagan (2007), Australia's creative economy: Definitions of the segments and sectors, http://eprints.qut.edu.au/archive/00008242 (accessed 23 January 2008).*
3 *2002–03 Australian Government Budget.*
4 *Calculated from P Higgs (2007), Australia's Creative Economy Information Sheet: 2006 census update: Growth in the creative workforce https://wiki.cci.edu.au/display/NMP/Topline+Results+from+the+Australian+2006+Census (accessed 23 January 2008).*

Publishing, Printing and Writing (about 18%) and Architecture, Design and Visual Arts (12%). The remaining sectors are much smaller.

Our analysis of the 17 case studies revealed that the healthcare system sources creative expertise in many ways. In addition to embedded and external creative specialists, some medical professionals undertake creative activities as part of their clinical work. Even patients are encouraged to utilise creativity for their own treatment and for assisting the treatments of others.

Creativity is highly integrated into the provision of healthcare goods and services and serves most aspects of the operation of the healthcare system, particularly in information and knowledge management, the supply of medical skills, clinical services and infrastructure. Australia's creative capability has a central role in helping the healthcare system to adapt, to become more efficient while delivering better outcomes and to provide the range of clinical services demanded by the community. The case studies identified many innovations involving multiple creative skills. The innovation processes appeared to be particularly effective when creatives worked closely with key stakeholders (medical professionals, patients or the community).

Information and knowledge management

Creative workers contribute to information and knowledge management in the healthcare system in four main arenas:

- The provision of health and clinical information — good writing skills, as well as technical healthcare knowledge, appear to be important to Australian medical publishing. Having high-quality journals encourages medical professionals to keep up to date in their clinical practices. Web developers, animators and multimedia professionals make complex information more understandable or culturally acceptable for disengaged individuals and groups, with improved health and lifestyle outcomes.
- The management of clinical information — the body of clinical information available is expanding rapidly, so obtaining the 'right' information is important for medical professionals as well as for patients. Librarians and software developers make the identification of appropriate and reliable published information for clinicians more efficient. Initiatives such as the Joanna Briggs Institute[5] provide readily accessible online information about the best evidence on clinical practices, benefiting both medical professionals and patients.
- The collection, management and use of patient data, particularly scans — software is central to the management of the growing body of information collected about patients. As the complexity of this information increases, clinicians need more digital tools to understand diseases and plan treatments.
- Institutional operations — software-based data-mining is being used to increase hospital efficiency and improve outcomes for patients such as altering procedures to reduce hospital-acquired disease.

The supply of medical skills

Virtual reality technologies are being used to educate new doctors and to train medical teams to work together effectively in crises and emergencies. Various software skills are also being used to develop technologies that enable people with non-professional skills to substitute for highly skilled professionals.

5 *www.joannabriggs.edu.au*

Healthcare services

The visual and performing arts, film, video and digital technologies were observed to be routinely used for the delivery of healthcare services. Music and the arts are integrated into the humanist-based medical therapies (such as music therapy) as well as being used in web-based mental health services and in hospital programs for rehabilitation and related activities. These interventions appear to help with some communication aspects, to reduce stress and offer some improvements in the quality of life for some of the most physically, mentally and socially handicapped. Visual and performing arts skills bring additional aspects to health services, including more holistic approaches to dealing with illness and different ideas and processes to innovation. However, employment in the visual and performing arts occupations within the healthcare system is diminishing in relative terms, and those skills may be an underutilised resource. A better evidence base for the effectiveness of Australian interventions using the visual and performing arts may be needed in order to encourage governments (and others) to provide more funding for them.

In contrast, film, video, radio, animation and multimedia appear to be gaining importance in healthcare. They are enabling diagnosis, treatment planning and monitoring, particularly in complex or one-off situations when the medical professional needs to understand interrelationships between several parts of the body and movement in three dimensions. Computer games are being used in diversionary therapy and for experiential learning in mental health therapies. While the most widely projected use of digital technologies is in telemedicine, rapid uptake may require several innovations and the establishment of supporting infrastructure.

Digital content is being used in many aspects of the healthcare system and its services, including online publishing of medical journals and lifestyle education materials and the use of games and entertainment content for diversionary therapies and mental health services. Graphics, visual displays and analysis are used in diagnosis, surgery planning and research, particularly to deal with complexities, multiple changes, multiple interacting components and 3D visualisation. These technologies are significant tools for researchers and clinicians addressing some of the most difficult problems in modern healthcare, particularly those posed by the brain and changes in its functions with disease and ageing.

With increasing technical sophistication and greater ease of use, animation technology is enabling 'non-creatives' to develop digital content. One case study showed how powerfully this capability enables healthcare workers to engage remote Indigenous and other non-mainstream groups and provide health education to them.

Section 1. Background

Policy makers and researchers are paying increased attention to the factors sustaining economic growth and the shift to services and high value added production in more advanced economies against a backdrop of competitive pressures from low cost countries. The rising importance of innovation and intangible assets—accumulated skills, design, brand, knowledge, organisational systems, and so on—is well established. However, cultural and related inputs also appear to be significant, and interest in their economic and social contributions is gaining momentum, particularly in an increasingly digital world.

In 1998, the United Kingdom's Department of Culture, Media and Sport began to map the contribution to the British economy[6] of a group of 13 industries collectively called the 'creative' industries.[7] The group included the cultural industries and software, media and advertising. Some have argued that these industries can be conceived as a group for reasons such as their common business model of originating ideas of expressive value, which they then commercialise.[8] Other authors have based the distinction on the particular form of intellectual property (i.e. copyright) that they commercialise.[9] Attempts have been made to measure variously defined creative industries in several other countries, such as Taiwan, South Korea, Hong Kong, Singapore, Canada and Norway.

CCI has examined the economic contribution of the creative activities, which encompass cultural and culture-related functions and information management services. The Australian creative capability comprises the following sectors:

- Architecture, Design and Visual Arts
- Music and Performing Arts
- Film, Radio and Television
- Writing and Publishing
- Advertising and Marketing
- Software.[10]

Most other studies have examined the specialist creative industries. The CCI studies assess the creative contribution to the economy more comprehensively by basing estimates on the creative workforce, which is defined as comprising the organisations specialising in creative production (the 'creative industries') and employees in specialist creative occupations 'embedded' within organisations producing 'non-creative' goods and services.[11]

This project explores the contribution of the Australian creative workforce to another sector. We selected the healthcare sector because of its particular interest to governments, policymakers and economists, in view of the its high labour content, knowledge intensity and information requirements and its high and rising costs. Australia

6 *See, for example http://www.culture.gov.uk/Reference_library/Publications/archive_1998/Creative_Industries_Mapping_Document_1998.htm?contextId={A0AF8413-7A4E-4776-ADEE-7C4DBBFF6913} (accessed 13 March 2008).*

7 *The definition of creative industries adopted is not consistent between countries and it has also changed in the United Kingdom. Those industries included in the initial British mapping were advertising, antiques, architecture, crafts, design, fashion, film, leisure software, music, performing arts, publishing, software, TV and radio.*

8 *W Hutton, A O'Keeffe, P Schneider, R Andari and H Bakshi (2007), Staying ahead—The economic performance of the UK's creative industries, The Work Foundation and NESTA http://theworkfoundation.com/products/publications/azpublications/creativeindustries.aspx (accessed 1 January 2008).*

9 *S Siwek (2002), Copyright in the US economy: The 2002 report, International Intellectual Property Alliance; Singapore Ministry for Trade and Industry (2003) Economic Contribution of Singapore's Creative Industries.*

10 *P Higgs, S Cunningham, J Pagan (2007), Australia's creative economy: Definitions of the segments and sectors., http://eprints.qut.edu.au/archive/00008242 (accessed 23 January 2008).*

11 *P Higgs, S Cunningham and J Pagan (2007) Australia's creative economy: Basic evidence on size, growth, income and employment, technical report available at http://eprints.qut.edu.au/archive/00008241 (accessed 23 January 2008)*

spends some 9.8%[12] of its gross domestic product on health—a proportion which has been rising steadily over many years. That proportion is projected to continue to increase as health expenditure rises in line with the ageing of Australia's population and the longer survival of increasingly fragile people.[13] Other cost pressures include demands for better access to healthcare, particularly in remote regions, and access to more sophisticated treatments.

The health system faces several supply-side problems, including shortages of medical professionals, particularly doctors in rural areas and specialists in hospitals, and the retirement of medical professionals in the baby boomer generation. Overseas demand for Australian healthcare professionals (doctors and nurses, in particular) may intensify as other countries with similar demographic profiles try to import medical professionals through immigration. Such international competition for trained personnel could further strain Australia's ability to ensure quality healthcare with good geographical coverage.[14] Contingent and contextual factors affecting the healthcare system include human-caused and natural disasters flowing from environmental changes, civil disturbances and the pressures of global population growth.

One particularly important issue is the high level of information intensity in healthcare. To deal with it, the information and communication technology (ICT) sector is developing broadband, software and computing capacity and the use of digitised information to bring significant changes to the healthcare system. The increasing use of ICT creates opportunities for better use of information and innovation to enhance productivity, to improve the effectiveness of healthcare (including through more holistic care for individuals), to deliver new services, and to deliver 'old' services in new ways. Progress has been uneven: there have been some leading-edge activities, but also some significant barriers (for example, computerised system incompatibilities, administrative conservativeness, lack of skills, and privacy concerns).

Such demand, supply and contextual challenges reflect a system under significant pressures for change, but provide opportunities for creative inputs and innovation. Indeed, the use of the visual and performing arts (including music) in healthcare is a longstanding practice, and is traceable to classical Greece. Most people are aware of artwork hung in healthcare institutions and of performances by musicians and actors in nursing homes and similar institutions. The arts often bring a different view to the innovation process and influence the solutions adopted.[15] There are media reports of cultural inputs from Australian film, games and publishing finding new lives in healthcare applications, providing new education tools, diversionary therapy and clinical applications.[16]

Numerous studies have examined the importance of individual creative sectors to healthcare. Examples include the importance of good design to the function, safety and efficiency of pathology laboratories[17], hospitals[18] and other healthcare institutions and the impact of (software) information systems on the quality, efficiency and cost of medical care.[19] Global expenditure by pharmaceutical companies on marketing and advertising[20] and the

12 *2005–06 data from http://www.aihw.gov.au/publications/hwe/hea05-06/hea05-06-c02.pdf (accessed 20 August 2008).*
13 *2002–03 Australian Government Budget.*
14 *The Australian medical workforce (2001), Department of Health and Aged Care.*
15 *Report to PMSEIC (2005), The role of creativity in the innovation economy, available at http://www.dest.gov.au/NR/rdonlyres/B1EF82EF-08D5-427E-B7E4-69D41C61D495/8625/finalPMSEICReport_WEBversion.pdf (accessed 1 July 2008).*
16 *See, for example, AAP General News (Australia), 21 January 2004, Lord of the Rings technology now saving lives.*
17 *For example, D Battisto, Change in clinical labs in hospitals, InformeDesign www.informedesign.umn.edu (accessed 19 September 2007).*
18 *J Schneider (2007), 'The top 3 patient safety concepts influencing hospital design', Building Design and Construction, 48(2):32 .*
19 *B Chaudry, J Wang, S Wu, M Maglione, W Mojica, E Roth, S Morton and P Shekelle (2006), 'Systematic review: Impact of health information technology on quality, efficiency and costs of medical care', Annals of Internal Medicine, 144(10):742.*
20 *For example, expenditure on marketing and advertising was estimated to be US$13.8 billion in 2005. http://www.imediaconnection.com/content/10832.asp (accessed 12 October 2007).*

development of healthcare advertising guidelines and other interventions in many countries point to the impact of these activities.[21]

In this project, we used a mix of statistical analysis, case studies and some literature reports to investigate the creative workforce and how it is assisting innovation and shaping changes to Australian healthcare. As discussed below, this method provides an opportunity to explore the range of creative occupations and activities, how the healthcare sector draws on the various internal and external sources of creative capability (and to what effect), and how digital creative capabilities, in particular, are being used in creative healthcare activities. The case studies also enable us to turn the spotlight back onto the statistical data to examine some of the limitations of the statistical methodology.

21 *D Newby and D Henry (2002), 'Drug advertising: Truths, half-truths and a few statistics', Medical Journal of Australia, 177(6):285.*

Section 2. Methodology

The Australian Bureau of Statistics (ABS) collects information on employment and income in Australian censuses using multi-digit classifications of occupation and industry of employment. Methodology developed at CCI[22] utilises the most detailed ABS classification tags to select data for a defined set of occupations and industries. For example, this method has been used to show that the creative workforce was about 5.2% of the total Australian workforce in 2006.[23]

The data on employment in the specialist creative occupations[24] were extracted from 2001 and 2006 Australian census data using the statistical tags listed in Appendix 1:

- ANZSCO (Australian and New Zealand Standard Classification of Occupations)—six digits, such as 223115 Software Designer and 253300 Designers and Illustrators
- ANZSIC (Australian and New Zealand Standard Industrial Classification)—four digits, such as 8612 Psychiatric Hospitals and 8622 Specialist Medical Services.

2.1 Definition of healthcare

The selection of the appropriate healthcare industry classifications was based on the ABS classification of health services, supplemented by activities consistent with the Organisation for Economic Co-operation and Development's list of healthcare activities that it uses in estimates of expenditure on healthcare[25]:

> *the sum of expenditure on activities that—through application of medical, paramedical, and nursing knowledge and technology—has the goals of:*
>
> *— Promoting health and preventing disease;*
>
> *— Curing illness and reducing premature mortality;*
>
> *— Caring for persons affected by chronic illness or health-related impairments or disability who require nursing care;*
>
> *— Assisting patients to die with dignity;*
>
> *— Providing and administering public health;*
>
> *— Providing and administering health programs, health insurance and other funding arrangements.*

In essence, the healthcare system was defined as comprising hospitals, nursing homes, medical, nursing, dental, pathology, radiology and other imaging technology, chiropractic, ambulance and physiotherapy service providers,

22 *P Higgs and S Cunningham (2007), Australia's creative economy: Mapping methodologies http://eprints.qut.edu.au/archive/00006228 (accessed 23 January 2008).*

23 *P Higgs (2007), Australia's creative economy information sheet 2006 census update: Growth in the creative workforce https://wiki.cci.edu.au/display/NMP/Topline+Results+from+the+Australian+2006+Census (accessed 23 January 2008).*

24 *P Higgs, S Cunningham and J Pagan (2007) Australia's creative economy: Definitions of the segments and sectors http://eprints.qut.edu.au/archive/00008242 (accessed 23 January 2008).*

25 *OECD Health Statistics, accessed 2 October 2007. OECD manual "A System of Health Accounts" (SHA): www.oecd.org/health/sha The definition is used for cross-country comparisons of expenditures on healthcare.*

manufacturers of medical devices, pharmaceutical wholesaling, health insurance organisations and health and community service providers. Centres of research and education were excluded from the quantitative analysis of the healthcare system unless their activities were carried out within healthcare organisations where the research was likely to be integrated with clinical practice.

As with any definition, there are a number of grey areas, and to avoid overestimates we adopted an approach that has a bias towards exclusion. We also excluded services that are unpaid and/or do not have identified health benefits. In particular, we have not included activities targeting 'wellbeing' as their primary objective, as the health impacts of such activities are often uncertain or unsubstantiated. Services for the aged and handicapped were not included unless provided in a nursing institution. While a significant proportion of such care is provided in institutions other than nursing homes and in the community, most of it is of a personal rather than a medical nature. Nursing and other professional medical services that are provided separately to such organisations were included in the dataset.

2.2 Data extraction and classification

Estimates of total healthcare employment were obtained by extracting data with health industry classifications, while the data on embedded creatives were identified by using both the health industry and the creative occupation tags.

The industrial classification was not sufficient to enable us to extract employment information from census data for people in creative occupations in organisations supplying goods and services to the healthcare system—we could obtain information only on the creatives embedded in healthcare. Nor were we able to identify robust alternative sources of industry data covering all required fields and collected within a consistent framework. Furthermore, some of the available data showed that firms providing goods, services or both to the healthcare sector also supplied other industries. We have used the case studies to illustrate some aspects of the external provision of creative goods and services to the healthcare system. Some case studies also explore how creative activities contribute from within the sector.

In the healthcare context, some creative occupations are similar to types of occupations otherwise considered 'non-creative'. We considered these case by case, taking into account the strength of the similarity. For example, the work of the radiography profession has some analogies with the work of medical photographers. However, we excluded radiographers on the basis of their technical professional training and the routine 'push button' nature of their imaging work. We considered medical record keepers not to be analogous to librarians (a creative occupation) due to the nature of the records archived and managed, and the medical record keepers' lesser tendency to be involved in non-standard searches for records.

It should be noted that the employment data will underestimate the contribution of embedded creatives for several reasons, particularly the following:

- Industry and occupational classifications that include other (non-creative or non-healthcare) activities were excluded unless the creative or healthcare activity constituted the main activity within the particular classification.
- The healthcare system has a particular classification and measurement problem: the appropriate placement of people employed in therapeutic occupations who deliver therapy through creative activities (such as

music). They are classified as therapists by the ABS.[26] However, music therapists have both clinical and music training. Their role is creative, as they perform music as part of the therapy and often create music in collaboration their clients. We have included the data on 'artistic therapists' separately.[27]

- People providing paid creative healthcare services as less than 50% of their job are not classified as being in creative occupations[28].
- The number of artistic people (visual artists, musicians, actors and so on) providing services on a volunteer basis may be particularly significant in the healthcare sector. Volunteer artistic performances to nursing homes and hospitals, in particular, are well established. Their continuance indicates that the providers, the institutions and the recipients see at least benefits to wellbeing from them, and perhaps also some health benefits.[29] Few data are available on these volunteers, and they are not included in this study.

2.3 Selection of case studies

We have used the case studies to examine aspects of creative activities relevant to the healthcare sector, taking into account the types of creative activities and features of the healthcare system. Our selections were particularly influenced by the major categories of health expenditure and the impact of key diseases, as indicated below.

Australia's total expenditure on healthcare in 2004–05 was $87.3 billion, of which expenditure on hospitals and high-level residential aged care comprised about 40% of the total, medical services 19% and pharmaceutical benefits 8% (the balance was for other capital and recurrent items). Government is a key player in healthcare (accounting for 68% of the total expenditure in 2004–05), and its pattern of expenditure is a significant guide to the important areas in healthcare (see Table 1).[30]

Table 1: Health and aged care portfolio expenditure, by outcome, 2006–07[31]

	Expenditure ($ billion)	Percentage of total
Access to medical services	11.7	27.3
Acute care	9.3	21.7
Access to pharmaceutical services	6.9	16.2
Aged care and population ageing	6.9	16.1
Private health	3.3	7.8
Primary care	0.9	2.0
Population health	0.7	1.7
NH&MRC (research funding)	0.6	1.4
Health system capacity and quality	0.6	1.3
Indigenous health	0.4	0.9
Hearing services	0.3	0.6

26 *Music therapists are classified as 'Complementary health therapists nec' (252299) in ANZSCO (2006).*
27 *The ABS's classification group ANZSCO 252299 comprises the occupations dance, drama and music therapists and hypnotherapists.*
28 *This type of error is inherent in estimates based on ABS census data as occupations are classified on the basis of the activity occupying most of the working time.*
29 *http://www.lifeenergyfoundation.org/category.php?id=12 (accessed 11 February 2008).*
30 *June 2007, Australian health and ageing system—the concise factbook.*
31 *The table does not include Departmental running expenses*

Biosecurity	0.2	0.5
Rural health	0.1	0.3
Health workforce capacity	0.1	0.3
Mental health	0.1	0.2

Source: *NH&MRC = National Health and Medical Research Council, Calculated from Chart 1 of Australian health and ageing system—The concise factbook, June 2007*

Another significant measure in healthcare is the impact of various diseases and disabilities. Measures of years of healthy life lost ('disability adjusted life years', or DALYs) have been used to quantify health loss from a comprehensive set of diseases, injuries and health risks of public health importance in Australia.[32] Of the total health loss calculated for 2003, over 75% was accounted for by six broad groups of causes: cancer; cardiovascular disease; mental disorders; neurological and sense organ disorders; chronic respiratory diseases; and injuries. The other most significant diseases were diabetes mellitus and musculoskeletal and genitourinary diseases.[33]

Also relevant was the disease pattern over an individual's life. While the main trend was for DALY rates to rise with age, there were small peaks in infancy and early adulthood. Most DALYs in early adulthood were attributed to injuries and mental disorders. Cancer, cardiovascular disease and sense organ disorders became more prominent in older people. Among the Australian states and territories, the greatest DALY burden (normalised for population) was in the Northern Territory; this was attributed to the Territory's higher proportion of Indigenous population, which has a higher incidence of cardiovascular disease, injuries and diabetes mellitus.[34]

Other factors used in case study selection were the centres of medical R&D and innovative clinical work and the various health system problem areas identified in government reports (Indigenous health outcomes, access to health services in rural and remote areas, the supply of medical professionals etc). Activities to prevent disease are the most cost-effective form of healthcare, so we have included some representatives of those activities. Because one of the aims of this project was to look at the nexus between creative activities and digitisation, our selection of case studies emphasised creative content and its role in healthcare. The use of ICT with limited or no cultural aspects, such as for large information systems in hospitals and general practitioner (GP) software, has been examined elsewhere, so this study included only a few such examples.

Potential case studies were identified from media reports and through 'snowballing' techniques, starting with discussions with government officials and healthcare providers. The case studies focused on all the creative occupational sectors, with the exception of the smallest group—Film, TV and Radio. However, film, TV and radio activities were included in some of the case studies demonstrating more than one creative activity, particularly in services based on multimedia production.

A case study was included in the analysis only if there was evidence of direct healthcare impacts from that specific intervention or that type of intervention, or evidence that the intervention led to behavioural changes which

32 *The DALY combines the descriptive epidemiology of each health condition of interest with a multidimensional numerical weighting for the severity of that condition.*

33 *S Begg, T Vos, B Barker, L Stanley and A Lopez (2008), 'The burden of disease and injury in Australia in the new millennium: Measuring health loss from diseases, injuries and risk factors', Medical Journal of Australia, 188(1):36.*

34 *ibid.*

reduced the frequency or duration of healthcare treatments. In addition, some case studies examined the way creative activities were improving the operation of elements of the healthcare system.

We interviewed 18 key people who were responsible for the organisation or organisational unit or who were the main innovators in the activity. They were asked about the roles and contributions of people employed in creative occupations in the organisation or providing services to it, their role in innovation, and the impacts of the creative contributions on the final good, service or activity in healthcare. Several other Australian examples of creative involvement in healthcare were identified and not selected for interview, or were interviewed and some of the information used in the report without a full case study being developed.

The 17 case studies (see Table 2) based on the semistructured interviews were supplemented with further research and discussion and approved by interviewees before they were included in the analysis. More than one interview was included in a case study where that could provide a broad perspective.

People from different types of organisations were interviewed:

- 7 commercial companies/service providers
- 2 not-for-profit service providers
- 6 universities/medical research organisations
- 3 hospitals/medical centres.

Table 2: List of case studies

Main sector	Name of organisation	
Publishing and Composition	Australasian Medical Publishing Company	
Architecture, Design and Visual Arts	Centre for Health Assets Australasia, University of New South Wales	Billard Leece Partnership Pty Ltd
Film, TV and Radio	Gait Analysis Centre, Royal Children's Hospital	MARVIN
Music and Performing Arts	Music Conservatorium, Melbourne University and Golden Stave Centre, University of Western Sydney	
Advertising and Marketing	Cochlear	
Software	Repatriation General Hospital (audit)	Howard Florey Institute (scan analysis)
Software	Centre for Health Informatics (search tool)	Clinical Training and Education Centre, University of Western Australia
Software (visualisation)	True Life Anatomy	Medic Vision
Software (web and web services)	depressioNet	Inspire Foundation
Software (telemedicine)	e-Medicine Centre, Lions Eye Institute	
Multimedia	Underworld	

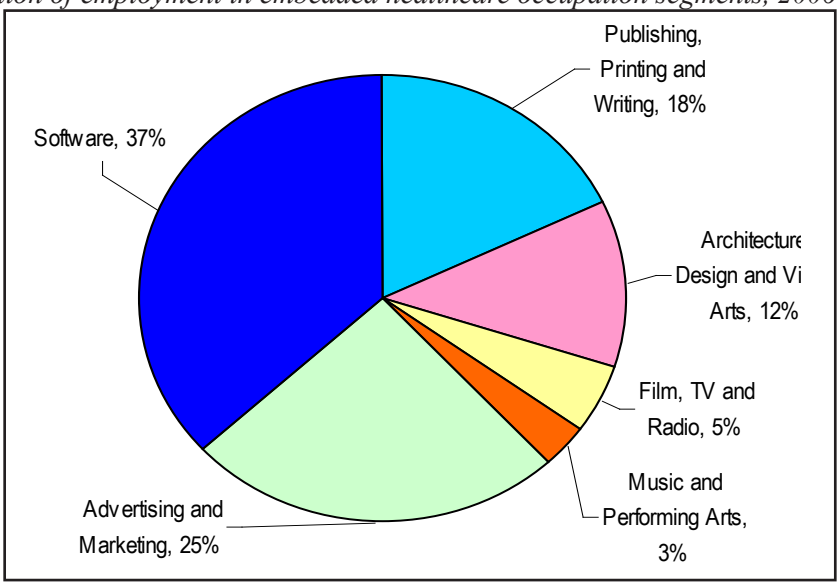
Section 3. Findings

3.1 Main statistical features of creative employment in the healthcare system

We estimate that there were some 2,900 people in creative occupations in healthcare in 2001 and 3,810 in 2006 ('embedded' creatives). They accounted for about 0.5% of total employment in the healthcare sector (2001 and 2006 censuses), lower than the average (2%) for the other non-creative sectors.[35] Figure 1 shows proportions from the main creative segments embedded in healthcare in 2006; the data for both 2001 and 2006 are provided in Table 2.1 in Appendix 2.

Software and Advertising and Marketing are the two largest segments, comprising about 37% and 25%, respectively, of total healthcare creative occupations in 2006, followed by Publishing, Printing and Writing (about 18%) and Architecture, Design and Visual Arts (12%). The remaining sectors are much smaller.

Figure 1: Proportion of employment in embedded healthcare occupation segments, 2006

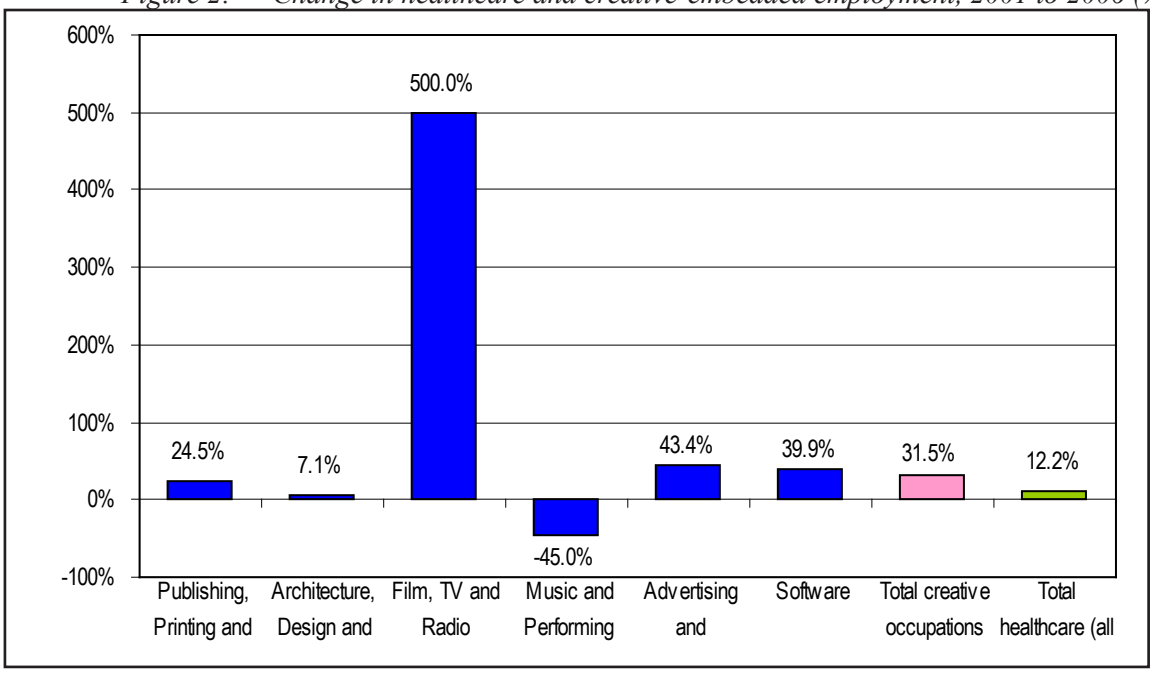


In addition, 477 artistic therapists were employed across the economy in 2006, of whom around 290 were in positions identifiable as being in the healthcare system. Some 19% of the healthcare artistic therapists were employed in hospitals, and the balance provided their services externally to the healthcare sector. Being classified as healthcare therapists, these people were not included in the statistical analysis of creative occupations, although they were included in case study examples.

Employment in the healthcare-embedded creative occupations grew slightly more than 2.5 times faster than total employment in the healthcare sector (see Figure 2). Growth was fastest in the Publishing, Writing and Printing; Film, TV and Radio; and Advertising and Marketing segments. The rapid rise of the number of people in Film, TV and Radio occupations was primarily due to greater employment of media producers in hospitals and in health and community service providers. The contrasting sharp decline in employment in Music and Performing Arts occupations was due mainly to a reduction in the employment of the Performing Arts subgroup over the five-year period.

35 *Calculated from P Higgs (2007), Australia's creative economy information sheet 2006 census update: Growth in the creative workforce.*

Figure 2: Change in healthcare and creative-embedded employment, 2001 to 2006 (%)



3.2 Creative employment in main components of the healthcare system

This section presents the key features of embedded creative employment in healthcare. More detailed information is in Appendix 2.

The healthcare system can be subdivided conceptually into three major groupings:

- hospitals and nursing homes (the 'institutions')
- manufacturers of medical and surgical equipment and pharmaceuticals ('manufacturers')
- health services and insurance service providers ('healthcare services').

This division also reflects the high-level categories of expenditure identified in government statistics.[36]

Institutional employment accounted for 48.8% of total employment in the healthcare system and almost all the growth (97.8%) in total healthcare employment between 2001 and 2006. Some 25% of all embedded healthcare creatives were employed in the institutions. Institutional creative employment grew almost 60% over the five years, at least twice as fast as growth in the total institutional workforce, driven primarily by the increase in employment in the Software segment.

The manufacturers employed only about 5.5% of the workers in the healthcare system but accounted for some 20% of total creative healthcare employment. The high concentration of creatives was due to two occupational segments—Advertising and Marketing and Software. The Advertising and Marketing segment constituted about one-third of total creative employment in the healthcare system, consistent with the strong commercial focus of the manufacturers group.

36 *See, for example, Australian health and ageing system—The concise factbook.*

Total employment in the healthcare services group was about the same in 2001 and 2006. In contrast, the number of people in creative occupations in health services increased over the period, albeit more slowly than in the other two groups. In 2006, the services group accounted for 46% of total employment in healthcare and 38% of creative healthcare workers.

3.3 Creative occupations and the healthcare system

This section examines each of the six major creative occupational segments in turn, using statistical data, the literature and case studies to develop some perspectives on the nature of contributions from the creative occupations. The focus is on embedded creatives, although in some areas industry data enabled us to include some indicative information on creative services provided from outside the healthcare system. The case studies span both internal and external creative services. Appendix 2 includes data tables for employment within each major creative healthcare segment; Appendix 3 contains more detailed information on the occupations comprising the segments.

3.3.1 Publishing, Printing and Writing

We estimate that 669 people were employed in the Publishing, Printing and Writing occupational segment within the healthcare sector in 2006.

Some 68% of them were librarians, most of whom (76%) were employed in the institutions. Their roles involved the conservation and distribution of publications to patients and to support medical professionals. Librarians may be particularly important in supporting medical professionals and their clinical decision-making.[37] The use of information sourced from hospital libraries has been shown to have impacts on general patient care, diagnosis and choice of drugs; it also reduces the length of patient stays in hospital.[38]

While medical records administrators have not been included in the creatives category, their duties can resemble those of librarians, particularly in the functions of storage and retrieval of information (although the information is of a different nature). However, with the move towards electronic medical record-keeping, the records management roles of librarians and medical records administrators are beginning to have parallels and skills in common with the role of information officers, especially software systems and database administration occupations.[39]

Only 40 embedded editors were identified from the 2006 census data, indicating that much healthcare writing, publishing and associated work is done outside the healthcare sector. Specialised healthcare publishing businesses make up a small proportion of the Australian publishing and printing industry, and statistical data on that subgroup of the industry are not available. Local printers and publishers focus mainly on the production of:

- explanatory medical material for patients
- newsletters and advice on specific topics for medical service providers
- Australian or Australian – New Zealand medical journals for doctors, nurses, researchers and other groups of healthcare providers.

37 *See, for example, J Marshall (1992), 'The impact of the hospital library on clinical decision making: The Rochester Study', Bulletin of the Medical Library Association, 80(2):169–178.*

38 *A Weightman and J Williamson (2005), 'The value and impact of information provided through library services for patient care: A systematic review', Health and Information Libraries Journal, 22(1):4–25*

39 *See www.myfutures.edu.au for a description of the functions of these occupations and relevant qualifications.*

Major overseas publishing houses provide most of the medical, dental and allied health journals and textbooks used in healthcare services and research by medical professionals, while a variety of professional journals are produced in Australia, generally by the professional associations. The case study[40] on the Australasian Medical Publishing Company (AMPCo; see Case Study 1) illustrates the commercial publishing of scholarly health and medical journals and books in Australia in those limited areas where there is a 'mass' market, in this case for GPs, clinicians and medical researchers and teachers. AMPCo produces the Medical Journal of Australia, which had a hardcopy circulation of more than 27,000 in 2007[41] and a larger online readership.

There is increasing pressure on medical professionals to ensure that their clinical practices are based on good quality research ('evidence-based' treatment) and that they engage in lifelong learning.[42] Research publications on the outcomes of clinical treatment have an obvious place in this context, and evidence of the usefulness of professional medical journals to healthcare comes mainly from continued demand for them. For example, the British Medical Journal and the Annals of the Royal College of Surgeons of England were identified in a survey of British surgeons as having relatively high readership across all medical subspecialties.[43] A survey of British nurses estimated that nearly three-quarters of the respondent nurses read professional journals on a monthly basis, finding them useful for keeping up to date professionally.[44]

The AMPCo example illustrates the way the creative occupations in the company (in particular, the writers) are contributing to the quality of the published material. This is important for the professional acknowledgment of the quality of the journal, which in turn increases the likelihood that it will be read for professional purposes. Because of the status of the journal and public interest in health matters, some of the medical findings announced in it are also publicised by other media.

Extract from Case Study 1: The Australasian Medical Publishing Company (AMPCo)

AMPCo is contracted to produce the Medical Journal of Australia (MJA) as a 'flagship voice for the profession' for the Australian Medical Association (AMA), which represents general practitioners, specialists, researchers and teachers of medicine. AMPCo also publishes a number of related books and provides publishing services that build on the intellectual property in MJA articles and the company's production skills. AMPCo publishes the MJA online and in print.

Employees identified in the creative occupations within AMPCo were in writing, printing and publishing, and advertising and marketing. The company's editorial staff of creatives have a mix of medical and scientific university qualifications. They also need to have good writing skills, as they are intimately involved in the iterative quality assurance process for the production of the journal through writing articles, rewriting submitted material and providing editorial and some technical advice. There are additional contributions to quality assurance from external sources—peer review of individual articles by medical professionals and content review by a committee of technical experts.

The marketing and production of the MJA are linked in a positive and mutually reinforcing strategy that builds on the high esteem for the journal within the medical profession, its high profile in the broader community and the high quality of the output. The kudos attached to working for the company producing the MJA is one reason AMPCo can retain the editorial staff who contribute to the high quality of its productions.

40 *A more complete write-up of most case studies will be available from the CCI wiki at < https://wiki.cci.edu.au/display/CreativeHealthcare/Home>*

41 *http://www.mja.com.au/classifieds/images/Downloads/MJA%201026.pdf (accessed 11 July 2008).*

42 *See, for example, J Glanville, M Haines and I Auston (1998), 'Finding information on clinical effectiveness, British Medical Journal, 317(7152):200–203.*

43 *T Jones, S Hanney and M Buxton (2006), 'The journals of importance to UK clinicians: A questionnaire survey of surgeons, BMC Medical Informatics and Decision Making, 6:24.*

44 *P Haig (1993), 'Nursing journals: Are nurses using them?', Nursing Standard, 8(1):22–5.*

The main consumer resources for healthcare information are the internet, pamphlets and health magazines produced by a mix of non-commercial organisations (particularly governments and research organisations) and businesses. Patients are increasingly turning to the internet to source health information. The functional boundaries for the writing and publishing occupations for this electronic resource may overlap with software occupations and particularly with developers of digital content. A quirky example of such digital content is the online comic Battle for the Bronchs[45], which was developed by TEQUILA\ Digital for pharmaceutical company GlaxoSmithKline Australia to appeal to young asthmatics. The aim is to encourage 'young avoiders' to proactively seek out more information on how to control their condition.[46]

3.3.2 Architecture, Design and Visual Arts

The estimated 467 embedded specialist creatives in the healthcare sector in 2006 included only 54 architects and interior designers. While Australian capital expenditure on new healthcare buildings, additions and refurbishments was estimated to be some $2.4 billion in 2002–03[47], most of the architectural services were provided by external suppliers. Calculations based on self-listings of areas of expertise of Australian architectural firms on the website of the Australian Institute of Architects[48] indicate that there are around 200 Australian architectural firms working in the health and aged care field (about 15% of all the architectural firms listed). A survey conducted jointly by the institute and the Centre for Health Assets Australasia drew responses from 36 Australian and 5 New Zealand architects and healthcare facility designers[49], gives a lower bound for the numbers of firms active in the healthcare field, and provides an indication of the nature of this group of firms. In the main, healthcare facility design was a key business strategy for this group. The most frequent projects were aged care facilities, general hospitals, medical centres and day care facilities, in that order. Most of the firms were less than 10 years old, with a median staff size of 11–25 employees.

Healthcare facilities, particularly hospitals are major capital items and complex organisations delivering a variety of services with increasing technology inputs.[50] Further, they are often surrounded by politically sensitive issues including community pressure to maintain the presence of outmoded or outdated facilities despite budget constraints or being superseded by new modes of care delivery, eg in the home or community. Despite significant cost pressures, the quality of the buildings is important, so governments and other facility providers need to balance potential savings in construction costs against long-term impacts on the facility's operational costs.[51] While the economic impact of good design is unknown, it quickly becomes apparent if poor design leads to inefficient functioning, and the impacts are felt for many years. There is considerable evidence that good design of a hospital's physical environment produces better clinical outcomes, improves patient safety and reduces stress for patients and staff.[52] Good design is also important to the functioning, safety and efficiency of pathology laboratories.[53]

45 *http://www.battleforthebronchs.com.au (accessed 24 August 2008).*
46 *http://www.wtbwa.com.au/index.php/archive/2007/11/23/battle-for-the-bronchs/ (accessed 8 July 2008)*
47 *Estimated from Health expenditure in Australia 2002–03, Australian Institute of Health and Welfare and Access Economics (2005), Private hospitals capital expenditure.*
48 *http://www.architecture.com.au/i-cms?page=3939 using the search terms medical/health/aged care, project management and institution.*
49 *J Carthey, V Chandra and R Colanzi (2006), Report into healthcare designers 2006, Australian Institute of Architects.*
50 *See, for example, S Chand (2002), 'Architecture and the hospital', Architecture Australia, July/August.*
51 *R Ulrich (2006), 'Evidence-based health-care architecture', Lancet, 368:S38–39.*
52 *R Ulrich (2006), 'Evidence-based health-care architecture', Lancet 368:S38–39; A Devlein and A Arneil (2003), 'Healthcare environments and patient outcomes', Environment and Behaviour, 35(2):665–694; N Daykin, E Byrne, T Sotorieu and S O'Connor (2008), 'The impact of art, design and environment in mental health care: A systematic review of the literature', Journal of the Royal Society for the Promotion of Health, 128(2):85–94.*
53 *For example, D Battisto, 'Change in clinical labs in hospitals'.*

However, design is particularly complex in healthcare, and both functional and humanistic values are important. In a health project, the architectural firm works with a user group to develop a scheme from the bones of the architectural brief. The architects need to understand how the users plan to use the building or hospital department and the flow of people, patients, family members, medical staff, supplies and physical requirements to fit the medical work. Overlaying this functional aspect are considerations of light, amenity, views and so on—all the other things that are part of the health system and ensure the wellbeing of patients and hospital staff (see Case Study 2).

Extract from Case Study 2: Billard Leece

Billard Leece Partnership (BLP) is a Melbourne architectural firm employing some 65 people, of whom about half work exclusively in health. The health team, which comprises architects and two health planners, works closely with an interior designer firm. The company uses software tools extensively to draw all the work in three dimensions, and the 3D models are particularly useful for examining views. Software links the work to a database that includes the design brief and the guidelines for health facilities.[1] The architects and interior designers are alerted immediately if their design does not conform to the design brief's space requirements for the rooms.

BLP is part of a consortium designing the new $950 million Royal Children's Hospital (Victoria). There are few occasions when entirely new major hospitals are built, and BLP considers that the way it married functional and humanistic considerations in its proposal was important in winning it the contract. For example, a key feature of the proposal is a two-storey circular coral aquarium with a staircase winding up from its base in the emergency department (ED) to the main hospital entrance. Children waiting to be seen and their accompanying siblings and parents will be able to look at the fish and coral, and the children can climb the staircase. There are several small ED waiting cubicles around the aquarium, so children can be moved quickly to the assessment stage while still being able to view the fish as a distraction and orientation device. People coming through the front entrance instead of the emergency entrance can use the staircase to access the ED.

The hospital is in Royal Park, very close to the zoo, and BLP is working with the zoo to use the juxtaposition to further de-institutionalise aspects of the hospital and make it a fun place rather than an awful one for children. Visits from the zoo's elephants and a butterfly enclosure at the hospital are under discussion.

BLP tries to take the lessons and innovations from its participation in one project and examine possible new applications. For example, the experience of small internal waiting rooms in the ED of the Royal Children's Hospital is being discussed in a new project for the ED expansion planned by the Princess Alexandria Hospital in Queensland.

In the remaining occupations in the embedded Architecture, Design and Visual Arts segment, there were an estimated 167 graphic designers, 84 photographers and 111 visual artists. The graphic designers and illustrators develop and prepare health information and pictures for publication and reproduction, with particular emphasis on tailoring the message for the intended audience.[54],[55]

Individuals employed in photographic occupations within healthcare are engaged in a variety of activities that could be included in other creative occupation groups. For example, the activities of some embedded photographers are directed towards the production of pamphlets (Publishing) and educational TV production[56] (Film, Radio and TV), and may have more characteristics in common with those groups. In addition, some photographers provide medical photographic services from within healthcare for diagnostic, medical management and patient educational purposes.[57] The classification system does not support an appropriate subdivision of these occupations.

54 *ANZSCO (2006).*

55 *See, for example, the list of publishing-related services offered by the graphic design section of the Educational Resource Centre of the Royal Children's Hospital, Victoria http://www.rch.org.au/erc/design/index.cfm?doc_id=22 (accessed 24 April 2008).*

56 *See, for example, the photographers employed in the production of an educational TV program, Going nuts with Macadamia, at the Royal Children's Hospital, Victoria http://www.rch.org.au/erc/gnwm/index.cfm?doc_id=24 (accessed 24 August 2008).*

57 *See, for example, G Reid and A Leong (2001), 'Operative photography in gynaecological surgery', Medical Journal of Australia, 174:285–287.*

Hanging art in hospitals has been traced back to the 14th century.[58] Since most of the artworks are purchased and are not specifically produced for the healthcare market, the provision of such art services is not examined here. Art therapy, however, is relatively recent, having been used in mental health treatments only since the 1950s. A number of small programs in Australia involve the use of art therapy; examples include a regional writing/visual arts program run by Arts Access for adults with mental health problems, university courses in art therapy[59] for the treatment of mental disorders, and in-hospital art therapy programs.[60]

The involvement of art and literature in the production of goods and services is receiving more scrutiny[61], particularly because of a desire to strengthen the evidence base for the impacts of visual and performing arts activities. Quantitative measurement is inherently more difficult than qualitative assessment, and more so in relation to healthcare. The difficulty arises because of such factors as the long times before outcomes are apparent, the often diffuse or indirect benefits[62], a lack of randomised controls, and inadequate sample sizes.[63],[64],[65] Nevertheless, such work has highlighted the extensive involvement of the visual and performing arts in modern healthcare and the existence of health benefits.

3.3.3 Film, Radio and TV

The Film, Radio and TV segment embedded in healthcare is relatively small (see Figure 1), consistent with previous mapping of these creative occupations showing that their employment was more narrowly confined to the specialist creative industry sector than the employment of any of the other creative occupational groups. In 2001, for example, the Film, TV and Radio occupations embedded in non-creative industries accounted for only 12% of total employment for those occupations.[66],[67]

Hospitals and nursing homes use general TV and radio services for entertainment, but apart from the occasional health program that use does not constitute the provision of healthcare services. However, we identified some in-house production of radio and TV programs for hospitals[68], as well as the provision of health programs produced externally, including through volunteer services.[69] Such productions have an entertainment function as well as providing information about the hospital and healthcare procedures. We identified no specific evaluations of impacts from these functions, but we considered their information role sufficient to include them in the study.

In addition, several of the case studies revealed some of the ways the healthcare sector uses film and film-related activities (such as animation) directly in healthcare services, and that those activities may be undertaken by people

58 *R Staricoff (2006), 'Arts in health: The value of evaluation', Journal of the Royal Society for the Promotion of Health, 126(3):116–121.*
59 *http://www.uq.edu.au/study/program_list.html?action=view_all&acad_prog=5151&year=2008 (accessed 23 March 2008).*
60 *See, for example, the Youth Arts Program at Westmead Children's Hospital.*
61 *See, for example, Francois Matarasso (1997), Use or ornament? The social impact of participation in the arts, Comedia; Janet Ruiz (2004), A literature review of the evidence base for culture, the arts and sport policy, Scottish Executive Education Department.*
62 *Jermyn H The Arts and Social Exclusion, a review prepared for the Arts Council of England 2001*
63 *R Ruddy and D Milnes (2005), Art therapy for schizophrenia-like illnesses, The Cochrane Library, Oxford.*
64 *R Staricoff (2006), 'Arts in health: The value of evaluation', Journal of the Royal Society for the Promotion of Health, 126(3):116–121.*
65 *J Ruiz (2004), A literature review of the evidence base for culture, the arts and sport policy, Scottish Executive Education Department.*
66 *P Higgs, S Cunningham and J Pagan (2007), Australia's creative economy: Basic evidence on size, growth, income and employment. http://eprints.qut.edu.au/archive/00008241 (accessed 23 January 2008)*
67 *The employment of all the other occupational groups employed in non-creative industries exceeded 42% in 2001.*
68 *http://www.rch.org.au/erc/gnwm/index.cfm?doc_id=24 (accessed 26 August 2008).*
69 *http://www.crescentsofbrisbane.org/Files/What%20is%20Radio%20Lollipop%2016%20August%202006.pdf (accessed 26 August 2008).*

who are not in creative occupations. For example, since the late 1970s medical professionals have often used video techniques to examine walking movements in order to manage medical conditions that significantly impair mobility. A case study (see Case Study 3) illustrates both the regular use of filming techniques for medical treatments and the interplay and synergies between healthcare and the film industry. It provides an example of positive reinforcements in innovation, in which the transfer of the creative technology between sectors sparked improvements and new applications, which were subsequently transferred back and adapted for additional applications. The innovations were developed by people in both creative and non-creative occupations.

Extract from Case Study 3: The use of filming technology for gait analysis

The commonest form of physical disability in Australian children is cerebral palsy arising from brain damage at or around the time of birth. In this condition, too much electrical activity goes to the muscles, resulting in spasmodic and unpredictable movements, muscles not growing properly and bones not aligning as in normal growth patterns. Treatment of the more severe cases usually involves the use of muscle relaxants (such as botulinum toxin), surgery to enhance movements by lengthening muscles and realigning bones[2], or both.

Specialised hospital centres in Australia, such as the Gait Centre at the Royal Children's Hospital (Victoria), use gait analysis to plan appropriate interventions to improve gross motor function and to alleviate posture and other distortions resulting from abnormal muscle movements, which are different in each child. In the clinical gait analysis laboratory of the Royal Children's Hospital, doctors use a small number of specialised video cameras, force plates, muscle activity sensors and computers to record how people walk. The information can either be used to support clinical decision-making or for research to evaluate the effectiveness of gait rehabilitation. A full gait analysis is done for about 250 children a year at the hospital, and a shorter video gait analysis is done for 500 more.

The technology is also used to help identify the appropriate treatment for children with spina bifida and some other conditions, including head injuries, bone dysplasias and spinal cord tumours. In addition to the work with children, some medical professionals at the Gait Centre are working with the gait analysis technology to investigate adults' responsiveness to various treatments for osteoarthritis and Parkinsons disease and rehabilitation after stroke. Other work using 3D motion analysis from appropriate placement of the cameras is investigating the cause of frontal gait apraxia (which affects about 20% of elderly people) and the potential for better diagnosis of motor dysfunction aspects of pervasive development dysfunction disorders in children with autism and Aspergers syndrome. The technology is also being used to investigate the success (or failure) of knee replacement surgery for people severely affected by osteoarthritis.[3]

Around the early 1990s, animators started to adopt and adapt gait analysis technology, using the information about how real people move to generate images of people moving for the film, video and computer games industries. This stimulated demand for the equipment, and several manufacturers invested in significant technological development, including conversion to digital technology. More cameras were used, with each camera recording in 2D and the digital information from all the cameras combined to provide 3D images showing how the individual walks from front, back, sides and above. The quantum leap in improvements in the quality of the technology and substantial reductions in camera prices have resulted in better data capture and analysis in the medical applications.

There are differences in the requirements of the technology in the hospital and film industry settings. In medical applications, accurate information providing a good representation of how the patient is really moving is the prime requirement, rather than speed. The movie industry has the opposite requirement—timeliness and looking good on the screen are paramount. Because of these different requirements, some equipment providers now sell slightly different products in the two markets.

The adaptations made in the movie industry have fed back into medicine. 'Classical' gait analysis follows how the bones and the big joints move, and that technology was the basis for the animated figure of Gollum in The Lord of the Rings. Happy Feet was filmed with a slightly improved technology that enabled visualisation in real time. The movie industry put some 200 markers on the face to better pick up facial features and movements, and that modification has been used to assist in the preparation of immobilisation masks used in the treatment of facial and other cancers in sensitive areas.[4] There is also some interest in the possible use of this modification for speech therapy applications.

With the increasing sophistication of information technology tools in the video and filming context, the possibility of animation is being opened up to less sophisticated technology users and wider applications in healthcare. As some of the case studies showed, animation is an effective way to develop culturally and contextually appropriate

healthcare information and education with the objective of reducing harmful behaviours and the spread of disease. One animation that is considered to be particularly effective was developed to help deliver healthcare messages to Indigenous Australians in the Northern Territory (see Case Study 4).

Significant evidence has accumulated that healthcare approaches for chronic conditions are most effective when they prioritise the health of a defined population, rather than individual patients seeking care.[70] The Northern Territory Government's 10-year strategy adopted a three-pronged whole-of-life approach to address chronic diseases — prevention, early detection to avoid complications, and best practice management. A key focus of the early interventions was on appropriate health education for all Territorians, but particularly for high-risk populations.[71]

The idea behind the innovation described in Case Study 4 came from a government official undertaking some tertiary multimedia studies. It was further developed under his direction, but with assistance from software developers and animators, other bureaucrats (who provided healthcare and education information) and Indigenous communities (who used the software to create avatars that spoke local languages).

Extract from Case Study 4: MARVIN

The Australian Indigenous population has a higher disease burden and shorter life expectancy than the rest of the population. There is a strong correlation between disease burden and known risk factors—tobacco, alcohol, illicit drugs, high body mass, inadequate physical activity, low intake of fruit and vegetables, high blood pressure, high cholesterol, unsafe sex, child sex abuse and intimate-partner violence and diseases.[5] The issue is most acute in the Northern Territory, where 29% of the population is classified as Indigenous. Many Indigenous Territorians live in remote areas, where the disease and injury burden is highest.[6]

The use of a high-technology tool, MARVIN, to engage Indigenous and other communities in health education messages had its genesis in the experiences of NT Government officials who were attempting to train and develop competencies in Indigenous workers involved in youth work, counselling, healthcare or teaching so that they would be able to identify people at risk from drug and alcohol abuse. Officials observed that training became less comprehensive with increasing remoteness, although remote communities were the ones most needing the training. An informal survey of the communities suggested that they wanted the content of the training material to be fun, engaging and more relevant to their context. They also wanted to have ownership of the material.

After some initial joint business–government development work on avatars delivering health education messages, a company, Inchain, was created and the software platform known as MARVIN ('Messaging Architecture for the Retrieval of Versatile Information and News') was developed. MARVIN provides an interface so that people with minimal experience in animation software packages can build an avatar with personality and attitude. It also enables communities to type in or record information to be spoken by the animated characters and to select backdrop scenery, enabling them to create a community-relevant, entertaining animation that speaks their language. The results are compelling—communities 'own' the health education material their members have helped to prepare.

The development of MARVIN generally involved a team of about six at any one time over two years. The team included software developers, animators, advisers from various backgrounds, trainers who reported on the impacts of the use of the technology in the communities, and NT Children's Services officers who advised on what would be required for people who didn't have literacy or language skills. The clients assisted in the development of appropriate avatars.

To date, Inchain has developed some 200 healthcare characters for governments, companies and healthcare organisations, including Baxter Pharmaceutical, the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs, AusAID and the Cancer Council. In September 2007, a memorandum of understanding was signed with Microsoft Partners in Learning to take MARVIN global. Some 25 million students and teachers in 14 countries have access to MARVIN, and extension to more countries is planned in 2008.

70 *WHO (2002), Innovative care for chronic conditions: Building blocks for action.*

71 *Menzies School of Health Research (2005), Educating to improve chronic health outcomes http://www.nt.gov.au/health/cdc/preventable/ed_improve_health_outcomes_cd.pdf (accessed 8 March 2008).*

3.3.4 Music and Performing Arts

With only 115 musicians and performing artists embedded in healthcare in 2006, this creative segment is the smallest in the sector.

We identified 43 musicians within the segment, although that number underestimates the contribution to healthcare from music activities in the work of music therapists.[72] More than 200 music therapists are registered with the Australian Music Therapy Association, and most of them indicate a specialisation or an interest in healthcare.[73] Music therapy is a form of evidence-based therapy that uses music as a tool for communication, change, transformation, and healing or wellbeing.[74] While it has ancient origins, it was formally adopted into modern healing practices (particularly in the United States and the United Kingdom) when it was noted that World War II soldiers benefited from music. Music therapy is now used with children, adolescents, adults and elderly people with mental health needs, developmental and learning disabilities, Alzheimers disease and other ageing-related conditions, substance abuse problems, brain injuries, physical disabilities, and acute and chronic pain, including for mothers in labour.[75] Music therapy is a highly skilled profession requiring a strong music background, and therapy training is almost wholly at the postgraduate level in Australian institutions.

Evidence supporting the effectiveness of music therapy in healthcare is mixed, due to problems with experimental design and measurement, such as small trials that preclude the use of randomised controls and produce insufficient data to determine the significance of the intervention. Some meta-analyses of the effectiveness of music therapy have been executed on data in the Cochrane database. Those reviews[76] indicate some positive effects for autistic spectrum disorder[77], pain relief[78], schizophrenia and schizophrenia-like illnesses[79], and psychopathologies in young people[80] but are inconclusive about its use for people with dementia.[81]

Technological changes are having some impact on the profession, particularly by allowing a greater emphasis on composition rather than improvisation. For example, patients can be encouraged to compose music using software programs that enable them to do it electronically. Research at the Golden Stave Foundation and the University of Sydney is investigating the use of silent 'soundbeams'[82] for clients with very high needs and restricted movements (such as clients with severe cerebral palsy) to enhance their emotional expression through sound.

The contributions of the 72 performing arts professionals identified in the healthcare system in 2006 may be bolstered by the activities of volunteers or by services provided without charge to the healthcare system. For example, the Humour Foundation employs 'clown doctors' on contract, but their services are provided free of charge to the healthcare system. The CTEC case study on scenario-based medical training (see Case Study 6) identified the

72 *Volunteers may also provide music services with possible health impacts. Being unpaid and having limited or no clinical training, they are not considered in this study.*
73 *Register of music therapists, Australian Music Therapy Association website http://www.austmta.org.au/. (accessed 6 January 2008).*
74 *From http://www.nordoff-robbins.com.au/Contents.asp?ID=4 (accessed 4 January 2008).*
75 *http://www.musictherapy.org/faqs.html#WHAT_IS_MUSIC_THERAPY (accessed 6 January 2008).*
76 *http://www.cochrane.org/reviews/en/index_list_m_reviews.html (accessed 7 January 2008).*
77 *Cochrane review—C Gold, T Wigram, C Elefant, Music therapy for autistic spectrum disorder.*
78 *Cochrane review—MS Cepeda, DB Carr, J Lau, H Alvarez, Music for pain relief.*
79 *Cochrane review—C Gold, TO Heldal, T Dahle, T Wigram, Music therapy for schizophrenia or schizophrenia-like illnesses.*
80 *C Gold, M Voracek and T Wigram (2004), 'Effects of music therapy for children and adolescents with psychopathology: A meta-analysis', Journal of Clinical Psychology and Psychiatry, 45:1054.*
81 *Cochrane review—AC Vink, JS Birks, MS Bruinsma, RJPM Scholten, Music therapy for people with dementia.*
82 *With this technology, the often random movements of hands, feet or head break an ultrasonic beam and are translated back into a synthesizer or keyboard, preprogrammed with scales. Thus, the person can create sound and, with some tuition, a form of music.*

involvement of medical instructors in performing arts activities, indicating that there may be additional performing arts functions in the healthcare system.

3.3.5 Advertising and Marketing

A notable feature of the distribution of Advertising and Marketing occupations over the healthcare system was their concentration in manufacturing, the most commercially oriented component of the system. Manufacturing accounted for 55% of total employment in the creative Advertising and Marketing occupations but only 5.5% of total healthcare employment. The desire to establish a high moral ground may be behind the public benefit work that the advertising and marketing divisions of some healthcare companies do by providing accurate healthcare, disease and disease management information of a general nature on websites.[83],[84]

The case studies revealed what may be another feature of the way healthcare organisations do business to achieve advertising and marketing results: the use of a variety of strategies that leverage the complex interrelationships within the healthcare sector and the varieties of markets that the particular organisation is dealing with. The most striking example we found was Cochlear, which dominates the manufacture of cochlear implants for the profoundly deaf. In this case, some of the company's marketing activities were undertaken through an advocate program: people who had already received an implant agreed to speak with people who were considering whether to have one done and may have been nervous about it.

3.3.6 Software

Information management is fundamental to healthcare, so governments, consumers and health providers generally consider that health information technologies are critical to transforming the healthcare system. The limited data available relating to the software industry suggest that the healthcare sector is a specialised market: only 5% (34 firms in 2004) of Australia's software firms focus on healthcare, supplemented by other firms that mainly supply other markets.[85]

The occupational data from the 2006 census indicated that there were some 1,400 software professionals employed within the healthcare sector. Using a different classification system[86] and extending the types of software occupations, we estimated that 1,660 people were employed in healthcare software occupations. Of them, 550 were IT managers or chief information officers who had not been included in the ABS definition because they were considered to be managers rather than producers. There were 123 in multimedia occupations, and 13 were web developers. Appendix 3 gives more information on employment in the software occupations.

Total spending on ICT in healthcare has been estimated to be about 3% of total Australian healthcare costs, or about $1–2 billion annually.[87] The small size of the software employment pool within the healthcare system and

83 *http://www.pfizer.com.au/Facts/QualityUse.aspx (accessed 26 August 2008).*

84 *http://www.msd-australia.com.au/page.asp?e_page=432922&3570=432933&section=432926&article=432933 (accessed 26 August 2008).*

85 *The Australian software industry and vertical applications markets: Globally competitive, domestically undervalued (2006), Centre for Innovative Industry Economic Research Consortium.*

86 *The ABS introduced a new classification system for occupations (ANZSCO) in 2006, while also providing the data under the previous classification system. The analysis in this report mostly uses the older classification so that growth rates can be calculated for employment. However, there is generally little difference between the classifications for creative occupations, except for software, where the newer classification provides more detail.*

87 *Impacts of advances in medical technology in Australia (2005), Productivity Commission research report, Australian Government.*

the size of the ICT expenditure demonstrates that software services are provided from both internal and external sources.

It has been suggested[88] that six key areas are common to the e-health strategies of developed countries:

- health administration and support
- electronic health records for sharing patient health data
- e-prescribing
- picture archiving and communications systems
- telehealth
- mobile health.

Software is central to all these applications.

The implementation of large administrative software systems for hospitals was a key priority for Australian healthcare in the 1990s. Stand-alone software solutions with a mosaic of additional specialised supplementary software are now being superseded by sets of software solutions that are interoperable, at least within institutions.[89] From 2000 onwards, the focus shifted to meeting clinical needs, healthcare delivery and more patient-centric processes as healthcare moved towards electronic record-keeping and patient-management systems.

With major software systems now in place in the healthcare institutions, the work of their internal information systems groups mainly involves the ongoing management of information systems and supervision of new (outsourced) implementations. Relatively little internal developmental work is done within hospitals—a situation reflected in the 2006 census data, which showed that IT managers outnumbered software engineers by about eight to one in the healthcare institutions. In contrast, IT managers and software engineers were in similar numbers in the manufacturers component of the healthcare system. This pattern is consistent with these firms engaging in a considerable amount of internal software development, possibly supplemented by some external services for the production of new medical and surgical devices.

Benefits predicted from the replacement of paper-based systems with computerised systems in hospitals and other health organisations have included efficiency gains, cost reductions and higher quality. A meta-analysis of various assessments of IT implementations in United States hospitals found three major benefits for quality: greater adherence to guideline-based care, better surveillance and monitoring, and fewer medication errors. Preventive health was the major domain for improvement, and decreased utilisation of care was the major efficiency gain.[90]

Australia's healthcare system is complex. Service delivery is split among the public, private and not-for-profit sectors, and the system involves a large volume of transactions between hospitals and other healthcare providers. Both patients and providers encounter many discontinuities in treatment across sectoral boundaries (for example, between hospital and community care) and between regions. There are also a need for more effective evaluation of clinical outcomes and a need to integrate new scientific evidence in clinical and management practices. The Australian Government has established several bodies to help coordinate the effort across jurisdictional and provider

88 *The Australian software industry and vertical applications markets: Globally competitive, domestically undervalued (2006), Centre for Innovative Industry Economic Research Consortium.*

89 *ibid.*

90 *B Chaudry, J Wang, S Wu, M Maglione, W Mojica, E Roth, S Morton and P Shekelle (2006), 'Systematic review: Impact of health information technology on quality, efficiency and costs of medical care', Annals of Internal Medicine, 144(10):742.*

boundaries and, in particular, to develop a framework that would encourage interoperability of software systems and applications.

The case study on software produced at the Repatriation General Hospital (South Australia) provided an example of software development work done within the hospital in the context of this environment. The hospital's information systems group developed an integrated hospital information management system. When the hospital experienced some difficulties with methicillin-resistant Staphylococcus aureus (MRSA) infections, the medical administration and the information systems group worked with the clinical services staff to develop a purpose-built local information system called ICE (Infection Control Enterprise). ICE reduced the paperwork, provided accurate performance statistics and pinpointed areas of concern. Following its introduction, the hospital made and sustained an approximate 80% improvement in infection control across the organisation, including a period of several infection-free months. It was a significant achievement internationally[91], and the United States Institute for Healthcare Improvement regards the Repatriation General Hospital as part of a select group of hospitals internationally acclaimed for infection control.[92]

While ICT is facilitating the redesign of the health system, various demographic and health trends will force that change with greater intensity. Australia is in a phase between 2002 and 2012 when the proportion of older people in the population is increasing sharply. Health expenditures typically rise sharply from about age 55, and the healthcare costs of a person over 65 are about triple those of a person in the general population. With more older people in the population, the pattern of disease burden will shift further towards chronic illnesses.

Studies suggest that healthcare services will need to be reinvented, which will require an understanding of complex systems and the science of system design. Software-based technologies are being introduced to facilitate the operation of many elements of the healthcare system in addition to computerised hospital administration. Organisational and technical systems will need to be designed with an understanding of the outcomes of people interacting with technology.[93]

Case studies were used to examine the creative contribution to some key features, in particular:

- assisting patients and medical professionals to find appropriate online information
- educating and skilling medical professionals individually and in teams
- extracting useful information from complex medical diagnostic scan data
- managing chronic conditions from a distance (telediagnosis and telemanagement).

Some of the case studies illustrate the way software is being used in innovation and the modification of 'traditional' health goods and services or the development of new ones. In some of these examples, skills in software development are combined with other expertise, including creative skills. To simplify presentation, some health services that are similar (in particular, the internet-mediated mental health services) and that are underpinned by software are included in this section rather than elsewhere.

91 *http:www.ihi.org/IHI/Topics/PatientSafety/SafetyGeneral/ImprovementStories/FSReducingMRSAInfectionsStayingOneStepAhead.htm (accessed 26 August 2008).*

92 *ibid.*

93 *E Coiera (2004), 'Four rules for the reinvention of health care', British Medical Journal, 328:1197.*

3.3.7 Finding medical information

The internet has become an information resource for many, and both the information on it and its use are expanding rapidly. The 2002 Pew Internet and American Life Project found that 62% of internet users had gone online seeking health information. Other surveys in the United States, Europe and Japan have found that 20–80% of internet users have sought online health information.[94]

This behaviour is potentially both an asset and a liability. It can be an asset if patients obtain information that supplements the in-office education provided by doctors, who are becoming increasingly busy and time-pressured. It can be a liability if patients without the tools to judge the quality of information rely on sources of unknown reliability.[95] Another problem is the sheer volume of information available. Trying to get information from the internet has been likened to 'drinking from a firehose and you don't even know what the source of the water is'.[96]

Extract from Case Study 5: Centre for Health Informatics

Informatics is the study of the structure, behaviour and interactions of natural and artificial systems that store, process and communicate information. The Centre for Health Informatics (CHI), which is Australia's largest academic research group in the emerging field of health informatics, researches the health system to develop new ideas and solutions to inform policy and healthcare practices.

Academic research organisations such as CHI have a significant role in the e-health agenda, as they are uniquely able to focus on research into long-term issues and bring together expertise from multiple disciplines—the types of activities for which neither industry nor government is well positioned.

Researchers at CHI have developed an online search engine to enable GPs to keep up to date in their field and retrieve relevant documents for decision support in a clinical setting.[7] This decision-support software is being commercialised. The HCF Research and Medical Foundation has provided a grant to CHI to develop a new health portal that uses concepts emerging from social networking sites such as Facebook and MySpace along with CHI technology to enable people to do high-precision online searches tailored to their needs as Australians. This will avoid problems such as the large amount of information of mostly American origin with varying relevance to the Australian situation.

The Joanna Briggs Institute was established to provide medical professionals and patients with access to evidence on the best medical practices. The Joanna Briggs Institute Clinical Online Network of Evidence for Care and Therapeutics (jBiConnECT) is a web-based facility that gives health professionals and consumers access to health information and tools to help achieve evidence-based practice in a variety of health settings, including in hospital wards.[97] Initiated by the Royal Adelaide Hospital and the University of Adelaide, the institute has established an international network and disseminates information to some 45 countries.

94 *L Baker, T Wagner, S Inger and M Bundorf (2003), 'Use of internet and e-mail for health care', Information Journal of the American Medical Association, 289:2400–2406; O Hefferman (2002), 'Patient use of the internet and health strategy', Irish Medical Journal, 95:25; J Powell and A Clarke (2002), 'The WWW of the World Wide Web: Who, What and Why?', Journal of Medical Internet Research, 4:e4.*

95 *H Lizska, T Steyer and W Hueston (2006), 'Virtual medical care: How are our patients using online health information?', Journal of Community Care, 31(5):368–378.*

96 *F McLellan (1998), 'Like hunger, like thirst: Patients, journals and the internet', Lancet, SII39–43.*

97 *Joanna Briggs Institute, 2006–07 annual report.*

3.3.8 Education and training of medical professionals

Medical errors occur for many reasons, including poor training, organisational problems and poor teamwork.[98] Procedures that result in undesirable consequences are damaging to the patient, to the reputation of the practitioner and to the hospital, and create a need for additional treatments and extended patient stays.

Preventable medical errors are a source of significant economic and social costs. According to an Australian study, some 14% of hospital admissions in New South Wales and South Australia were associated with a preventable adverse event.[99],[100] The estimated cost in additional hospital stays is more than $800 million annually.[101] However, the total cost is much higher, as the estimate does not take into account subsequent hospital treatments, loss of productivity and long-term costs from disabilities.[102] While the sources of medical errors can be complex, analysis of the adverse events indicated that human technical error was a source in 34.6% of cases, and that better education and training might have helped to prevent many of them.[103]

Medical and surgical training traditionally involves learning on cadavers or animals, with further training on live people, but cadavers are in short supply and people prefer to deal with experienced doctors. Reductions in doctor working hours in hospitals also have the potential to reduce opportunities for surgical training. In the United Kingdom, several reforms (including the implementation of the European Working Time Directive) have reduced opportunities for surgical trainees to hone their skills through experience.[104] In 1999, the Australian Medical Association adopted the Voluntary Code of Practice[105], which provided guidelines on shiftwork and extended working hours to minimise the risk of doctors becoming fatigued from long work hours. There are some indications that hospitals have found that the performance levels of new doctors dropped as a consequence of fewer patient contact hours.[106]

Various innovations using artificial representations of a real world for experiential learning (simulation) have been, or are in the process of being, introduced to provide alternative or additional methods or tools in medical training. Examples of simulators in which software is a key component include simulation training used mainly for teams of medical professionals (Case Study 6) and digital simulator-based education, particularly for trainee doctors.

Doctors are required to learn a substantial body of facts and theories during their medical training. but transferring theoretical knowledge to the diagnosis and treatment of acutely ill patients is a significant hurdle. Apprenticeship-

98 *LT Kohn, JM Corrigan and MS Donaldson (1999), To err is human: Building a safer health system (1999), US Institute of Medicine, National Academy Press, Washington DC; P Bradley and K Postlethwaite (2003), 'Setting up a clinical skills learning facility', Medical Education, 37(1):6–13.*

99 *R McL Wilson et al, Quality in Australian Healthcare Study 1995, Medical Journal of Australia 163(9):458–471.*

100 *WB Runciman, RK Webb, SC Helps, EJ Thomas, EJ Sexton, DM Studdert and TA Brennan (2000), 'A comparison of iatrogenic injury studies in Australia and America: Reviewer behaviour and quality of care', International Journal for Quality in Health Care, 12(5):379–388*

101 *The final report of the Taskforce on Quality in Australian Health Care, Appendix 7, Australian Government Publishing Service, Canberra, June 1996*

102 *R McL Wilson, BT Harrison, RW Gibberd and JD Hamilton (1999), 'An analysis of the causes of adverse events from the Quality in Australian Health Care Study', Medical Journal of Australia, 170:411–415.*

103 *ibid.*

104 *I Varley, J Keir and P Fagg (2006), 'Changes in caseload and potential impact on surgical training: A retrospective view of one's hospital experience', BMC Medical Education, http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1379640 (accessed 18 March 2008).*

105 *National Code of Practice: Hours of work, shiftwork and rostering for hospital doctors http://www.ama-act.com.au/files/National%20Code%20of%20Practice1.pdf*

106 *P Carver, The impact of the restriction of the hours of work of doctors in training and service delivery and education, http://www.health.nsw.gov.au/amwac/amwac/pdf/Aus_doctors_in_training_Carver.pdf (accessed 18 March 2008).*

style training of hospital interns and registrars (the 'see one, do one, teach one' approach), in which that transfer is supposed to occur, has implications for patient safety and is no longer considered appropriate in isolation.[107]

The uncertain and pressured environments of emergency departments and intensive care units are particularly challenging for doctors learning clinical reasoning and medical intervention skills and provide little opportunity for constructive performance feedback.[108]

Simulation has long been used in the aviation industry, where it was initially used to teach motor skills and then, from around 1970, to teach crisis management, teamwork and leadership. Anaesthetics, cardiology, critical care and surgery led the introduction of scenario-based simulation training as an adjunct to medical education, including in Australia, where this form of training was first used about 10 years ago.

Scenario simulation training has several advantages, including:

- no injury to real patients
- the potential to simulate several scenarios to teach the best techniques
- objective assessment of trainees' skills
- reduced cost and greater speed in training.[109]

In addition to clinical skills, simulation training can teach aspects of medical care as practised, including communication, teamwork, stress management, decision making and the ability to prioritise tasks under pressure.[110]

Simulation rooms typically contain the sorts of equipment used in hospital departments. However, the development of computerised manikins that model human anatomy and physiology and can be used in a variety of simulated settings has been particularly useful for simulating disease and trauma and patient responses to medical interventions. There are now many service providers of simulation training to develop new skills in healthcare and to ensure that the skills of medical practitioners are kept up to date. In particular, clinical skill centres that can provide a variety of clinical simulations are increasingly being used in Australia[111], indicating a professional recognition of the effectiveness of this type of training.

107 *See, for example, To err is human (1999), US Institute of Medicine; P Bradley and K Postlethwaite (2003), 'Setting up a clinical skills learning facility', Medical Education, 37(1):6–13.*

108 *V Ypinazar and S Margolis (2006), 'Clinical simulators: Applications and implications for rural medical education', Rural and Remote Health, 6:527.*

109 *From http://www.flindersmeditech.com/simulation/sim_importance.php# (accessed 27 February 2008).*

110 *B Flannagan, D Nestel and M Joseph (2004), 'Making patient safety the focus: Crisis resource management in the undergraduate curriculum', Medical Education, 38:56–66.*

111 *V Ypinazar and S Margolis (2006), 'Clinical simulators: Applications and implications for rural medical education', Rural and Remote Health, 6:527.*

Extract from Case Study 6: The Virtual Hospital at the Clinical Training and Education Centre

The Clinical Training and Education Centre (CTEC) at the University of Western Australia is Australia's flagship medical and surgical skills training centre. Scenario-based education for a wide range of medical skills development is offered at the centre, for groups ranging from medical trainees to entire hospital department teams. CTEC estimates that it has trained more than 20,000 medical professionals from Australia and from some neighbouring countries.

The Centre for Anaesthesia Skills and Medical Simulation (CASMS) at CTEC had its genesis in 1997 in an anaesthesia simulator (a computerised manikin), some disused operating equipment and space in a nursing school building. In 2000, the centre's architect-designed and purpose-built facility was opened, with three independent simulation suites, a surgical workshop and a lecture room.

Each suite in the facility comprises a simulation room, an adjoining control room where course leaders control events, and an adjacent 'debriefing' room. The simulation rooms can be equipped and presented as an operating theatre, emergency department resuscitation area, recovery room, medical practitioner's office or other area. Real hospital equipment is used, as well as an anaesthesia simulator that is preprogrammed to represent a patient, male or female, 14–80 years of age, presenting with symptoms specified by the instructors and responding according to the drugs and treatments it is given. Miscellaneous equipment, such as a fog machine to simulate a hospital fire or chemical dispersion, is also available to enhance the reality of the scenario.[8]

While the manikin and equipment are purchased items, the innovative audiovisual arrangements that videotape the scenarios for playback were developed for CTEC. Each simulation room has two zoom cameras, a scan converter (for the machines monitoring vital signs) and digital videotape machines. The outputs from the cameras and scan converter are interconnected to an event-logging control system with which the operator can note particular events on all the records simultaneously via a touch-screen as the scenario unfolds. In the feedback sessions, the videotapes can be recalled to the same point with a single control for discussion and learning. All the audiovisual systems are connected to a videoconference system so that the training activities within the centre can be transmitted to multiple or distant locations. The software controlling this system was developed by a Perth company.

The originators of the facility were medical professionals, and the trainers now at the centre have both medical and educational qualifications (or equivalent skills recognition). The initial points of the scenarios, including the health status of the manikin, are scripted to provide the learning challenge. A member of the centre's staff acts directly in the scenario to feed information to the group. The scenarios are designed to teach skills and medical knowledge to novice medical professionals and to teach whole teams of professionals with a variety of levels and types of skills, particularly behavioural skills, to work together in a crisis.

It is difficult to measure the impact on behaviours, particularly in team training for emergencies when there are many variables. However, the size and increasing demand for CTEC's services demonstrates professional recognition of its usefulness. Some of CTEC's work is for the upskilling of doctors coming from overseas who are seeking registration by the AMA Board.

Medical education using digital virtual reality is a relatively recent introduction. The Australian company Medic Vision is one of a handful of companies in the world that provide medical virtual reality training solutions. Although this form of training has not received accreditation from the major medical professional organisations, several internationally recognised hospitals have bought Medic Vision's products for use in medical training and for pre-operative honing of surgical skills.[112] Thus it may be in the process of being adopted as a partial alternative for the traditional medical training mechanisms.

While Medic Vision on-sells simulators, it also produces two:

- The epidural injection simulator was produced by the company's team of software engineers, CAD, graphic and product designers, 3D modellers and curriculum consultants (that is, mostly creatives)
- The surgical drilling simulator was initiated in the Australian research sector, and the company's innovation team further developed and modified it to make it suitable for the market.

112 *See www.medicvision.com.au (accessed 23 November 2007).*

A meta-analysis of studies on training for surgical procedures on virtual reality simulators found that the simulators reduced the time taken to complete training and could distinguish between experienced and novice trainees.[113]

3.3.9 Extracting useful information from complex scan data

Modern imaging techniques such as CT (X-ray computed tomography) and MRI (magnetic resonance imaging) have been used to create pictures of parts of the living human body and have substantially enhanced the ability of medical professionals and researchers to evaluate and measure anatomical and pathological structures. A particular benefit is that this has enabled diagnosis at earlier stages in the progression of diseases such as cancer, leading to better survival rates.[114]

The human nervous system is the most complex organ known, and the use of imaging techniques on the human brain has meant that clinicians and researchers have needed to deal with very large and complex sets of data. Disorders of the brain and mind, such as depression, stroke, Parkinsons disease, epilepsy, dementia and schizophrenia, pose the largest health, economic and social burdens to Australia of any disease group.[115] Estimates indicate that the cost of treatment and rehabilitation is about 5% of the healthcare budget in Australia, and higher still in countries such as Canada, the United Kingdom and New Zealand[116], which have health systems with some similar characteristics to Australia's.

Case Study 7, which describes some of the research at the Howard Florey Institute, illustrates some of the diverse ways creative activities contribute to sophisticated technology development and medical diagnosis. The research is directed at finding early markers for some brain diseases to enable earlier medical intervention, with the possibility of halting or slowing disease progression. In this example, software professionals within the organisation and from external service providers developed tools that enabled the efficient collection and analysis of brain scans. Some medical professionals also undertook software creative activities.

113 *S Haque and S Srinivasan (2006), 'A meta-analysis of the training effectiveness of virtual reality surgical simulators', Information Technology in Biomedicine IEEE, 10:51–58*

114 *F Vidal, Bello F, Brodie, K, John N, Gould D, Phillips R and Avis N (2006), 'Principles and applications of computer graphics in medicine', Computer Graphics Forum, 25:113.*

115 *Brain and mind report: Impact of the neurosciences (2003), report to the Prime Minister's Science, Engineering and Innovation Council.*

116 *G Andrews and C Mathers (2003), The burden of disease. www.crufad.org/research/burden.htm (accessed 26 August 2008).*

Extract from Case Study 7: Neuroimaging at the Howard Florey Institute

The Howard Florey Institute (HFI) focuses on fundamental neuroscience to develop new strategies to understand and treat neurological and psychiatric disorders.[9] The neuroimaging and neuroinformatics group, led by Professor Gary Egan, uses fMRI (functional magnetic resonance imaging) and PET (positron emission tomography) techniques to investigate neurological disorders and normal brain function by observing how the living brain works at a very fine level of detail. Neuroimaging involves very large amounts of image data, so part of the research requires the development and use of appropriate software tools to manage and analyse the data and produce images that explain what is happening in the brain.

Imaging data from the scanners in the nearby Royal Children's Hospital and the Royal Melbourne Hospital are automatically collected and delivered to the HFI's main imaging supercomputing facilities. Users at desktops can set up queries so that the data are processed through imaging analysis software routines. This arrangement uses three sources of software tools—a data collection and management tool (developed by HFI and other Melbourne research institutes), a tool set (developed by a commercial software provider in Melbourne) and a range of subroutines for specific applications (both standard and built by researchers at HFI).

HFI researchers use standard routines to examine neural activity in image data from prespecified areas of the brain to determine whether those areas are responding to stimuli. However, exploratory visualisation of the datasets from larger regions (such as the cortex, hippocampus etc) or the whole brain can provide insight into underlying neural activity, identify very early pathological changes and facilitate improved data modelling and experimental design.[10] This requires more sophisticated tools to detect signal from noise in the very large dataset. Researchers at HFI developed a new tool, Response Exploration (REX), that manipulates data in real time from the images from thousands of small volumes of the brain and identifies where changes are occurring in response to an external stimulus or activity.[11]

However, even simple tasks (such as touching a thumb with various fingers in a set sequence) involve several changes in the brain—some areas are being stimulated at the same time as others are being inhibited—and the neural activities occur in different areas over the progress of the movement, reflecting the areas responsible for the movement, attention and other factors. The pattern of neural activity can also change subtly as the activity is learned through repetition over several weeks.

The researchers faced the difficulty of trying to illustrate and explain the multiple dynamic changes. A graphic artist took the imaging data results and produced a stylised body with cutaway sections of the brain showing the areas stimulated as the movement progressed. The result is essentially a film animation in which the stylised body does the tasks the individual is doing in the scanner, with the brain activity shown on the brain slices.[12]

Another HFI project is trying to find biomarkers of multiple sclerosis (MS)—the structures in the brain and the central nervous system that show the first and earliest signs of change or deterioration giving rise to symptoms. In the early stages in the progression of the disease, the optic nerve is often damaged, and a loss of visual acuity is one of the first things people notice. HFI researchers have used the technology they had developed to identify lesions characteristic of MS in the white matter pathways of the optic nerve. This marker is not always present in all patients and they are continuing to look for a consistent early biomarker for MS, as it would be useful for testing new experimental therapies for early intervention.

HFI researchers are also using neuroimaging and associated technologies to investigate early markers for Huntingtons disease, why the elderly drink less water and so are more susceptible to heat stress, the relationship between hunger perception and obesity, brain development patterns in premature babies and the diminished perception of pain in Alzheimers sufferers.[13]

As researchers seek to explore larger sections of the brain and to identify pathological changes at earlier stages and their effects on the brain's function, the collection and manipulation of data and the ability to represent the data in a comprehensible way pose increasing challenges. Researchers at the Howard Florey Institute used graphics as an explanation and illustration tool (Case Study 7). In another case study, of True Life Anatomy, software and particularly graphics were used in a tool developed to use scan data to construct an accurate 3D representation of bones in the hand and the foot and their movement in space. This tool is used for planning orthopaedic surgery and to explain the planned intervention to the patient.[117] Both examples illustrate the need to deal with complex information through visualising it, and the contribution from creative activities to achieve that goal.

117 *www.truelifeanatomy.com (accessed 26 August 2008)*

3.3.10 Telemedicine

With higher pressures on the health system, new models of care are being developed to deal with chronic diseases, which account for some 80% of the disease burden. They include multidisciplinary teams of health professionals, patient self-management of conditions (supported by medical professionals), more emphasis on home-based and ambulatory care using care plans, calls and reminders, and remote monitoring of the patient's condition. Telemedicine or telehealth (medical practice across distance using telecommunications and other information-sharing technologies) has been swept up into a newer and broader form of distance healthcare—internet-mediated access to health services markets, products and capabilities.[118]

The application of telemedicine usually involves several innovations, from technology developments and the introduction of additional infrastructure to changes in the interactions between medical professionals and in their modes of service delivery. Case Study 8 describes the development of a cluster of innovations that made it easier to provide medical services that monitor various eye conditions.

Almost half a million Australians are registered as visually impaired, and Australia spends some $650 million per year supporting people who are legally blind.[119] Cataracts, glaucoma and trachoma are the leading causes of blindness, and jointly account for about 70% of all blindness.

If glaucoma remains untreated, it leads to permanent loss of vision due to high pressures in the eye progressively damaging the optic-nerve axons. Glaucoma is the second most common cause of blindness in the western world, accounting for 12.5% of the registrations for blindness, and the incidence of glaucoma rises sharply with age. An estimated 0.4% to 1.6% of Australians over 40 years old have glaucoma-impaired vision.[120]

Another cause of blindness is diabetic retinopathy, a complication of diabetes in which blood vessels normally nourishing the retina are damaged. Over 800,000 Australians have diabetes[121], and diabetic retinopathy is the most common cause of blindness in working-age adults in Australia and in the Indigenous population regardless of age. Early detection through regular eye examinations can prevent blindness in almost all people with diabetic retinopathy.[122]

118 *J Tan, W Cheng and W Rogers (2002), 'From telemedicine to e-Health: Uncovering new frontiers of biomedical research, clinical applications and public health services delivery', Journal of Computer Information Systems, 42(5):7–18.*
119 *Lions Eye Institute 2003 annual report.*
120 *Cooper RL (1990), 'Blind registrations in Western Australia', Australian and New Zealand Journal of Ophthalmology, 18:421–426.*
121 *http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Diabetic_retinopathy?OpenDocument (accessed 26 February 2008).*
122 *http://www.lei.org.au/go/community-service/eye-screenings/diabetic-retinopathy (accessed 26 February 2008).*

Extract from Case Study 8: e-Medicine at the Lions Eye Institute, University of Western

The Centre of Excellence in e-Medicine is located at the Lions Eye Institute (LEI) in Perth. The centre undertakes R&D, education and training, and clinical services with the objective of using technology to improve medical care and the delivery of medical services. Its areas of focus are diagnosis, direct clinical treatment, prevention, consultative and follow-up services, remote monitoring, rehabilitation services and patient education.

Researchers at the centre have developed digital imaging devices and several software programs to aid in high-input screening and in the diagnosis of debilitating eye diseases. Professor Yogesan, a medical informatics specialist, is director of the centre and has a joint appointment at the University of Western Australia. He is involved in all of the projects discussed here, many of which build on accumulated knowledge and expertise at the Centre of Excellence in e-Medicine at LEI.

Professor Yogesan developed a computer-aided diagnostic test for glaucoma.[14] It is an improved tool based on software that allows ophthalmologists to view the optic disc in 3D and to compare the image with stored earlier images from the same patient and thus follow the glaucoma progression. A Sydney company sells the product under licence from LEI.

Ophthalmologists in eye clinics typically use expensive, bulky and complex devices to examine eyes. Recent advances have reduced some of this complexity, but require expensive staff to operate the instruments. Professor Yogesan and his team tackled the need for a more cost-effective methodology for examining and screening eyes by combining the lens and digital technology into a single low-cost device that can examine both the front and the back of the eye using innovative optical design, software and new light sources. The skills of software developers and optical and electronic engineers were used for developing the device.

The device can help with the diagnosis of many eye diseases, including cataracts.[15] Now licensed to a company, it has the potential to replace the direct ophthalmoscope used by GPs for more than a hundred years. The device is much simpler to use, and healthcare workers who are not ophthalmologists require only a few minutes training to be able to deliver accurate results. It is also suitable for use in remote locations. The cost of the new device is expected to be less than one-tenth of the cost of other devices in the market (which cost more than $50,000).

Ophthalmologists visit rural areas of Western Australia on a few occasions each year, so when patients need emergency eye care as result of accidents or disease they are usually flown to Perth. Researchers at the e-Medicine Centre of Excellence developed web-based telemedicine software to support a tele-ophthalmology service for remote locations. The software includes a web-based multimedia information management system that enables several users to securely input and exchange patient data, including images, video and audio. Nurses obtain patients' eye images, which are then transferred over the internet to ophthalmologists at LEI for assessment and feedback.

Trials of the tele-ophthalmology service at Carnarvon Regional Hospital indicated its usefulness for dealing with primary, secondary and follow-up care, as well as for emergencies. Among the benefits identified were reduced emergency evacuations to Perth, the acquisition of skills for emergency treatment at rural hospitals, and significant cost reductions.[16],[17] LEI now provides the service on an ongoing basis.

LEI has received funding from the Australian and Western Australian governments for applying the system in metropolitan areas in a tele-ophthalmology service that links public hospitals and primary care providers. LEI undertakes a preliminary screening that identifies those who can be safely sent to their primary care providers and those with acute or rapidly progressing disease (such as diabetic retinopathy) who need to be moved up the queue for rapid treatment to avoid further damage to their sight. The key benefit is the reduction in the queue of people waiting to see ophthalmologists. Data are being collected to assess the impact of the service on healthcare costs. Other software, which can identify a range of abnormalities from colour blindness to serious diseases, has been developed. Teachers in schools can operate it on personal computers, and it is objective and avoids the need for a school visit by a specialist. The software appears suitable for mass eye screening, and trials are in place in India and California.

With increased broadband capacity, long-distance surgery supervision was initially explored and then adopted through a link-up between the Nepean Hospital in western Sydney and the Blue Mountains District Hospital in Katoomba. This allowed a specialist intensivist at one hospital to supervise a resuscitation team at a peripheral hospital in a 'virtual critical care unit' (ViCCU). Internet-mediated services also open the possibility of providing education, monitoring and treatment services for chronic conditions, which are a significant burden on the healthcare system and patients, where adequate communications infrastructure is available.

Mental health therapies have, at their core, interaction among individuals. As people spend more time interacting with others online, counselling and various forms of computer networking could become more relevant in this area of healthcare. Several organisations in Australia provide mental health counselling and/or information services online. There is significant need for them. According to the National Mental Health Survey[123], about 5% of the adult population has depression, with the incidence slightly higher in females (6.6%) than males (3.4%). In women, the incidence of depression declines with age from a high point at 18–24 years; in males, it peaks at 35–44 years. About half the people with affective disorders (of which depression is the commonest form) access professional health services, usually a GP.[124] They are likely to have other mental illnesses, to be socially isolated, to lack support and to be unemployed or in part-time employment.

The long-term economic burden of mental illness is significant due to contingent factors, such as premature death and disability, the need to provide treatment and support services, and reduced productivity and loss of income for those with the mental illness and their carers.[125] Each year, depression-associated disability costs the economy $14.9 billion and results in more than 6 million lost working days.[126] In 2001, expenditure on mental health services for depression was $1.1 billion (2.2% of all allocated health expenditure). There is some association between depression and suicide: in 2005, 2,101 suicides occurred at a median age of 41.8 years.[127]

We examined online mental health services in two case studies: depressioNet, which provides mental health services for adults with mild to moderate depression (Case Study 9); and the Inspire Foundation for troubled youth (Case Study 10). It has been difficult to gauge the effectiveness of online depression services because, for ethical reasons, services cannot be withheld.[128] However, research suggests that a working alliance, which is regarded as an essential component of successful therapy, can be established online and that this mode of interaction may be an advantage because it has disinhibitory effects.[129]

The case study on depressioNet focused on the development of the organisation's new website to support the direct delivery of mental health services. This was a new venture for the organisation, which had previously focused on providing information relating to depression and online peer support groups. Although the new website was primarily developed from the organisation's software capability, creative humanist expertise contributed by providing advice on how to make it appealing to the potential client base. Once the website is developed, the amount and spread of creative contributions will be reduced to software maintenance sufficient only to ensure ongoing website service delivery.

A feature of depressioNet's service is its encouragement of patients' culturally creative activities (writing, poetry, illustrations etc) to help them tell their stories. While the process of producing a creative work may benefit the individual, the popularity of this part of the website suggests that the created product has some direct or indirect therapeutic effect on the patient's peers.

123 *Mental health and wellbeing: Profile of adults, Australia 1997, ABS Cat 4326.0, Australian Bureau of Statistics.*
124 *Internet-based services had not been established in Australia at the time of the survey.*
125 *Burden of disease due to mental illness and mental health problems (2007), VicHealth http://www.vichealth.vic.gov.au/assets/contentFiles/Research%20Summ%20BOD_FINAL_Web.pdf (accessed 1 January 2008).*
126 *See, for example, http://beyondblue.org.au*
127 *Suicides 2005, ABS Cat. 3309.0, Australian Bureau of Statistics.*
128 *A Headey, J Pirkis, B Merner, A VandenHeuvel, P Mitchell, J Robinson, J Parham and P Burgess (2006), 'A review of 156 local projects funded under Australia's National Suicide Prevention Strategy: Overview and lessons learned', Australian e-Journal for the Advancement of Mental Health, 5(3):5–15.*
129 *J Cook and C Doyle (2002), 'Working alliance in online therapy as compared to face-to-face therapy: Preliminary results', CyberPsychology & Behavior, 5(2):95–105.*

Extract from Case Study 9: depressioNet

depressioNet, a web-mediated service for people with depression, was initiated in 1999. Its public operational face is its website, which is designed to assist people with mild to moderate depression. The site presents facts on depression (its types, causes, treatments, management and relationship to other illnesses); news clips and research reports on depression; personal stories from people with depression; information about where support is available in the community; and access to online support, including email (to the depressioNet team), chat rooms and a forum. Access to this online support is managed to provide a secure place for clients to share and exchange views and to seek help from their peers, effectively providing virtual networks of mutual support. Clients provide their own stories and some use avatars, poetry or other artistic expression to help them express themselves or explain their feelings. The stories are vetted before being placed on the website. The success stories are reputed to be the most popular part of the website[18], and it is through them that the arts (writing, poetry and visual arts) contribute to the therapeutic aspects of the depressioNet website-mediated service.[19]

A profile of depressioNet users indicates that most found the website through a search engine. About three-quarters of depressioNet's clients are female. Most clients had been formally diagnosed with depression, and their usage of depressioNet is at least monthly and tends to be long term.[20] depressioNet's main forms of marketing are the links to it from various websites, occasional news stories and electronic marketing, particularly through Google. While the organisation does not pay to place ads on the search results page, it tries to ensure visibility by appearing high on the list of search results.

At the end of 2007, depressioNet was reshaping its model to move towards being an interactive, integrated provider of support services online for people with mild to moderate depression. With funding from the Australian Government, depressioNet will start to provide counselling services by professionals and trained peers. depressioNet will expand from its current 10 full-time staff (and myriad volunteers) with the addition of two psychologists and three counsellors to provide online counselling and information in real time through interactive sessions. depressioNet is also considering whether to use a range of additional technologies, including webinars, podcasts and SMS for information delivery and exchange.

Online counselling is considered feasible, as it is claimed that cues in the nuances and language used in client electronic communications are often significant indicators of their mental and other health status. However, a number of liability, duty of care and other issues arise as a consequence of healthcare service delivery, and depressioNet has the additional challenge of being one of the early movers in this area.

depressioNet will also hire three support staff to manage the development of the IT infrastructure. In addition to the potential integration of the additional technologies, the website is being redesigned (by an external service provider in consultation with depressioNet) to match the organisation's transition. It will be fundamentally repositioned so that the PC (or mobile modem) is viewed as the front door to the services the organisation provides, and the structure of the website will reflect the natural flow of human service delivery.

While the new website will continue to offer the previous services, the web presentation will be substantially revamped to make it more attractive and accessible to potential clients. For example, the redesign is taking into consideration the ways different people think (e.g. left brain/right brain dominance); the significance of colour, visual art and music therapy; and the need for resources for people from non-English speaking backgrounds. For inputs on cultural/artistic elements, depressioNet is seeking advice from ad hoc contacts (such as friends who are dancers), as well as in-house expertise (for example, on colour therapy).

The Inspire Foundation also encourages client cultural creative activities, although in its case many of those activities are used to foster community involvement, confidence building, skills development and social engagement among troubled youth. An indication of the size of the problem comes from the National Survey of Mental Health and Wellbeing, which found that around 12% of young Australians aged 12 to 17 experience mental illness annually. Most mental illnesses begin before age 25, and adolescent depression is the most frequently reported mental health problem.[130]

130 *I Hickie, G Groom and T Davenport (2004), Investing in Australia's future, Mental Health Council of Australia.*

Extract from Case Study 10: Inspire Foundation

The Inspire Foundation was launched in 1996 with the objective of using technology, particularly the internet, to improve the mental health of young people. The foundation's website[21] provides a menu of immediately accessible materials and activities in three primarily internet-based programs:

- *Reach Out—an interactive service helping young people get through tough times by providing information and encouraging help-seeking behaviour*
- *Act Now—providing opportunities for young people to take action on community issues*
- *Bean Bag—providing resources and information support services for people in underserved communities.*

The target client base is the 16–25-year age group, although the dominant age group within this range differs among the programs.

The internet has proven to be a particularly powerful medium for engaging young people, including those who have traditionally been hard to reach. Some 85% of Australian 18–24-year-olds use the internet[22] and, while detailed statistics on their use-patterns are limited, it appears that about 17% use it for advice and support. Statistics on usage of Inspire's website indicate that rural youth use the site more than the average (20–25%), while non-English speaking and Indigenous youth (15% and 2% respectively) use it at rates comparable to their representation in the wider population.

Inspire's experience with young people indicates that they do not regard the internet as 'distant', and there is considerable other evidence showing that young people are harnessing ICT to engage with communities.[23] Many of the young people's postings on the Inspire website and forums indicate that they feel barriers to connecting with other people face to face in the real world. However, they can gain a sense that other people share their perceptions and become more relaxed about connecting in physical space as a result of their experiences of personal interactions online. Appropriate information is posted on the website in a youth-oriented context to demystify the role of health professionals, so that young people feel more comfortable about approaching them. Scalability is another key advantage of internet technology over other methods of service delivery in the mental health system. When Reach Out was launched, it cost around $2 per user to access the program; the cost is now a little over 60 cents, despite the much larger (and still growing) user base.

Reach Out comprises a database of fact sheets, information on support services in communities, a chat room for sharing stories and learning about Reach Out, a staff-moderated forum for sharing experiences through digital (multimedia) storytelling and Reach Out Central (see below). Recent additions to Reach Out include a teachers' network and internship program, and the Inspire Foundation plans to add information resources for healthcare and youth community welfare professionals.

Reach Out Central is an online computer gaming environment to teach young people the skills that they need to manage and to get through mental health difficulties. It has adapted some content from a school-based intervention that used cognitive behaviour theory in an educational context. Three people from Inspire worked with a web development company and consulted computer games experts to build a small prototype. After an evaluation and modifications, Reach Out Central was launched in 2007. In essence, the game encourages players to befriend and help computer-controlled characters that inhabit an online world. Players have the opportunity to make choices in an environment reflecting a real-world context of friends, partying, work and life in general.

Data indicate that Reach Out is having an impact. Some 38% of survey respondents indicated that they sought professional after using the website. Most of the Reach Out user group is female (80%), but one of the achievements of Reach Out Central is that it is attractive to young males. Since the launch of Reach Out Central, more than half (56%) of new Reach Out members have been male.

ActNow provides information sheets on community and global issues, suggestions for socially useful things young people can do about the wider issues important to them, profiles of relevant civic organisations, and a variety of interactive mechanisms for sharing stories and information online.

Bean Bag works with 17 youth centres to provide free access to computers and multimedia devices (such as digital still and video cameras) and training for some of the most disadvantaged groups in Australia. The aims are to develop skills in the use of the technology and to improve mental health and connectedness through participation in artistic creativity.

3.3.11 Multimedia applications

As we have noted in our statistical analysis, relatively few people are in specialist multimedia occupations embedded in the healthcare system. The boundaries between software, film, video and digital content are difficult to define, and many of the innovations described in this report have multimedia components (animation, embedded videos, music and text). However, we identified several examples of 'pure' multimedia during our work.

One case study—of a CD-ROM produced for the sex education of female teenagers (Underworld), including information on sexually transmitted diseases—illustrated the way multimedia could be used to produce a funny, slightly irreverent education resource likely to appeal to its primary audience. Other case studies included multimedia innovations that were mainly focused on research and education, such as gait analysis research and clinical tools, and the MARVIN tool for Indigenous health education.

Multimedia has also been used as a therapy. A diversionary therapy technology developed by ACID (the Australasian Cooperative Research Centre for Interaction Design)[131] in partnership with the Brisbane Royal Children's Hospital is used to divert children's attention during painful procedures by involving them in a colourful, 3D augmented-reality experience with a cartoon-like character called 'Hospital Harry'.

131 *http://www.interactiondesign.com.au*

Section 4. Conclusions

After assessing Australian interventions and similar interventions overseas, we conclude that the creative occupations have significant impacts in all the key areas of the healthcare system: the supply, management and use of healthcare information; the supply of medical professionals; the development of medical infrastructure; and the provision of medical goods and services.

However, the healthcare system sources creative expertise in many ways. Embedded and external creative specialists contribute, but many medical professionals undertake creative activities as part of their clinical work. Even patients are encouraged to use creativity in their own treatment and to help in the treatments of others. Creativity is pervasively integrated into the healthcare system and serves most aspects of it, making quantification of its contribution difficult.

Nevertheless, we can draw some conclusions about areas of the system in which creativity makes particularly important contributions: information and knowledge management; the supply of medical skills; clinical services; and infrastructure.

4.1 Information and knowledge management

Developing, obtaining and managing information are critical to the healthcare sector. The main areas in which creative activities contribute to the system include the following:

- Providing health and clinical information—Good writing skills and technical healthcare knowledge are important in Australian medical publishing. High-quality journals contribute to the quality of care by making it more likely that doctors and nurses will keep up with new evidence-based advances in their fields.
- Managing clinical information—With a vast and rapidly expanding body of information available, finding the 'right' information is important for medical professionals as well as for patients and others. Librarians and software developers are making the search more efficient. As the community turns more often to online medical information, the activities of web developers are becoming more important.

The skills of web developers, animators and multimedia professionals are bridging the gap for disengaged individuals and groups, making complex information more understandable and culturally acceptable, and improving health and lifestyle outcomes. This work is relatively new, but the diversity of the Australian population could be a foundation for developing applications that are also useful in other countries.

- Collecting, managing and using patient data, particularly scans—Software is central to the management of the growing body of information collected about patients. As the complexity of this information increases and doctors attempt to map the functions and dysfunctions of the brain or the movement of body parts in 3D, digital functions to aid clinicians' understanding and planning are becoming more visual, using videos, animation and other graphical displays.
- Improving institutional operations—Software for data-mining makes hospitals more efficient, reduces hospital-acquired disease, reduces medication errors, minimises costs and saves lives.

4.2 Supply of medical skills

Ensuring an adequate supply of well-trained medical professionals means training new practitioners and continually upgrading the skills of clinicians. Virtual reality is being used to develop medical skills, reduce mistakes, reduce training costs, help doctors apply their book learning in complex or difficult clinical situations, and work effectively in teams.

We found that a variety of creative skills were behind the development of infrastructure for simulating clinical scenarios, and were in use in regular training programs. Digitally based virtual reality is beginning to be used and may become an important tool with the potential to improve conventional, experience-based learning while reducing teaching costs.

Software and related skills are being used to enable the replacement of highly skilled professionals by people with non-professional skills in some circumstances. The knowledge accumulated from experience by medical specialists is being made available through computerised knowledge bases to help others deal with complex situations. In one example, multimedia and software-based resources are being used to support schoolteachers who are partly substituting for medical professionals to screen people's eyes in remote locations. Digital technologies may have much wider application in this area, potentially alleviating pressures from medical skills shortages.

4.3 Healthcare services

We found that the visual and performing arts, and film, video and digital technologies, are starting to be routinely used to deliver mental health services. Music and the arts are integrated into humanist-based therapies and appear to improve patients' engagement with others. Such interventions can address some significant psychological and physical mental handicaps, with diverse benefits including faster and more accurate diagnosis and treatments. The visual and performing arts are also routinely used in web-based mental health services to encourage communication and engagement, and in hospital programs for rehabilitation and related activities. The use of computer games may be at the exploratory stage, but we observed their use in diversionary therapy and for experiential learning in mental health therapy.

Film, video, animation and multimedia are enabling diagnosis, treatment planning and the monitoring of treatment outcomes. They are being applied in complex and one-off situations, particularly where the medical professional needs to understand interrelationships between many parts of the body and movement in three dimensions.

However, the most widely projected use of digital technologies is in telemedicine. Despite expectations, the uptake of telemedicine is considered to be disappointingly slow. This may be due to the need for several innovations and the establishment of supporting infrastructure. In the case study example of remote eye diagnostics, we observed the development of several software applications, hardware devices and new arrangements between medical professionals and other service providers.

4.4 Infrastructure and architecture and design

Providing infrastructure requires architectural and design services, and those services require an accumulation of knowledge and experience unique to the health sector. Linkages to stakeholders also underpin the ability of

architectural and design services to make significant contributions to the efficiency and functional quality of healthcare facilities, beyond the basic dictates of standard guidelines developed for such facilities.

Software packages give 3D perspectives and monitor essential design components, but they are not widely used to understand flows of medical professionals, hospital staff, patients and communities. Architect-inspired humanistic and aesthetic design elements can contribute to the function of buildings and to the wellbeing of staff, patients, their families and visitors.

4.5 The visual and performing arts in healthcare

We found the visual and performing arts segment to be the smallest of the creative groups embedded in the healthcare system. However, that group (and people performing its functions) contribute to patients' healing and wellbeing, to some of the skills of medical professionals and to the wellbeing of those working in and visiting healthcare facilities.

The visual and performing arts enable a more holistic approach to medical care than technological approaches. When used directly as therapy, interventions based on the visual and performing arts appear to improve communication (by connecting patients more closely to medical providers and patient support groups, family and friends), to reduce stress and to enhance wellbeing. They offer a chance to deliver better quality of life for the most physically, mentally and socially handicapped.

There is much evidence that participation in humanist activities teaches new medical professionals about better communication with their patients and fosters a better understanding of the body–mind connection. Many Australian universities offer combined medicine and arts degrees, and there is a (limited) focus on the study and practice of the arts in a medical context.[132] Stress among medical professionals appears likely to be high and increasing; while some professionals participate in art and writing, that participation appears to be for personal or artistic reasons, rather than to relieve stress.[133]

Employment in the visual and performing arts occupations in the healthcare sector is not keeping pace with the growth of the sector. Few consistent employment patterns are obvious, with the possible exception of hospitals' reduced paid employment of performing artists and musicians. The reduction may be due to funding problems, to changes in priorities (such as a switch to more emphasis on the production of TV and video), or both.

The visual and performing arts appear to be an underutilised resource in Australian healthcare. Even the use of visual and performing arts therapies (such as music therapy) is largely stagnant.[134] We attribute this to a number of factors. While our project did not set out to examine government programs, we observed that few state or territory governments[135] provide targeted support for the visual and performing arts in healthcare, although some support 'creeps in' under various programs related to community wellbeing.

Some charitable organisations provide healthcare support based on the visual and performing arts. Hospitals and other institutions are under great pressure to reduce costs, and they are making greater use of (largely untrained)

132 *The Australasian Association for Medical Humanities was established in 2004. Sydney University has a postgraduate program in medical humanities, and some of the other universities offer optional undergraduate courses in medical humanities.*
133 *Lisa Colley, masters thesis, University of Technology, Sydney.*
134 *Music therapy is not eligible for a Medicare rebate, and this may be an additional reason for a low level of demand for this service.*
135 *Victoria and South Australia provide some support through community wellbeing programs.*

volunteers or reducing or dispensing with the services of trained professionals. This may be due partly to the lack of a robust evidence base for the effectiveness of Australian interventions based on the visual and performing arts. It seems that those developing arguments to support such interventions must rely heavily on overseas reports of similar programs.

British practitioners have collected an evidence base to bolster their case for continued support, and we note that some Australian measurement projects are underway. There may be some reluctance to do this work because of design difficulties and the additional costs. More evidence may be needed to argue the case that the visual and performing arts add to the effective operation of the Australian healthcare system's institutions and services.

4.6 Digital content

While the importance of software to healthcare is well established, we observed that digital content is being used, and explored for further use, in many diverse parts of the healthcare system and its services. The uses include online publishing of medical journals and lifestyle education materials, and the use of games and entertainment content for diversionary therapies and mental health services. However, digital content is also being used to address some of the most difficult problems in modern healthcare.

For example, graphics and visual displays are used in diagnosis, surgery planning and research, particularly to deal with complexities, multiple changes, multiple interacting components and 3D visualisation. As medical interest turns to dealing with brain functions and changes in the brain with ageing, physical trauma or disease, software capabilities will be particularly important in research and development. However, after analyses and medical procedures have become more standardised, the need for such skills is likely to diminish.

Animation technology is becoming simpler to use, bringing with it the possibility of enabling 'non-creatives' to develop digital cultural content. The example of MARVIN (Case Study 4) shows how animation powerfully increases our ability to engage remote Indigenous and other non-mainstream groups and provide health education to them.

4.7 Supporting change in the healthcare system

There is consensus that the healthcare system needs to change if it is to address the range of demand, supply and contextual challenges that it faces, and to at least maintain the quality of health outcomes and the supply of medical service providers. The innovations identified in this study demonstrate that Australia's creative capability has a central role in helping the system to adapt, to become more efficient while delivering better outcomes and to provide the range of clinical services demanded by the community. The innovative processes identified in the case studies appeared to be particularly effective when creatives worked closely with stakeholders (medical professionals, patients and the community). Many creative skills were used to develop the innovations.

Overall, healthcare creative employment is growing faster than total employment in the system, and the growth is particularly significant in technological areas (film, TV, software). Interestingly, some medical professionals are using the technologies routinely. With some training and technological enhancements, and in the hands of clients, they are also being applied in healthcare. With further technological advances, such uses could expand opportunities for innovation and improvements to the healthcare system.

In contrast, interest in the visual and performing arts in healthcare appears to be waning. However, those arts bring additional possibilities to health services and more holistic approaches to dealing with illness. They also bring different ideas and processes to innovation. This appears to be a weakness that needs to be addressed to optimise the outcomes for Australian healthcare.

Appendix 1: Creative occupation and healthcare industry classifications

Tale A1.1 Creative occupations (ANZSCO)

Code	Description
129611	Media Producer
212111	Architect
222100	Marketing and Advertising Professionals
222113	Marketing Specialist
222117	Advertising Specialist
223113	Systems Designer
223115	Software Designer
223117	Applications and Analyst Programmer
223119	Systems Programmer
229211	Librarian
229915	Archivist
252311	Urban and Regional Planner
253000	Artists and Related Professionals Not further defined
253100	Visual Arts and Crafts Professionals
253111	Painter (Visual Arts)
253115	Potter or Ceramic Artist
253179	Visual Arts and Crafts Professionals Nec (not elsewhere classified)
253211	Photographer
253300	Designers and Illustrators
253311	Fashion Designer
253315	Industrial Designer
253317	Interior Designer
253319	Illustrator
253400	Journalists and Related Professionals Nfd
253411	Editor
253419	Copywriter
253413	Print Journalist
253479	Journalists and Related Professionals Nec
253421	Technical Writer
253511	Author
253513	Book Editor
253617	Film and Video Editor
253619	Stage Manager
253679	Film, Television, Radio and Stage Directors
253711	Music Director
253713	Singer
253715	Instrumental Musician
253811	Actor

Code	Description
253813	Dancer or Choreographer
253879	Actors, Dancers and Related Professionals Nec
253911	Radio Presenter
253913	Television Presenter
254921	Museum or Gallery Curator
312113	Architectural Associate
399711	Library Technician
399913	Museum or Art Gallery Technician
499200	Performing Arts Support Workers
499211	Sound Technician
499213	Camera Operator (Film, Television or Video)
499223	Production Assistant (Film, Television or Radio)
499227	Make Up Artist
499279	Performing Arts Support Workers Nec
599511	Desktop Publishing Operator
619211	Library Assistant

Table A1.2 Health sector (industry ANZSIC 2006)

Code	Description
7421	Health Insurance
8600	Health Services, undefined
8611	Hospitals (except Psychiatric Hospitals)
8612	Psychiatric Hospitals
8613	Nursing Homes
8620	Medical and Dental Services, undefined
8621	General Practice Medical Services
8622	Specialist Medical Services
8623	Dental Services
8630	Other Health Services, undefined
8631	Pathology Services
8632	Optometry and Optical Dispensing
8633	Ambulance Services
8634	Community Health Centres
8635	Physiotherapy Services
8636	Chiropractic Services
8639	Health Services Nec
2832	Medical and Surgical Equipment Manufacturing
2543	Medicinal and Pharmaceutical Product Manufacturing

Appendix 2: Creative employment in the major healthcare segments

Table A2.1 Creative occupations, by sector and total employment in the healthcare system

Healthcare occupation segments	Year: 2001		Year: 2006		Change in employment between 2001 and 2006 (%)
	Number employed	Proportion of total creatives (%)	Number employed		
Publishing, Printing and Writing	550	19.0	685	17.8	24.5
Architecture, Design and Visual Arts	436	15.0	467	12.3	7.1
Film, TV and Radio	30	1.0	180	4.7	500.0
Music and Performing Arts	209	7.2	115	3.0	–45.0
Advertising and Marketing	657	22.7	942	24.7	43.4
Software	1,016	35.1	1,421	37.3	39.9
Total employment in healthcare creative occupations	2,898	100	3,810	100	31.5
Total employment in healthcare (all occupations)	641,501		719,743		12.2

Institutional employment

Institutional employment accounted for 48.8% of total employment in the healthcare system. Almost all the growth (97.8%) in total healthcare employment between 2001 and 2006 was due to increases in institutional employment.

Some 25% of all healthcare creatives were employed in the institutions. Institutional creative employment grew more than twice as fast as the total institutional workforce, driven mainly by the increase in software employment. Most of the decline in total healthcare music and performing arts occupations was due to the reduction in such occupations in the institutional setting. Advertising and marketing occupations made up a smaller proportion of institutional creative employment than in creative healthcare overall, reflecting the overwhelming provision of hospital services by public institutions.[136]

Table A2.2 Creative occupations, by sector and total employment in healthcare institutions

Healthcare occupation segments	Year: 2001		Year: 2006		Change in employment between 2001 and 2006 (%)
	Number employed	Proportion of creatives by sector (%)	Number employed	Proportion of creatives by sector (%)	
Publishing, Printing and Writing	272	34.9	378	30.4	39.0
Architecture, Design and Visual Arts	154	19.8	190	15.3	23.4

136 *An indication of this is provided by data from the Australian Institute of Health and Wellbeing; public hospital recurrent expenditure accounted for 99% of total hospital recurrent expenditure in 2004–05.*

Film, TV and Radio	12	1.5	77	6.2	541.0
Music and Performing Arts	72	9.2	34	2.7	–52.8
Advertising and Marketing	53	6.8	80	6.4	50.9
Software	216	27.7	485	39	124.5
Total creative occupations in healthcare institutions	779	99.9[a]	1,244	100	59.7
Total employed in healthcare institutions (all occupations)	281,530		360,209		27.9

a Not 100% due to rounding.

Manufacturer employment

The medical and surgical equipment manufacturers and the medicinals and pharmaceutical manufacturers group employed about 5.5% of workers in the healthcare system and accounted for some 20% of total creative healthcare employment. Employment in creative occupations is more concentrated in this group (1.5% in 2006). While the total employment (all occupations) in this group was growing more slowly (4.8%) than the whole healthcare system over the 2001 to 2006 period, employment in the creative occupations was growing faster (46.9% increase).

The high concentration of creatives was due to two occupational groups: advertising and marketing, and software. Advertising and marketing employment in manufacturing made up about one-third of total creative employment in the healthcare system. Employment in the architecture, design and visual arts segment was overwhelmingly in design occupations.

Table A2.3 Creative occupations, by sector and total employment in medical and surgical equipment and medicinals and pharmaceuticals manufacturers

Healthcare occupation segments	Year: 2001		Year: 2006		Change in
	Number employed	Proportion of creatives in manu-facturers (%)	Number employed	Proportion of creatives in manu-facturers (%)	
Publishing, Printing and Writing	36	5.9	62	9.6	72.2
Architecture, Design and Visual Arts	81	13.4	24	3.7	70.4
Film, TV and Radio	0	0.	14	2.2	
Music and Performing Arts	13	2.2	4	0.6	69.2
Advertising and Marketing	295	48.8	311	48.1	5.4

Software	180	29.7	232	35.9	28.9
Total creative occupations in healthcare	605	100	647	100	6.9
Total employed in healthcare (all occupations)	22,897		23,211		1.3

Healthcare services employment

Total employment in the healthcare services group was about the same in 2001 and 2006. In contrast, the number of people in creative occupations in the health services group increased over the period, but more slowly than in the institutional or manufacturers groups. In 2006, the services group accounted for 46% of total employment in healthcare and 38% of creative healthcare workers. This group showed a small decline in employment in software occupations but faster growth in advertising and marketing, compared to the other healthcare sectors. Analysis at finer detail revealed that the number of people in software occupations increased for medical services and most health services but was static for health insurance and dental and optical service providers. The largest falls in software employment were among the pathology service providers, community health centres and some health services.

Table A2.4 Creative occupations and total employment in the healthcare services group

Healthcare occupation segments	Year: 2001		Year: 2006		Change in employment between 2001 and 2006 (%)
	Number employed	Proportion of creatives in healthcare services (%)	Number employed	Proportion of creatives in healthcare services (%)	
Publishing, Printing and Writing	242	17.4	245	14.5	1.2
Architecture, Design and Visual Arts	201	14.5	199	11.8	–1.0
Film, TV and Radio	0	0.0	89	5.3	NA
Music and Performing Arts	19	1.4	69	4.1	263.0
Advertising and Marketing	309	22.2	551	32.6	78.3
Software	620	44.6	603	35.7	–2.7
Total creative occupations in healthcare services	1,391	100	1,689	100	21.4
Total employment (all occupations) in healthcare services	337,074		336,323		–0.2

Appendix 3: Data for embedded creative segments

Table A3.1 Number of people in creative occupations in the healthcare sector in 2006—publishing, printing and writing

Healthcare sector group	Librarians and archivists	Editors, authors	Technical writers and journalists	Total
Institutions	345	9	24	378
Manufacturers	16	3	27	46
Healthcare services	93	58	94	245
All healthcare sector groups	454	70	145	669

Table A3.2 Number of people in creative occupations in the healthcare sector in 2006—architecture, design and visual arts

Healthcare sector group	Architects and interior designers	Graphic designers and illustrators	Industrial and other designers and urban planners	Photo-graphers	Visual artists	Total
Institutions	27	61	3	60	39	190
Manufacturers	8	19	37	0	14	78
Healthcare services	19	89	9	24	58	199
All healthcare sector groups	54	169	49	84	111	467

Table A3.3 Number of people in creative occupations in the healthcare sector in 2006—film, radio and TV

Healthcare sector group	Media producer	Director, editor, presenter	Total
Institutions	67	10	77
Manufacturers	13	1	16
Healthcare services	77	5	82
All healthcare sector groups	157	16	175

Table A3.4 Number of people in creative occupations in the healthcare sector in 2006—music and performing arts

Healthcare sector group	Musicians	Performing artists	Total

Institutions	17	23	40
Manufacturers	0	4	4
Healthcare services	26	45	71
All healthcare sector groups	43	72	115

Classification systems for software occupations (and the industry) are problematic because of rapid technological changes and difficulties in distinguishing between functions. The ASCO 1992 system provides relatively little information on the software occupations but, having been used for a longer period of time, it can be used to provide information on employment trends. Table A3.5 provides employment data for all software occupations in the healthcare sector, using the ANZSCO 2006 system of classification (which has a finer categorisation of the occupations). The wider range of software occupations than was used in previous analyses[137] was selected to enhance the information base on the significance of the activities. Of particular note in the table are the relatively large numbers of IT managers, and the small numbers of web designers and developers and multimedia designers and specialists.

Table A3.5 Number of people in creative occupations in the healthcare sector in 2006—software

Healthcare sector group	IT managers	Software engineers	Software analysts, developers and programmers and ICT testers	Web designers, developers and administrators	Multimedia designers and specialists	Total
Institutions	272	32	368	44	7	723
Manufacturers	57	53	106	14	3	233
Healthcare services	182	106	348	65	3	704
All healthcare sector groups	551	191	822	123	13	1,660

137 *P Higgs, S Cunningham and J Pagan (2007), Australia's creative economy—Definitions of the segments and sectors. http://eprints.qut.edu.au/archive/00008242 (accessed 23 January 2008).*

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